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Sectorial systems of sustainability innovation: drivers, stakeholders and practices

Supervisor: Prof.ssa Raffaella Cagliano

Assistant Supervisor: Ing. Annachiara Longoni

Master Graduation Thesis by:

Gionata Girardin 798866

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Abstract

Over the last decades, public opinion, academics and corporations have showed an increasing attention toward sustainability. Companies have increased their commitment to sustainability initiatives and have integrated the sustainability objectives into their core business strategies, showing that sustainability is no longer being questioned as a passing trend. In this context, it is interesting to investigate the relation between sustainability and innovation. This relation brings to analyse both the antecedent factors that orient and motivate the firm's decisions in the development of sustainability initiatives and the enabling role of collaboration with external stakeholders. As recognised, an innovation process is subjected to the influence of technological regime in which it is developed. Therefore, this aspect has brought to analyse the determinants of sustainability innovations and the role of stakeholder collaborations within a technological regime perspective. This research work, starting from the Institutional theory including Resource based view, Stakeholder theory and the technological regime approach, analyse through a Content Analysis the sustainability reports relative to a sample of firms belonging to the automotive and electric and electronic sectors. The innovations identified by the analysis of corporate reports have been classified through a framework able to classify the sustainability innovations in both the environmental and social sphere. This research has highlighted the relevance of stakeholder collaborations in the development of sustainability innovations and partially has confirmed the influence of past performance and strategic approach to sustainability as driver for the sustainability development. Regarding the classification of stakeholders in primary and secondary actors, it has been possible to identify the relevance of suppliers among the primary stakeholders and the significant role of governments, NGOs and knowledge leaders among the secondary ones. Instead, the analysis of drivers and stakeholder collaborations within the technological regime perspective has brought to the conclusion that the differences relative to the technological regime affect the role of drivers and stakeholder collaborations.

Keywords: sustainability innovation, sustainability driver, stakeholder collaboration, past performance

Sommario

Negli ultimi decenni, opinione pubblica, studiosi e aziende hanno mostrato una crescente attenzione verso il concetto di sostenibilità. Le compagnie hanno incrementato il loro impegno nello sviluppo d'iniziative sostenibili integrando gli obiettivi di sostenibilità all'interno della loro strategia di business. Tale comportamento dimostra come la sostenibilità non possa più essere considerata un trend passeggero. In questo contesto, è interessante studiare la relazione tra sostenibilità e innovazione. Tale relazione porta ad analizzare sia i fattori antecedenti, che orientano e motivano le decisioni aziendali relative allo sviluppo delle iniziative di sostenibilità, che il ruolo abilitante della collaborazione con gli stakeholder esterni. Come riconosciuto in letteratura accademica, un processo d'innovazione è soggetto all'influenza dei regimi tecnologici in cui è sviluppato. Pertanto, tale aspetto ha guidato l'analisi driver per lo sviluppo delle innovazioni sostenibili e il ruolo delle collaborazioni con gli stakeholder esterni all'interno della prospettiva dei regimi tecnologici. Questo lavoro di ricerca, partendo dall'Institutional theory e includendo la Resource Based View, la Stakeholder Theory e l'approccio dei regimi tecnologici, analizza attraverso la Content Analysis i report di sostenibilità relativi ad un campione di aziende appartenenti ai settori automotive ed elettrico/elettronico. Le innovazioni identificate all'interno dei report aziendali sono state classificate attraverso un framework in grado di definire le innovazioni sostenibili sia all'interno della sfera sociale che in quella ambientale. Questa ricerca ha evidenziato la rilevanza delle collaborazioni con gli stakeholder nello sviluppo delle innovazioni sostenibili e parzialmente ha confermato l'influenza delle performance passate e dell'approccio strategico della compagnia alla sostenibilità come driver per lo sviluppo sostenibile. Riguardo alla classificazione degli stakeholder in attori primari e secondari, è stato possibile identificare la significatività dei fornitori nello sviluppo delle innovazioni sostenibili tra gli stakeholder primari e il ruolo significativo di governi, NGO e knowledge leader tra quelli secondari. Mentre, l'analisi dei ruoli assunti dai driver per lo sviluppo dell'innovazione sostenibile e delle collaborazioni con gli stakeholder all'interno di una prospettiva di regime tecnologico ha portato alla conclusione che le differenze relative a tali regimi influenzano parzialmente il ruolo dei driver e delle collaborazioni.

Parole chiave: innovazione sostenibile, driver per la sostenibilità, collaborazione con gli stakeholder, prestazioni passate

Executive summary

Context and research objectives

Over the last decades, sustainability has received growing attention from firms and scholars. Pressures from public opinion, regulators, governments, NGOs and financial enterprises have contributed to an unprecedented rise of public attention drawn to the concept of sustainability. The development of sustainability awareness has brought this issue to become a key for business success and progress, leading executives to integrate sustainability objectives into their core business strategies (Boons and Lüdeke-Freund, 2013; Schaltegger et al., 2013). The concept of sustainability mainly derives from the most frequently quoted definition of sustainable development included in the Brundtland Report: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). This definition has led to evaluate the sustainability according to the Triple Bottom Line approach, which incorporates the three main aspects of sustainable development: economic, environmental and social. Therefore, it is possible to affirm that the corporate sustainability is reached through the successful market-oriented realisation and integration of environmental, social and economic challenges (Schaltegger et al., 2013).

In the academic literature and corporate ambit, the concept of sustainability is often associated to the innovation. Several authors argue that the commitment of companies in the development of innovations related to sustainability represents a tool to satisfy new business opportunities and the global challenges. For this reason, companies are faced with the need to understand that today sustainability is equivalent to innovation (Asongu, 2007; Nidumolu et al., 2009). The sustainability innovations have to be able to generate not only economic outcomes but also positive environmental and social effects. The attention relative to the effects generated in terms of sustainability is very high and makes companies subjected to external pressures in particular from institutional stakeholders. These external pressures are directly linked to the performance levels obtained by companies in the sustainability ambit. In this context, it is clear that a negative performance trend in terms of sustainability can influence the firm's decision making process regarding the implementation of sustainable initiatives. Therefore, deficient performances in terms of sustainability can be a factor able to orient the firm's development process of sustainability innovations. The relation between sustainability and innovations has also brought to the introduction of firm's stakeholders as a relevant source of innovative ideas to generate new solutions. The engagement of stakeholders for the development of sustainability innovations cannot only be associated to their contribution in terms of innovativeness. Indeed, a firm in order to be considered actually sustainable has to reach the sustainability internally and through its supply chain partners until to generate positive impacts on customers and communities (Krause et al. 2009). Naturally, the relation between sustainability and the innovation development is affected by numerous factors that can lead companies to follow different innovation paths (Kamien and Schwartz, 1982). Among these factors, numerous authors have

argued starting from the empirical observation that the innovation development varied significantly across technological regimes (Malerba, 2005).

This research work is focused on sustainable innovation at the operations and supply chain level. The research context is linked to the concept of sustainability innovation, which considers the design or modification of a process, product, organization or management practice that includes economic, environmental and social targets (Van Kleef and Roome, 2007). Many authors support the idea that sustainability innovation should be linked to radical changes rather that incremental, in order to conduct to a real sustainable development (Van Kleef and Roome, 2007; Pagell and Wu, 2009; Hall and Vredenburg, 2003).

Given the relevance of the relationship between sustainability and innovation, the research work has focused the attention on different aspects of sustainability innovation. In particular, according to academic literature, some aspects appear to be fundamental: on the one hand drivers and motivations that lead towards sustainability innovation development, on the other hand the role of stakeholder collaboration in the development process. Furthermore, it has been interesting to evaluate these aspects within different technological regimes, in order to verify if the impact generated by a given technological regime on a generic firm's innovation process, as indicated in the academic literature, continues to occur in a more specific ambit as that relative to the corporate sustainability.

The role of sustainability drivers

In the academic literature, several authors sustain the existence of different determinants and predictors of sustainable development. One of the most considered factors is represented by the strategic approach to sustainability. This factor indicates as companies characterized by different approaches to sustainability are oriented to the development of different typologies of sustainability innovations. Therefore, the level of proactivity lead a firm towards the development of specific sustainability innovation typologies. The authors in this research ambit sustain as companies with a more proactive approach to sustainability, considering this issue as an engine for the growth, result to be more committed in the development of sustainability innovations (Taylor et al. 2012; Chen & Chang 2012). In accordance with academics, starting from the Institutional theory, it has been possible to define the firm's strategic approach to sustainability considering both internal and external factors, extending in this way the Institutional Theory view to internal factors (Yarahmadi, 2012; Hartman, 1999). The factors considered in the literature to define the firm's sustainability approach are: compliance, stakeholder pressure, other external pressure (e.g. resource scarcity or competitors' commitment to sustainability), opportunity and competitive advantage, recruiting, voluntariness and top management commitment. In addition to the impact of the strategic approach to the development of sustainability innovations, this research work has also investigated a more innovative factors proposed by Berrone et al. (2013). These authors sustain as the past performances can play a role in sustainability strategies and in the development of sustainable innovation.

Berrone et al. (2013) have argued that strong regulatory and normative institutional pressures make environmental innovation more attractive to firms, especially to those displaying greater deficiency gaps, and the availability and specificity of a firm's resources facilitate the implementation of these risky practices. Therefore, these companies, in accordance with the RBV, tend to improve their sustainability performances through the implementation of innovations able to generate a competitive advantage. On the base of this statement, it is possible to consider past performances in terms of sustainability as a possible factor that can explain firm's choices in terms of sustainability innovation.

Sustainability and stakeholder collaboration

In the sustainability context, the establishment of stakeholder collaboration is identified as instrument to face environmental and social problems with the aim to generate a sustainable development for the involved actors. Various authors retain as the complexity of sustainability issues leads companies to collaborate with a wide range of external stakeholders that can be a source of knowledge and competencies outside the firm's main domain (Arts, 2002; De Bruijnand Tukker, 2002; Hartman and Stafford, 1997; Seuring and Müller, 2008; Srivastava, 2007). The two theoretical approaches that have made interesting contributions to the analysis of the relationship between stakeholder engagement and innovation are the Stakeholder theory and Resource Based View (RBV) of the firm. The stakeholder theory provides a suitable theoretical framework to analyse the relationship between business and society from a sustainable development viewpoint (Wheeler et al., 2003) and suggests that strengthened stakeholder relationships can result in significant competitive advantages in form of trust reputation and innovation (Rodrıguez et al., 2002). In the context of Resource Based View, the ability to engage with external stakeholders in collaborative relationships and to integrate their competencies in the development of sustainable innovations can be considered a firm's capability (Albino et al. 2012; Ayuso et al. 2006; Yarahmadi 2012).

Technological regimes and innovation

The academic literature highlights as the technological regimes can affect the development of innovations. Indeed, various authors recognize that innovation rate, typology of innovations and the determinants of innovative activities greatly differ across sectors. Taking into consideration the evolutionary literature on technological regimes, it is possible to analyse the innovation process on the base of its features and determinants at the industry and firm levels providing a multidimensional, integrated and dynamic view of sectors (Malerba, 2005). The application of technological regime approach for the examination of sustainability innovation process allows obtaining a better understanding of the knowledge bases and of the learning processes that underlie the development of sustainability innovations, bringing new insights on the sources of innovation, determinants and on the directions of the resulting technological trajectories.

Gap and research objectives

The present research work analyses the sustainability innovation under both the environmental and the social point of view unlike the part of academic literature that often neglects the social side of sustainability and sustainability innovation (Kleindorfer et al. 2005; Pagell & Wu 2009).

The present research work aims to investigate both aspects that motivate the decisions of companies in the development of sustainability innovations and the role of stakeholder collaborations in their development. Subsequently, such aspects have been also analysed within a technological regime perspective thanks to the introduction of technological regime approach.

First of all, it has been necessary to investigate the determinant factors for the development of sustainability innovation. The academic literature uses the Institutional theory for analysing the factors that lead firms to take specific strategic decisions, also in the sustainability ambit (Yarahmadi 2012; Hartman 1999). In this context, numerous authors have highlighted the role of different strategic approaches. According to the academic literature the present research work aims to support and extend the theoretical framework of Institutional theory including the concept of strategic attitude. Indeed, this theory is focalized on the external factors that bring a firm to act in a specific way, in this case to develop sustainability innovations. Therefore, the goal in this situation is to include within the analysis in addition to the external factors also the internal ones that affect the firm's decisions about the implementation of sustainability innovations and programs, both in the environmental and social contexts. Furthermore, considering the considerations of some authors, as Berrone et al. (2013), it has been also possible to underline the role of firm's past performance in the development of sustainability innovations. On this basis, it has also been possible to include this variable as possible factor linked to the implementation of different typologies of sustainability innovations.

The second stream of research of this work aims to contribute to the support of the argument for which a collaborative approach between a firm and stakeholders is necessary to face in a profitable and better way the challenge of sustainability. In particular, within this research work, it is relevant the study of relation between different types of sustainability innovation and the various identified stakeholders. As previously seen, the theoretical framework that support this research work in this ambit is composed by the Stakeholder theory and the Resource based view. These two theories are fundamental to place the arguments and concepts analysed in the research, which aim to extend and support these theoretical approaches. In particular, in the analysis of sustainability innovations and stakeholder collaborations, it has been possible to support and extend the knowledge relative to the Resource based view, which sustains that a firm to obtain a relevant competitive advantage has need to exploit specific and not replicable competences and resources. For several authors, the collaborative attitude of a firm identifies a resource of competitive advantage.

In order to improve and enhance the understanding of the relations described above, it is possible to introduce an industrial sector perspective. This introduction derives by the fact that in the academic literature numerous authors have underlined the relevant influence that the structure and the features of an industrial sector have on the development of innovation. This statement can be assessed also in the sustainability ambit (Marsili, 2001; Malerba et al., 1996; Malerba and Orsenigo, 1995; Oltra and Saint Jean,

2009). Through the application of technological regime approach of Marsili (2001), it has been possible to identify the features of the two industrial sectors included in this research work. The comparison of such characteristics, mainly relative to knowledge basis and learning process that underline the development of sustainability innovations may bring new insights on the sources of innovation and on the directions of the resulting technological trajectories. The application of technological regime approach allows obtaining a better understanding of the knowledge bases and of the learning processes putting more attention on the innovation process itself and on its features and determinants at the industry and firm levels.

The research questions to which I would like to answer through this research work are:

Q1: Which are the drivers of sustainable innovations?

> **Q1.1:** Are past performance drivers of sustainable innovations?
> **Q1.2:** Is the company sustainability strategic position driver of sustainable innovations?

Q2: Which stakeholder collaborations impact on sustainable innovations?

Q3: Does the technological regime of the industry impact on the relationship between drivers and sustainable innovations?

> **Q3.1:** Does the technological regime of the industry impact on the relationship between past performance and sustainable innovations?
> **Q3.2:** Does the technological regime of the industry impact on the relationship between the company sustainability strategic position and sustainable innovations?

Q4: Does the technological regime of the industry impact on the relationship between stakeholder collaborations and sustainable innovations?

Research methodology

The research has followed different steps which are shown in the Figure 1.

Figure 1 - Development stages of research work

The research started with an extensive literature review: first of all, it has been investigated the concept of sustainable innovation, then, the analysis moved towards the role of stakeholders in the development of sustainability innovations, broadening the study to all firms' stakeholders. Simultaneously the firms'

approach to sustainability and the relation between the technological approach and innovation were deeply investigated.

At the end of the literature review, it has been possible to develop four research questions which have driven the following phases of the process. The research has been conducted through a *Content Analysis*, which is suggested from many authors in order to analyse sustainability reports (Cowton, 1998, Jose and Lee, 2006). This methodology has been used to analyse sustainability reports of the sample firms. This source of data has been chosen because it is able to provide abundant of information required for the analysis. Moreover, it has been possible to use other typologies of data, institutional websites, balance sheets and the Bloomberg platform in order to collect performance data.
The collected information concerns the sustainability innovations developed by firms in operations and supply chain, collaborations with stakeholders for their development and drivers which characterize firm's strategic approach to sustainability. The data analysis has been performed through quantitative techniques. Moreover, it has been possible to add real examples which allow overcoming analytical problems and giving strength and effectiveness to the results obtained. The performed analysis is focused on two different sectors: electric/electronic sector and automotive sector. These two sectors are characterized by some common aspects as a high impact in terms of sustainability and a high innovation rate. The sample is composed of forty firms, twenty for each sector.

The firms have been chosen through the following criteria:

- Belonging to the automotive or electric and electronic sector
- Commitment in the sustainability innovation development and in the implementation of sustainability initiatives
- Inclusion in almost one of the sustainability indexes, among DJSI and MSCI World Index, which allows to demonstrate the sustainability commitment of the firms
- Release of sustainability corporate reports

These criteria have allowed selecting firms actually engaged in sustainability, which can be considered "best performer" in the selected sectors. The sample, even if limited in size, allows both performing quantitative analysis and supporting the results with real examples drawn from the firms.

The quantitative analysis has been performed through non parametric techniques. In order to analyse the relation between the strategic approach to sustainability and sustainability innovation, it has been applied the test of Kruskal-Wallis. Instead, regarding the relation between past performances and sustainability innovations, it has been used the test of Spearman's rank correlation. The same method has been performed to investigate the last typology of relation between stakeholder collaborations and sustainability innovations. The same statistical method has been performed to analyse the relations within the single different technological regimes in the investigation of the third and fourth research questions.

Results and discussion

Before to report and discuss the results of the research work, it is necessary to briefly describe the framework used for the classifications of sustainability innovations. The considered framework has been proposed by Benaglia and Cola (2013) and allows classifying the sustainability innovations according to three main dimensions, beyond the distinction between environmental and social innovation:

- Degree of innovation: indicates the complexity of the initiatives distinguishing in incremental or radical innovations.
- Object of innovation: distinguishes the innovation on a process or a product. It considers also a third category represented by initiatives which involve the modification of both processes and products in the environmental sphere and by programs which require the redesign of business in the social sphere.
- Area of impact of the innovation: it refers to the area in which the innovation generates its impact. The considered categories identify an internal level and two external levels. Externally the impact can be detected in the context of the traditional supply chain or beyond that, for example in the moment of use. For the social innovation the external dimension corresponds to the actor who is the target of the innovation: employees, supply chain partners, consumers and society as a whole.

The application of the framework has allowed collecting the data relative to the sustainability innovations. These data with those relative to the strategic sustainability approach and past performance of firms have been subsequently used in order to investigate the research questions.

Which are the drivers of sustainable innovations?

Regarding the relation between the past performance and the sustainability innovation development, it has not possible to identify relevant results. The analysis on the overall sample does not confirm the statement of Berrone et al. (2013), who have supposed that companies with deficiency performance gap in terms of sustainability are more attracted to the development of specific innovation typologies. On the contrary, the relation between the strategic approach to sustainability and the sustainability innovations development has shown interesting results. The identified values are partially in accordance with the academic literature. Indeed, proactive firms, moved by drivers like voluntariness and the search of competitive advantage, seem to be oriented towards innovation able to generate extended impact through radical and incremental modifications of products (Hellström 2007; Tseng et al. 2013; Hansen, Grosse-Dunker, Reichwald 2009; Klassen & Vachon 2006; Hart 1995; Hart 1997; Vachon & Klassen 2008). At the same time, it is also relevant for the more proactive company the development of internal innovations able to generate an incremental modification on firm's processes.

Which stakeholder collaborations impact on sustainable innovations?

The second research question has investigated the relation between the sustainability innovations and the stakeholder collaborations. The analysis has brought to these conclusions:

- As underlined by various authors, it has been possible to recognise the existence of a strong relation between the collaboration established with external stakeholders and the development of sustainability innovations (Albino et al. 2012; Klassen & Vachon 2008; Vachon & Klassen 2006; Yarahmadi 2012; Ayuso et al. 2006; Nieto & Santamaria 2007; De Marchi 2012; Pagell & Wu 2009; Holmes & Smart 2009).
- In the academic literature, it has been hypothesized as different stakeholders, described as bearers of specific resources and competences, are linked to different typologies of innovations (Yarahmadi 2012; Albino et al. 2012; De Marchi 2012; Ayuso et al. 2006; Holmes & Smart 2009). As said, at the base of this research work there is the Stakeholder theory, which proposes a fundamental distinction among the primary and secondary stakeholders (Ayuso et al. 2006). Starting from this consideration, the results partially confirm the statements of the academic literature even if it has not been possible to identify a strong difference between the two typologies of stakeholders. Indeed, the secondary stakeholders mainly show an orientation to develop radical innovations able to generate an extended impact beyond the firm's boundaries.
- Analysing more in detail the secondary stakeholders, it is possible to make some considerations on the single actors. In this context, the actors more relevant are governments, NGOs, other companies and knowledge leaders. Starting from the NGOs, it is possible to highlight their different role within the sustainability components. Indeed, this typology of stakeholder results not relevant in the environmental field but on the contrary in the social field its correlation values show a strong contribution in the development of sustainability innovations. This result is confirmed in the academic literature, where various authors have highlighted the growing importance of NGOs in the social commitment of private corporations (Weisbrod, 1997; Young, 1999). On the contrary of the NGOs, the knowledge leaders are relevant in the environmental field but not in the social one. Also for these actors it is possible to highlight their role in the development of radical and complex innovations able to generate positive impact beyond the traditional supply chain of a company. Another important secondary stakeholder is represented by the other companies. These actors, as the two previously analysed, are seen in the academic literature as a source of unique and inimitable resources and capabilities. In particular, for the other companies the results, in accordance with the statements of various authors, show an inclination in the social field to the development of radical innovations relative to the implementation of new business able to generate positive impacts on customers and communities (Ammenberg and Hjelm, 2003) From the results also the governments represent a relevant stakeholder. In accordance with the academic literature also this actor show to provide an

important contribution to the development of radical and complex innovation in the social field (Milliman and Grosskopf, 2004).

- Regarding the primary stakeholders, it is possible to note the fundamental role assumed by suppliers in the development of sustainability innovations while customers don't show any relevance in this ambit. In particular, the suppliers show a wide involvement in the development of environmental innovation. In this ambit, the collaboration with this actor is relevant for the development of any typologies of innovations. Instead, in the social field the suppliers are mainly relevant for the development of internal incremental innovations linked to processes. This important role assumed by suppliers has been recognized by different authors, who sustain as the privileged position occupied by this actor about processes and products of the company makes them owners of complementary skills and resources that allow them to be involved in a wide range of sustainable innovations (Albino et al., 2012; Yarahmadi, 2012; Ayuso et al., 2006; Nieto and Santamaria, 2007; Vachon and Klassen, 2008; Vachon and Klassen, 2006).
- Lastly, it is interesting to highlight the strong relation between the establishment of multi stakeholder collaborations and the development of sustainability innovations. In accordance with the academic literature the establishment of multi stakeholder collaborations are considered positive and significant in both the environmental and social components for the development of radical and complex sustainability innovations (Klassen and Vachon, 2008; Vachon and Klassen, 2006). In particular, this role is evident in the social field where the establishment of collaboration with more than one typologies of stakeholder results relevant only for the development of radical initiatives able to generate an extended impact beyond the traditional supply chain (Elbers, 2004; Utting, 2002).

Does the technological regime of the industry impact on the relationship between drivers and sustainable innovations?

The two considered drivers for the development of sustainability innovations assume opposite roles within the two technological regimes. Indeed, the complex system regime seems to be more influenced in the decisions about the development of sustainability innovations by the strategic approach to sustainability. On the contrary, in the science-based regime the most influence on the development of sustainability innovations is generated by the past sustainability performance in particular in the environmental ambit. This difference can be partially explained through the features of the two technological regimes in terms of technology, knowledge and learning process. As indicated by Marsili (2001) the complex system regime is characterized by high complex knowledge bases that require the presence of different competences and skills. Instead, the science based regime is characterized by high industry specificity. Such considerations can bring to think that more complex knowledge bases and a more complex technology lead the companies to link their decisions to the strategic approach rather than to the pressure linked to the past performances.

Does the technological regime of the industry impact on the relationship between stakeholder collaborations impact on sustainable innovations?

This investigation has bring to identify some different innovation behaviours within the two technological regimes not in the typologies of sustainability innovations developed but mostly in the typology of stakeholder involved in the establishment of collaborations. Observing the results, it is possible to note as the stakeholder collaborations in general have a strong influence on the sustainability innovation development in both the technological regimes considered in this research work. The more interesting contributions coming from the analysis of the correlation values relative to the single actors included in the two technological regimes.

- In accordance with the technological regime classification of Marsili (2013), it is possible to verify a greater involvement of different typologies of external stakeholders in the complex system regime than the science-based regime. The relevance of the involvement of five different typologies of stakeholders in the complex regimes versus the only two significant typologies engaged in the science-based regime confirms the statements of Marsili. The author has associated this greater and diversified involvement to the need to obtain different competences and skills within a technological regime characterized by complex knowledge bases and technology.
- In the academic literature, various authors have highlighted the fundamental role assumed by the knowledge leaders, which are mainly able to provide high benefits in the complex system regime (Malerba, 2005; Marsili, 2001, 2002). This aspect is confirmed by the results, which show as the involvement of knowledge leaders in the development of sustainability innovations is significant in the overall sustainability and in both the environmental and social components.
- Another aspect that highlights the influence of the technological regimes in the relation between the stakeholder collaborations and the sustainability innovations is relative to the development of multi stakeholder collaborations. This result shows as within the complex system regime, characterized by a complex knowledge and by a need of different competences and skills, companies tend to establish multi stakeholder collaborations in order to manage this complexity also within the innovation process (Blomqvist et al., 2004; Caloghirou et al., 2004; Chang, 2003; Macpherson et al., 2004).

Research contributions and limitations

The present work extends the research field of the considered theories and gives some interesting implications for firms and managers.

- The present research work highlights the fundamental role of stakeholder collaboration in the development of different typologies of sustainability innovations. In this sense, this research work allows not only the validation of the set of stakeholders proposed by some authors in the academic literature (Albino et al. 2012; Yarahmadi 2012; Ayuso et al. 2006; Holmes & Smart 2009)

but also indicates which can be the roles of different actors in the development of specific typologies of programs and innovations. This aspect enriches the academic literature in the sustainability ambit proposing a further step in the study of relations between firms and stakeholders, not restricting the analysis to a general consideration.

- Furthermore, this research work has investigated the possible drivers to sustainability within the context of technological regimes. Such analysis has allowed observing in accordance with the academic literature relative to this ambit as the determinants of a specific innovation path vary on the base of the features relative to technological regimes (Malerba, 2005; Marsili, 2001, 2002; González-Benito and González-Benito, 2006, 2010). Therefore, it has been possible to note as the features of a technological regime affect the role of innovation determinants not only in a general innovation ambit but also in the specific sustainability ambit.
- In particular, it has been possible to identify as the stakeholder collaborations vary on the base of features relative to the knowledge bases and to the learning process. Therefore, the orientation of firms towards the establishment of specific typologies of innovations change on the base of the considered technological regime.
- From a managerial point of view, the present research work not only helps to understand the role of collaboration but indicates the need and the potential to identify stakeholders with competences and appropriate resources in order to support specific typologies of sustainability innovations. Based on the firm's strategic needs and on the typology of impact that a company wants to generate in terms of sustainability, the firms and executives can develop links and collaborations with different typologies of stakeholders.

The research work has some limitations that it is necessary to make explicit.

- First of all, some limits are related to the quantitative analysis of the results. As described during the previous chapters the analysed sample is not very large and this may lead to results not particularly strong from a statistical point of view.
- The inclusion of firms belonging to two technological regimes can reduce the comparability of data. Similarly, the creation of a sample through the selection of best performer companies can shed light on characteristics and dynamics that are not necessarily common to the companies of the whole sector.
- Another limitation is related to the calculation of the sustainability performance of companies. In particular for the companies is even more difficult to define standard indicators able to evaluate the performances in the sustainability ambit. This difficulty is even more evident on the social dimension of sustainability where the development both in the corporate and academic ambit is in the initial phases.
- Regarding the technological regime approach, the main limitations are relative to the technological regime classification of Marsili. Indeed, it is necessary to analyse in a deeper way the

features defined by Marsili for the inclusion of industrial sectors in the different technological regimes. Such updating can take into consideration also new evaluation dimensions as the market demand and the external stakeholder perception of a specific sector.

Regarding the opportunities of future development for the research in this ambit, in my opinion the main opportunity to development is linked to the introduction of companies that are not included among the best performers of their sector. In this direction, it will be possible to address the attention towards different realities in terms of dimension, localization in order to study a different approach to collaboration with different typologies of stakeholders of firms very different. In addition, it will also be interesting to expand the sample in quantitative and qualitative terms, increasing the number of companies and the number of industrial sectors/technological regimes. The aspect relative to the introduction of technological regimes allows identifying many possible opportunities of development. Indeed, as shown by the academic literature, it will be possible to analyse in a more detail the features used by Marsili in order to associate the industrial sectors to the different technological regimes. Furthermore, other authors have expanded the sample of the factors considered in the characterization of the industrial sector taking into account in addition to features relative to knowledge bases and technologies also characteristics able to define the actors and the networks linked to the considered industrial sector.

Riepilogo

Contesto e obiettivi della ricerca

Nel corso degli ultimi decenni, la sostenibilità ha ricevuto una crescente attenzione da aziende e studiosi. Pressioni provenienti da opinione pubblica, regolatori, governi, NGO e organizzazioni finanziarie hanno contribuito ad una crescita senza precedenti dell'attenzione pubblica riguardo il concetto di sostenibilità. Lo sviluppo di una coscienza sostenibile ha portato tale tema a diventare una chiave per il progresso e il successo aziendale, guidando i dirigenti delle compagnie a integrare gli obiettivi di sostenibilità all'interno delle loro strategie di core business (Boons and Lüdeke-Freund, 2013; Schaltegger et al., 2013). Il concetto di sostenibilità deriva principalmente dalla più quotata ed utilizzata definizione di sviluppo sostenibile contenuta all'interno del Brundtland Report: "lo sviluppo sostenibile è tale se è in grado di soddisfare i bisogni delle generazioni correnti senza compromettere la capacità delle generazioni future di soddisfare i loro bisogni" (WCED, 1987). Questa definizione ha guidato a valutare la sostenibilità in accordo all'approccio Triple Botton Line, il quale incorpora i tre principali aspetti di sviluppo sostenibile: economico, ambientale, sociale. Perciò è possibile affermare che la sostenibilità aziendale è raggiunta attraverso il successo di mercato orientato alla realizzazione ed integrazione delle sfide ambientali, sociali ed economiche (Schaltegger et al., 2013).

In letteratura accademica e in ambito aziendale, il concetto di sostenibilità è spesso associato al tema dell'innovazione. Numerosi autori sostengono che l'impegno delle compagnie nello sviluppo dell'innovazione in ambito di sostenibilità rappresenta uno strumento per soddisfare nuove opportunità di business e per affrontare le sfide globali. Per questa ragione, le compagnie hanno bisogno di comprendere che oggi la sostenibilità equivale all'innovazione (Asongu, 2007; Nidumolu et al., 2009). Le innovazioni sostenibili devono essere in grado di generare non solo risultati economici ma anche effetti positivi in ambito ambientale e sociale. L'attenzione riguardante gli effetti generati in termini di sostenibilità è molto alta e rende le compagnie soggette a pressioni esterne in particolare da parte degli stakeholder istituzionali. Tali pressioni esterne sono direttamente collegate ai livelli di performance ottenuti dalle compagnie in ambito di sostenibilità. In questo contesto, è chiaro che un andamento negativo in termini di sostenibilità può andare ad influenzare il processo decisionale di una compagnia riguardo all'implementazione di iniziative sostenibili. Di conseguenza, carenti prestazioni in termini di sostenibilità possono essere un fattore in grado di orientare il processo di sviluppo d'innovazioni sostenibili. La relazione tra sostenibilità e innovazione ha inoltre portato all'introduzione degli stakeholder aziendali come fonte rilevante di idee innovative per la generazione di nuove soluzioni. Il coinvolgimento degli stakeholder nello sviluppo dell'innovazione sostenibile non può essere solamente associato al loro contributo in termini di innovatività. Infatti, un'azienda per essere considerata effettivamente sostenibile dev'essere in grado di raggiungere una propria sostenibilità interna e di generare sostenibilità attraverso i propri partner della supply chain fino a raggiungere i clienti e le comunità (Krause et al. 2009). Naturalmente la relazione tra sostenibilità e sviluppo dell'innovazione è influenzata da numerosi fattori

che possono guidare una compagnia a seguire differenti percorsi innovativi (Kamien and Schwartz, 1982). Tra questi fattori numerosi autori partendo da un'osservazione empirica sostengono che lo sviluppo innovativo varia in maniera significativa all'interno di differenti regimi tecnologici (Malerba, 2005).

Questo lavoro di ricerca è focalizzato sull'innovazione sostenibile a livello delle operations e della supply chain. Il contesto di ricerca è legato al concetto di innovazione sostenibile, il quale considera la progettazione o modifica di un processo, prodotto organizzazione o pratica gestionale che includa obbiettivi economici ambientali e sociali (Van Kleef and Roome, 2007). Molti autori sostengono che l'innovazione sostenibile per condurre a un reale sviluppo sostenibile dovrebbe essere legata a cambiamenti radicali piuttosto che incrementali (Van Kleef and Roome, 2007; Pagell and Wu, 2009; Hall and Vredenburg, 2003).

Data la rilevanza della relazione tra sostenibilità e innovazione, tale lavoro di ricerca ha focalizzato la propria attenzione su differenti aspetti dell'innovazione sostenibile. In particolare in accordo con la letteratura accademica alcuni di questi aspetti appaiono essere fondamentali: da un lato è possibile considerare i driver e le motivazioni che guidano verso lo sviluppo dell'innovazione sostenibile, dall'altro lato è possibile considerare il ruolo della collaborazione con gli stakeholder esterni nel processo di sviluppo. Inoltre, è risultato interessante valutare tali aspetti all'interno di differenti regimi tecnologici con l'obiettivo di verificare se l'impatto che un dato regime tecnologico ha su un generico processo innovativo di una compagnia, come indicato in letteratura accademica, si ripropone in un ambito maggiormente specifico come può essere quello della sostenibilità aziendale.

Driver per la sostenibilità e performance passate

In letteratura accademica, molti autori sostengono l'esistenza di differenti fattori che determinano lo sviluppo sostenibile. Tra questi, uno dei fattori maggiormente considerati è rappresentato dall'approccio strategico alla sostenibilità. Tale fattore indica come compagnie caratterizzate da differenti approcci alla sostenibilità siano orientate allo sviluppo di differenti tipologie di innovazione sostenibile. Quindi, il livello di proattività guida una compagnia verso lo sviluppo di specifiche tipologie di innovazione. Gli autori in tale ambito di ricerca sostengono come compagnie con un approccio maggiormente proattivo alla sostenibilità, considerando tale tema come motore per la loro crescita, risultano essere maggiormente impegnate nello sviluppo di innovazioni sostenibili (Taylor et al. 2012; Chen & Chang 2012). In accordo con i ricercatori accademici, partendo dall'Institutional theory è stato possibile definire l'approccio strategico di un'azienda alla sostenibilità considerando sia fattori interni che esterni, estendendo in questo modo la base teorica dell'Institutional theory alla considerazione dei fattori interni (Yarahmadi, 2012; Hartman, 1999). I fattori considerati in letteratura accademica per definire l'approccio aziendale alla sostenibilità sono: compliance, pressione degli stakeholder, altre pressioni esterne (ad esempio scarsità di risorse o impegno dei competitors in ambito sostenibile), opportunità e vantaggio competitivo, attrazione talenti

(recruiting) e volontarietà e impegno del top management. In aggiunta all'impatto dell'approccio strategico nello sviluppo dell'innovazione sostenibile, questo lavoro di ricerca ha anche investigato un fattore maggiormente innovativo proposto da Berrone et al. (2013). Questi autori sostengono come le performance passate possano svolgere un ruolo nella definizione delle strategie di sostenibilità e nello sviluppo dell'innovazione sostenibile. Berrone et al. (2013) hanno sostenuto che una forte pressione normativa rende l'innovazione ambientale maggiormente attrattiva in special modo per aziende che mostrano elevati deficit negativi in termini di performance ambientali. Perciò, tali compagnie, in accordo con la RBV, tenderanno a migliorare le proprie prestazioni in termini di sostenibilità implementando innovazioni in grado di generare vantaggio competitivo. Sulla base di tale affermazione è possibile, quindi, considerare le performance passate in termini di sostenibilità come un fattore che possa spiegare le scelte aziendali nello sviluppo dell'innovazione sostenibile.

Sostenibilità e collaborazioni

In ambito di sostenibilità la definizione di una collaborazione con stakeholder esterni è identificata come uno strumento per affrontare problematiche ambientali e sociali con l'obiettivo di generare uno sviluppo sostenibile per gli attori coinvolti. Vari autori ritengono come la complessità delle tematiche di sostenibilità guidi le compagnie a collaborare con un'ampia varietà di stakeholder esterni che possono divenire una fonte di conoscenza e competenze esterne al contesto aziendale domain (Arts, 2002; De Bruijnand Tukker, 2002; Hartman and Stafford, 1997; Seuring and Müller, 2008; Srivastava, 2007). I due approcci teorici che hanno fornito i contributi più interessanti nell'analisi della relazione tra il coinvolgimento degli stakeholder e l'innovazione sono la Stakeholder theory e la Resource Based View (RBV). La Stakeholder theory fornisce un adeguato framework teorico per l'analisi della relazione tra business e società dal un punto di vista dello sviluppo sostenibile (Wheeler et al., 2003) e suggerisce che il rafforzamento delle relazioni con gli stakeholder può generare un significativo vantaggio competitivo in termini di reputazione e innovazione (Rodrıguez et al., 2002). Nel contesto della Resource Based View, la capacità di generare relazioni collaborative con gli stakeholder esterni e di integrare le loro competenze nello sviluppo di innovazioni sostenibili può essere considerata come una competenza aziendale (Albino et al. 2012; Ayuso et al. 2006; Yarahmadi 2012).

Regimi tecnologici e innovazione

La letteratura accademica evidenzia come i regimi tecnologici possono influenzare lo sviluppo dell'innovazione. Infatti, vari autori riconoscono che il tasso di innovazione, la tipologia di innovazione e i determinanti delle attività innovative variano notevolmente all'interno di differenti settori. Prendendo in considerazione l'evoluzione della letteratura accademica relativa ai regimi tecnologici, è possibile analizzare il processo d'innovazione sulla base delle sue caratteristiche e dei suoi determinanti a livello di industria e di azienda, fornendo una visione dinamica, multidimensionale e integrata dei vari settori (Malerba, 2005). L'applicazione dell'approccio dei regimi tecnologici per l'analisi del processo

d'innovazione in ambito di sostenibilità permette di ottenere una migliore comprensione delle conoscenze di base e dei processi di apprendimento su cui si fonda lo sviluppo delle innovazioni sostenibili, portando nuove conoscenze riguardo fonti d'innovazione, determinanti e percorsi di sviluppo relativi a specifiche tecnologie.

Gap e obiettivi della ricerca

Il presente lavoro di ricerca analizza l'innovazione sostenibile sia da un punto di vista ambientale che sociale a differenza di quella parte di letteratura accademica che spesso trascura il lato sociale della sostenibilità e dell'innovazione sostenibile (Kleindorfer et al. 2005; Pagell & Wu 2009).

Tale lavoro di ricerca mira a indagare sia gli aspetti che motivano le decisioni delle compagnie nello sviluppo dell'innovazione sostenibile che il ruolo della collaborazione con gli stakeholder in tale sviluppo. In seguito, tali aspetti sono stati analizzati anche all'interno di una prospettiva riguardante i regimi tecnologici.

Innanzitutto, è stato necessario indagare i fattori determinanti per lo sviluppo dell'innovazione sostenibile. La letteratura accademica utilizza l'Institutional theory per analizzare i fattori che guidano le aziende nelle scelte strategiche anche in ambito di sostenibilità (Yarahmadi 2012; Hartman 1999). In questo contesto, numerosi autori hanno evidenziato il ruolo dei differenti approcci strategici. In accordo con la letteratura accademica, il presente lavoro di ricerca mira a supportare ed estendere il framework teorico dell'Institutional theory, includendo il concetto dell'attitudine strategica. Infatti, questa teoria è focalizzata nella valutazione dei fattori esterni che portano una compagnia ad assumere specifiche decisioni e comportamenti. L'obiettivo in tal senso è di includere all'interno dell'analisi, in aggiunta ai fattori esterni, anche i fattori interni che influenzano il processo decisionale di un'azienda riguardo all'implementazione di programmi e innovazioni sostenibili, sia in un contesto sociale che ambientale. Inoltre sulla base delle considerazioni di alcuni autori, come Berrone et al. (2013), è stato possibile rilevare anche il ruolo che le performance passate di una compagnia assumono nello sviluppo delle innovazioni sostenibili. In questo contesto, è stato possibile includere questa variabile come un fattore che orienta all'implementazione di specifiche tipologie di innovazione sostenibile.

Il secondo flusso di ricerca del seguente lavoro di tesi sostiene come un approccio collaborativo tra un'azienda e i suoi stakeholder esterni sia necessario per affrontare le sfide in ambito di sostenibilità in modo profittevole e positivo. In particolare, all'interno di tale lavoro di ricerca risulta rilevante lo studio della relazione tra le differenti tipologie di innovazione sostenibile e le varie tipologie di stakeholder indentificate. Come visto in precedenza, il framework teorico che supporta tale lavoro di ricerca in questo ambito è composto dalla Stakeholder theory e dalla Resource Based View. In particolare, nell'analisi dell'innovazione sostenibile e della collaborazione con gli stakeholder, è stato possibile supportare ed estendere la conoscenza riguardante la Resource Based View, la quale sostiene che una compagnia per

ottenere un vantaggio competitivo rilevante ha bisogno di sfruttare competenze e risorse specifiche e non replicabili. Per vari autori, l'attitudine aziendale alla collaborazione rappresenta una vera e propria fonte di vantaggio competitivo.

Per migliorare e rafforzare la comprensione delle relazioni descritte in precedenza, è possibile introdurre la prospettiva dei regimi tecnologici. Tale introduzione deriva dal fatto che numerosi autori in letteratura accademica abbiano sottolineato l'influenza rilevante delle strutture e caratteristiche dei settori industriali nello sviluppo dell'innovazione. Tale considerazione può essere quindi introdotta in ambito sostenibile (Marsili, 2001; Malerba et al., 1996; Malerba and Orsenigo, 1995; Oltra and Saint Jean, 2009). Attraverso l'applicazione dell'approccio dei regimi tecnologici definiti da Marsili (2001), è stato possibile identificare le caratteristiche dei due settori industriali inclusi in tale lavoro di ricerca. La comparazione di tali caratteristiche, principalmente relative alle conoscenze di base e al processo di apprendimento su cui si fonda lo sviluppo delle innovazioni sostenibili, può portare nuove conoscenze riguardanti le fonti d'innovazione e i possibili percorsi di sviluppo. L'applicazione dell'approccio dei regimi tecnologici permette di ottenere una migliore comprensione delle caratteristiche distintive dei processi di apprendimento e della natura delle tecnologie, focalizzando l'attenzione sui processi d'innovazione e sui determinanti di tali processi a livello industriale e aziendale.

Le domande di ricerca a cui ho cercato di dare risposta sono:

Q1: Quali sono i driver dell'innovazione sostenibile?

> **Q1.1:** Le performance passate risultano essere un driver per lo sviluppo dell'innovazione sostenibile?
> **Q1.2:** La posizione strategica di un'azienda in ambito di sostenibilità è un driver per lo sviluppo dell'innovazione sostenibile?

Q2: Quali tipologie di collaborazione con gli stakeholder esterni incide sullo sviluppo dell'innovazione sostenibile?

Q3: I regimi tecnologici impattano sulla relazione tra driver e sviluppo dell'innovazione sostenibile?

> **Q3.1:** Il regime tecnologico impatta sulla relazione tra performance passate e innovazioni sostenibili?
> **Q3.2:** Il regime tecnologico impatta sulla relazione tra la posizione strategica di una compagnia in ambito di sostenibilità e le innovazioni sostenibili sviluppate?

Q4: Il regime tecnologico impatta sulla relazione tra la collaborazione degli stakeholder e le innovazioni sostenibili sviluppate?

Metodologia della ricerca

La metodologia di ricerca adottata nel lavoro di tesi comprende diverse fasi, sintetizzate in Figura 1.

Figure 2 - Fasi di sviluppo della tesi

La ricerca è iniziata con un'estesa revisione della letteratura: per prima cosa è stato indagato il concetto di innovazione sostenibile e successivamente l'analisi si è spostata verso il ruolo che gli stakeholder assumono nel processo di sviluppo dell'innovazione sostenibile, estendendo lo studio a tutti gli stakeholder aziendali. Simultaneamente sono stati studiati in maniera approfondita anche gli approcci aziendali alla sostenibilità e il legame tra approccio tecnologico e innovazione.

Al termine della revisione della letteratura accademica, è stato possibile sviluppare quattro domande di ricerca che hanno guidato verso le successive fasi del processo di sviluppo. La ricerca è stata condotta attraverso una Content Analysis, che è stata suggerita da vari autori per l'analisi dei report di sostenibilità (Cowton, 1998, Jose and Lee, 2006). Questa metodologia è stata analizzata per analizzare i report di sostenibilità delle aziende del campione. Tale fonte è stata scelta perché in grado di fornire l'ampia quantità di dati richiesta per l'analisi. In aggiunta, è stato possibile utilizzare altre fonti di dati, siti istituzionali, documenti di bilancio e la piattaforma Bloomberg per raccogliere i dati riguardanti le performance aziendali.

Le informazioni raccolte riguardano le innovazioni sostenibili sviluppate dalle aziende all'interno delle proprie operations e della supply chain, le collaborazioni con gli stakeholder, i driver che caratterizzano l'approccio aziendale alla sostenibilità e le performance aziendali in ambito di sostenibilità. L'analisi dei dati è stata eseguita attraverso delle tecniche quantitative. In aggiunta, è stato possibile fornire esempi reali che hanno reso i risultati ottenuti maggiormente robusti.

L'analisi è focalizzata su due differenti settori: elettrico/elettronico e automotive. Questi due settori sono caratterizzati da due aspetti comuni come l'alto impatto in termini di sostenibilità e l'elevato tasso d'innovazione. Il campione è composto da quaranta aziende, venti per ogni settore.

Le aziende sono state scelte attraverso i seguenti criteri:

- Appartenenza al settore automotive o elettrico/elettronico
- Impegno nello sviluppo delle innovazioni sostenibili e nell'implementazione delle iniziative di sostenibilità

- Inclusione in almeno uno degli indici di sostenibilità, tra DJSI e MSCI World Index, i quali dimostrano l'impegno delle aziende in ambito di sostenibilità
- Pubblicazione dei report aziendali relativi alla sostenibilità

Questi criteri hanno permesso di selezionare aziende effettivamente impegnate nell'ambito sostenibile, che possono essere quindi considerate come "best performer" nei propri settori di appartenenza. Il campione anche se limitato in termini di grandezza, permette di effettuare un'analisi quantitativa supportata da esempi reali forniti dalle aziende stesse.

L'analisi quantitativa è stata realizzata attraverso tecniche non parametriche. Per analizzare la relazione tra l'approccio strategico alla sostenibilità e lo sviluppo dell'innovazione sostenibile, è stato applicato il test di Kruskal-Wallis. Invece riguardo alla relazione tra le performance passate e le innovazioni sostenibili, è stata utilizzato il test di correlazione per ranghi di Spearman. Lo stesso metodo è stato utilizzato per studiare la relazione tra la collaborazione con gli stakeholder e lo sviluppo delle innovazioni sostenibili. I medesimi metodi statistici sono stati successivamente utilizzati per studiare tali relazioni all'interno del contesto dei regimi tecnologici fornendo in questo modo i risultati per le domande di ricerca tre e quattro.

Risultati e discussione

Prima di riportare e discutere i risultati del lavoro di ricerca, è necessario descrivere brevemente il framework utilizzato per la classificazione delle innovazioni sostenibili. Il framework considerato è stato proposto da Benaglia e Cola (2013) e permette di classificare le innovazioni sostenibili in accordo a tre dimensioni principali in aggiunta alla distinzione tra innovazioni ambientali e sociali:

- Grado d'innovazione: indica la complessità delle iniziative distinguendo le innovazioni tra incrementali o radicali
- Obiettivo dell'innovazione: distingue tra innovazione di processo e di prodotto. Inoltre, viene considerata una terza categoria che varia in base alla natura dell'innovazione. Nella sfera ambientale si considerano modifiche che riguardano simultaneamente processi e prodotti, mentre nella sfera sociale questa terza categoria identifica programmi che richiedono la progettazione di un nuovo business.
- Area d'impatto dell'innovazione: essa è riferita all'area in cui l'innovazione genera il proprio impatto. Le categorie considerate identificano un livello interno e due livelli esterni d'impatto. Esternamente l'impatto può essere indirizzato nel contesto tradizionale della supply chain o oltre i confini tradizionali della compagnia fino a raggiungere consumatori e comunità attraverso la generazione di un così detto impatto esterno.

L'applicazione del framework ha permesso di raccogliere i dati riguardanti le innovazioni sostenibili. Tali dati assieme a quelli relativi alla variabile che identifica l'approccio strategico e alle informazioni

riguardanti le performance passate delle compagnie sono stati successivamente utilizzati per studiare le domande di ricerca del seguente lavoro di tesi.

Quali sono i driver dell'innovazione sostenibile?

Riguardo la relazione tra le performance passate e lo sviluppo dell'innovazione sostenibile, non è stato possibile identificare dei risultati rilevanti. L'analisi sul campione complessivo non ha permesso di confermare l'affermazione di Berrone et al. (2013), i quali sostengono che compagnie con gap prestazionali negativi in termini di sostenibilità sono maggiormente orientate allo sviluppo di specifiche tipologie d'innovazione. Al contrario, la relazione tra l'approccio strategico alla sostenibilità e lo sviluppo dell'innovazione sostenibile ha mostrato risultati interessanti. I valori identificati sono parzialmente in accordo con la letteratura accademica. Infatti, aziende proattive, caratterizzate da driver come volontarietà e ricerca del vantaggio competitivo, sembrano essere orientate verso innovazioni in grado di generare un impatto esteso attraverso modifiche incrementali e radicali dei prodotti aziendali (Hellström 2007; Tseng et al. 2013; Hansen, Grosse-Dunker, Reichwald 2009; Klassen & Vachon 2006; Hart 1995; Hart 1997; Vachon & Klassen 2008). Allo stesso tempo, è risultato rilevante per le aziende maggiormente proattive lo sviluppo d'innovazioni interne indirizzate a generare modifiche incrementali dei processi aziendali.

Quali tipologie di collaborazione con gli stakeholder esterni incide sullo sviluppo dell'innovazione sostenibile?

La secondo domanda di ricerca ha indagato la relazione tra lo sviluppo dell'innovazione sostenibile e la definizione di collaborazioni con gli stakeholder esterni. Tale analisi ha portato alle seguenti conclusioni:

- Come sottolineato da vari autori, è stato possibile riconoscere l'esistenza di una forte relazione tra la collaborazione definita con gli stakeholder esterni e lo sviluppo delle innovazioni sostenibili (Albino et al. 2012; Klassen & Vachon 2008; Vachon & Klassen 2006; Yarahmadi 2012; Ayuso et al. 2006; Nieto & Santamaria 2007; De Marchi 2012; Pagell & Wu 2009; Holmes & Smart 2009).
- In letteratura accademica, si ipotizza come differenti stakeholder, descritti come portatori di specifiche risorse e competenze, siano legati a differenti tipologie d'innovazione (Yarahmadi 2012; Albino et al. 2012; De Marchi 2012; Ayuso et al. 2006; Holmes & Smart 2009). Come detto in precedenza alla base di tale lavoro di ricerca vi è la Stakeholder theory, la quale propone una fondamentale distinzione tra stakeholder primari e secondari (Ayuso et al. 2006). Partendo da tale considerazione, i risultati parzialmente confermano le affermazioni presenti in letteratura accademica, anche se non è stato possibile identificare una forte variazione di comportamento tra stakeholder primari e secondari. In generale, però, gli stakeholder secondari hanno mostrato un

maggiore orientamento verso lo sviluppo d'innovazioni radicali in grado di generare un impatto esteso oltre i confini aziendali.

- Analizzando più in dettaglio gli stakeholder secondari, è possibile fare alcune considerazioni riguardanti i singoli attori. In questo contesto, gli attori maggiormente rilevanti sono governi, NGO, altre compagnie e knowledge leader. Iniziando dalle organizzazioni non governative (NGO), è possibile evidenziare i differenti ruoli assunti da tale attore nelle due componenti della sostenibilità. Infatti, questa tipologia di stakeholder non risulta rilevante in campo ambientale ma al contrario in campo sociale i suoi valori di correlazione mostrano un contributo significativo nello sviluppo di innovazioni sostenibili. Questo risultato conferma quanto affermato in letteratura accademica, dove vari autori hanno evidenziato la crescente importanza che le organizzazioni non governative stanno assumendo nello sviluppo d'innovazioni sociali che coinvolgono imprese private (Weisbrod, 1997; Young, 1999). Al contrario delle NGO, i knowledge leader sono rilevanti in campo ambientale ma non in quello sociale. Anche per questi attori è stato possibile evidenziare il loro ruolo nello sviluppo d'innovazioni radicali complesse in grado di generare un impatto positivo oltre la tradizionale supply chain di una compagnia. Un'altra importante tipologia di stakeholder secondario è rappresentata dalle così dette altre compagnie. Questi attori, come i due precedentemente analizzati, sono visti in letteratura accademica come una fonte di risorse e capacità uniche e inimitabili. In particolare, per le atre compagnie i risultati, in accordo con le affermazioni di vari autori, mostrano un'inclinazione in campo sociale allo sviluppo d'innovazioni radicali relative all'implementazione di nuovi business in grado di generare impatti positivi su clienti e comunità (Ammenberg and Hjelm, 2003). Dai risultati anche i governi rappresentano una tipologia di stakeholder secondario rilevante per lo sviluppo dell'innovazione sostenibile. In accordo con la letteratura accademica, tale attore mostra di essere in grado di fornire un importante contributo allo sviluppo d'innovazioni radicali in campo sociale (Milliman and Grosskopf, 2004).
- Riguardo gli stakeholder primari, è possibile notare il ruolo fondamentale assunto dai fornitori nello sviluppo dell'innovazione sostenibile mentre i clienti non mostrano nessuna rilevanza in questo ambito. In particolare, i fornitori mostrano un ampio coinvolgimento nello sviluppo dell'innovazione ambientale. In questo ambito, la collaborazione con tale attore è rilevante per lo sviluppo di ogni tipologia di innovazione. Invece, in campo sociale i fornitori sono principalmente rilevanti per lo sviluppo d'innovazioni interne di tipo incrementale legate ai processi. Questo importante ruolo assunto dai fornitori è stato riconosciuto da differenti autori, i quali sostengono come la posizione privilegiata che tale attore occupa riguardo ai processi e ai prodotti di una compagnia lo rendono possessore di competenze e risorse complementari che gli permettono di essere coinvolto in un'ampia varietà d'innovazioni sostenibili (Albino et al., 2012; Yarahmadi, 2012; Ayuso et al., 2006; Nieto and Santamaria, 2007; Vachon and Klassen, 2008; Vachon and Klassen, 2006).

- In ultimo, è interessante evidenziare la forte relazione tra la definizione di collaborazioni multi stakeholder e lo sviluppo dell'innovazione sostenibile. In accordo con la letteratura accademica, la definizione di collaborazioni multi stakeholder è considerata positiva e significativa sia in ambito sociale che ambientale per lo sviluppo di innovazioni sostenibili di tipo radicale (Klassen and Vachon, 2008; Vachon and Klassen, 2006). In particolare, questo ruolo è evidente in ambito sociale, dove la definizione di collaborazioni con più di una tipologia di stakeholder risulta rilevante per il solo sviluppo di iniziative radicali volte a generare un impatto esteso oltre la tradizionale supply chain di una compagnia (Elbers, 2004; Utting, 2002).

I regimi tecnologici impattano sulla relazione tra driver e sviluppo dell'innovazione sostenibile?

I due fattori considerati come driver per lo sviluppo dell'innovazione sostenibile assumono ruoli opposti all'interno dei due differenti regimi tecnologici. Infatti, nel complex system regime il fattore che ha maggiore influenza sulle decisioni relative allo sviluppo delle innovazioni sostenibili sembra essere l'approccio strategico di una compagnia alla sostenibilità. Al contrario, nel science-based regime l'influenza maggiore è generata dalle performance passate, in particolare in ambito ambientali. Questa differenza può essere parzialmente spiegata attraverso le caratteristiche dei due regimi in termini di natura tecnologica, conoscenza di base e processo di apprendimento. Come indicati da Marsili (2001), il complex system regime è caratterizzato da basi tecnologiche e conoscenze di base molto complesse che richiedono la presenza di differenti competenze e risorse per lo sviluppo dell'innovazione. Invece, il science-based regime è caratterizzato da un'elevata specificità industriale. Tali considerazioni possono portare che un regime bastato su una tecnologia e una conoscenza di base maggiormente complessa guidi le compagnie a legare le proprie decisioni all'approccio strategico piuttosto che alle pressioni esterne legate alle performance passate dell'azienda.

Il regime tecnologico impatta sulla relazione tra la collaborazione degli stakeholder e le innovazioni sostenibili sviluppate?

Lo studio di questa domanda di ricerca ha portato ad identificare differenti comportamenti nello sviluppo dell'innovazione all'interno dei due regimi tecnologici. Tali differenze non sono rilevanti in termini di tipologia d'innovazione sviluppata ma prevalentemente riguardano la tipologia di stakeholder coinvolto nella definizione delle collaborazioni. Osservando i risultati è possibile notare come le collaborazioni con gli stakeholder in generale hanno una forte influenza nello sviluppo delle innovazioni sostenibili in entrambi i regimi tecnologici considerati in questo lavoro di ricerca. I contributi maggiormente interessanti provengono dall'analisi dei valori di correlazione relativi ai singoli attori analizzati all'interno dei due regimi tecnologici.

- In accordo con la classificazione di Marsili (2010) dei regimi tecnologici è stato possibile verificare un maggior coinvolgimento di differenti tipologie di stakeholder esterni nel complex system regime rispetto al science-based regime. Nel complex system regime risulta rilevante il coinvolgimento di cinque differenti tipologie di stakeholder contro le sole due tipologie significative all'interno del science-based regime. Tale risultato conferma la considerazione di Marsili, il quale ha associato un coinvolgimento maggiore e diversificato degli stakeholder al bisogno di ottenere differenti competenze e risorse all'interno di un regime tecnologico caratterizzato da conoscenze di base e tecnologie complesse.
- Nella letteratura accademica, vari autori hanno evidenziato il ruolo fondamentale assunto dai knowledge leader all'interno del complex system regime (Malerba, 2005; Marsili, 2001, 2002). Questo aspetto è confermato dai risultati, i quali mostrano come il coinvolgimento dei knowledge leader nello sviluppo dell'innovazione sostenibile è significativo sia nella sfera ambientale che sociale della sostenibilità.
- Un altro aspetto che evidenzia l'influenza dei regimi tecnologici nella relazione tra le collaborazioni con gli stakeholder e le innovazioni sostenibili è relativa allo sviluppo di collaborazioni multi stakeholder. Questo risultato mostra come all'interno del complex system regime, caratterizzato da una conoscenza di base complessa e dal bisogno di differenti competenze e risorse, le compagnie tendono a stabilire collaborazioni con più di una tipologia di stakeholder allo stesso tempo in modo da gestire questa complessità all'interno del processo d'innovazione (Blomqvist et al., 2004; Caloghirou et al., 2004; Chang, 2003; Macpherson et al., 2004).

Contributi e limiti

Il presente lavoro estende il campo di ricerca delle teorie considerate e fornisce alcuni interessanti spunti per il mondo aziendale e manageriale.

- Il presente lavoro di ricerca evidenzia il ruolo fondamentale della collaborazione con gli stakeholder nello sviluppo di differenti tipologie d'innovazione sostenibile. In questo senso, tale lavoro di ricerca permette non solo di validare l'insieme degli stakeholder proposti dai vari autori in letteratura accademica (Albino et al. 2012; Yarahmadi 2012; Ayuso et al. 2006; Holmes & Smart 2009) ma indica il ruolo che i differenti attori possono assumere nello sviluppo di specifiche tipologie di programmi e innovazioni. Questo aspetto arricchisce la letteratura accademica in ambito di sostenibilità proponendo un ulteriore passo nello studio delle relazioni tra aziende e stakeholder, non restringendo l'analisi a considerazioni di carattere generale.
- Inoltre, questo lavoro di ricerca ha studiato i possibili driver per lo sviluppo della sostenibilità all'interno del contesto dei regimi tecnologici. Tale analisi ha permesso in accordo con la letteratura accademica di osservare come i driver che determinano lo sviluppo di specifici percorsi d'innovazioni variano sulla base delle caratteristiche relative ai regimi tecnologici (Malerba, 2005; Marsili, 2001, 2002; González-Benito and González-Benito, 2006, 2010). Perciò, è stato possibile

notare come le caratteristiche dei regimi tecnologici influenzano i driver dell'innovazione non solo nell'ambito generale dell'innovazione ma anche nello specifico ambito della sostenibilità.

- In particolare, è stato possibile identificare come le collaborazioni con gli stakeholder variano parzialmente sulla base delle caratteristiche relative alle conoscenze di base e ai processi di apprendimento dei regimi tecnologici. L'orientamento delle aziende verso specifiche tipologie d'innovazione varia all'interno dei differenti regimi tecnologici.
- Da un punto di vista manageriale, il presente lavoro di ricerca non solo aiuta a comprendere maggiormente il ruolo delle collaborazioni ma indica il bisogno e il potenziale d'identificare gli stakeholder con competenze e risorse appropriate in modo da supportare specifiche tipologie di innovazione sostenibile. Basandosi sui bisogni strategici delle aziende e sulle tipologie d'impatto che una compagnia vuole generale in termini di sostenibilità, le aziende e i dirigenti possono sviluppare legami e collaborazioni con differenti tipologie di stakeholder.

Il lavoro di ricerca possiede alcune limitazioni che è necessario esplicitare:

- Per prima cosa alcuni limiti riguardano l'analisi quantitativa dei risultati. Come descritto nei capitoli precedenti il campione realizzato non è di ampie dimensioni e ciò potrebbe rendere i risultati non particolarmente robusti da un punto di vista statistico.
- L'inclusione di aziende appartenenti a due differenti regimi tecnologici può ridurre la comparabilità dei dati. Inoltre, la creazione di un campione attraverso la selezione di compagnie così dette "best performer" di settore può mettere in luce caratteristiche e dinamiche che non sono necessariamente comuni all'intero settore di appartenenza.
- Un'altra limitazione riguarda il calcolo delle performance di sostenibilità aziendali. In particolare, per le compagnie è ancora molto difficoltoso definire indicatori standard in grado di valutare le performance in ambito di sostenibilità. Tale difficoltà è ancora più evidente nella dimensione sociale della sostenibilità, dove lo sviluppo di tale tema è ancora in fase iniziale sia in ambito accademico che aziendale.
- Riguardo i regimi tecnologici, le principali limitazioni sono relative alla classificazione di Marsili. Infatti, sarebbe necessario analizzare maggiormente le caratteristiche definite da Marsili per la selezione dei vari settori industriali all'interno dei regimi tecnologici. Tale analisi, ad esempio, potrebbe prendere in considerazione anche nuove dimensioni di valutazione legate al mercato della domanda e alla percezione che gli stakeholder hanno di uno specifico settore in ambito di sostenibilità.

Riguardo le opportunità di sviluppo futuro per questo ambito di ricerca, in mia opinione la principale opportunità è legata all'introduzione di compagnie non incluse tra le così dette "best performer" del loro settore di appartenenza. In questa direzione sarebbe possibile spostare l'attenzione verso differenti realtà in termini di dimensione e localizzazione in modo da studiare un differente approccio alla collaborazione

con differenti tipologie di stakeholder all'interno di aziende di natura differente. Inoltre, sarebbe anche interessante espandere il campione da un punto di vista qualitativo e quantitativo, incrementando il numero di compagnie e il numero di settori industriali/regimi tecnologici. L'aspetto relativo all'introduzione di regimi tecnologici permette di identificare molte possibili opportunità di sviluppo infatti come mostrato dalla letteratura accademica è possibile analizzare tali regimi tecnologici o direttamente settori industriali con un maggior dettaglio. Alcuni autori ad esempio hanno ampliato l'insieme dei fattori che caratterizzano i regimi tecnologici prendendo in considerazione oltre alle caratteristiche relative alle conoscenze di base e alla tecnologia anche fattori in grado di definire gli attori e le reti che caratterizzano questi specifici regimi.

1 Sustainable development

Over the last two decades a large number of influential events, initiatives and publications have contributed to an unprecedented rise of public attention drawn to the concepts of sustainable development and sustainability. In reality, the need to conciliate economic growth and an equal resource distribution in a new model of development has begun to emerge from the 70', as a consequence of the achieved awareness about the fact that the concept of traditional development, exclusively linked to the economic growth, shortly would lead to the collapse of natural systems. It is now clear that the only economic growth is not sufficient, real development is obtained with an improvement of quality life in a long term way. In its broadest sense, the sustainability concept implies the capability of a development process to sustain the reproduction of economic, human and natural capital.

Today, sustainable development is embraced by business, governments, social reformers and environmental activists, all of which put their own interpretation on what sustainable development means. Indeed, sustainable development has been defined in many ways, but the most frequently quoted definition is from "Our Common Future", also known as the Brundtland Report: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). The central element of such definition is the necessity to search for equity between present and future generations but also within the same generation among the different economic, political, social and geographical realities. The two key concepts in support of the central element of the definition are the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given, andthe idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

The success of such statement, mainly of ecological nature, has driven the international debate, causing numerous insights and further development of the concept of sustainability, which over time has been extended to all dimensions that contribute to development (Banerjee, 2007; Luke, 2005; Redclift, 2005). In this context, sustainability, therefore, has not to be understood as an immutable state or vision, but rather as a continuous process, which recalls the need to combine the three fundamental and inseparable dimensions of development: environmental, economic and social. These three dimensions have been defined in the following terms within the academic literature. The term economic sustainability indicates the capacity of an economic system to generate a durable growth of economic indicators, through the efficient combination of resources. Instead, the environmental sustainability is the capability to appraise the environment ensuring the protection and renewal of natural resources. Lastly, with the concept of social sustainability, it is possible to identify the capability to guarantee the well-being conditions in terms of security, health and education. In summary, the concept of sustainable development is identifiable in an ethical and political principle, which implies that the many economic and social dynamics of modern economics are comparable with the improvements of life conditions and with the capacity of natural resources to reproduce. However, it's fundamental to highlight as such dimensions are strictly interrelated among them from a multiplicity of connections. Therefore, these components have to be analysed within

a systemic vision, as elements that together contribute to reach a common goal. This means that each planning initiative has to take into account the reciprocal interrelations.

In the academic literature, the presence of these fundamental interrelations is shown within the most popular elucidation of sustainable development, which consists of the three circles model of economic, social and environmental considerations, often referred to as the three pillars of sustainability and, within the corporate agenda, the triple bottom line (Elkington, 1994). Because of the interconnections among its factors and purposes, sustainable development is essentially about the effective integration of social, economic, and ecological considerations at all scales from local to global (Schnurr and Holtz, 1998). On the base of this model, the objective of sustainable development is to maximise the goals across all three systems and is illustrated by the intersection of these circles.

Naturally, in order to achieve the sustainable development objective, it is not possible to neglect the fundamental role played by corporations inside the sustainability system. Indeed, it is now commonly accepted that society will never achieve sustainable development without corporate support, as the private sector represents the main productive force of the economy (Bansal, 2002). Therefore, the private sector can potentially play an integral role in sustainable development by providing financial and personnel resources, infrastructure, innovation and technology, and promoting good governance (Bansal, 2002; Jenkins, 2005; Kolk and van Tulder, 2006; Sachs, 2005). Corporate actors have generally embraced the notion of sustainable development, acknowledging the need to move from a narrow, technical understanding of their social and environmental impacts towards identifying their wider role in society (Schmidheiny, 1992; Starik and Rands, 1995; Throop et al., 1993), and both academia and corporate practice have provided a range of corporate level definitions and operationalization of the concept.

1.1 Corporate sustainability

As previously said, the business sector plays a fundamental role in the sustainable development of society. For this reason, over the past two decades the operations management literature has been increasingly interested in understanding how firms can become sustainable, which requires to meet the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). In the academic literature the sustainability within the business ambit is indicated with the term corporate sustainability, which is used to refer to the triple bottom line and to the long-term profitability of organisations (e.g., Bansal, 2002; Dyllick and Hockerts, 2002). The concept of corporate sustainability can be reassumed as the successful market-oriented realisation and integration of ecological, social and economic challenges to an organisation (Schaltegger et al., 2013). Through the analysis of academic literature, a sustainable company can be defined considering three main elements (Dyllick and Hockerts, 2002): 1) a sustainable corporation considers not only economic but also social and environmental aspects, which is consistent with the triple bottom line concept; 2) corporate sustainability requires a long-term business orientation as a basis for satisfying stakeholders' needs now and in the future; and 3) a sustainable corporation follows the rule of living on the income derived from capital, not on the capital itself.

Observing these definitions for a sustainable company, it is necessary to split and evaluate the own performance on the base of three dimensions: economic, social and environmental (Elkington, 1998; Porter & Kramer, 2006; Carter & Rogers, 2008). This division is fundamental in order to assess the improvements of a firm in all the three ambits of sustainability. Indeed, talking about a sustainable corporate, to be successful on economic dimension of the triple bottom line is only a necessary condition for a firm to stay in business for the long term. Instead, to become sustainable it is necessary to improve performance relative to environmental and social dimensions. Naturally, the practices traditionally introduced by firms are focused on the improvement of economic performance, but with increased attention to the issue of sustainability, firms and academic literature have expanded their focus on the effects that corporate practices have on environmental and social performance. In general in the research ambit, a practice is defined as a process that incorporates knowledge of firm and aims at achieving certain type of performance (Szulanski, 1996; Flynn et al., 1995). However, in the case of sustainability the aim of practices is to improve firm's environmental and social performance while remaining profitable, so for this reason many research works have analysed and studied corporate practices in terms of environmental and social impacts even if rarely the three components of sustainability have been treated at the same time.

In the academic ambit, the performance improvements required to establish a sustainable management of a firm is often linked to its innovation development process. It is widely accepted that innovation is key for business success (Cooper, 2001; Totterdell et al., 2002; Zhang and Doll, 2001). In the past, innovation success has been measured predominantly in the economic sphere (e.g. market success). However, recently the non-economic sphere has increasingly become a matter of corporate management and the recognition of non-economic aspects in management has been strongly influenced by the vision of sustainable development. Sustainability has led to analyse the innovation development on the base of triple bottom line evaluating the improvements derived by an implementation of an innovation in social and environmental terms.

1.2 Sustainability and innovation

In the academic ambit the theme of sustainability is often positively linked to the innovation one. This relation depends on the role that the academic literature acknowledges to these two elements. Indeed, both innovation and sustainability are seen as fundamental driver for the development of a company.

The increasing awareness about sustainability has brought society in general to be less tolerant of companies that fail to address their social responsibilities and consequently this behaviour has generated more pressure on managers and companies (Asongu J., 2007). Many management scholars and consultants have argued that these new demands offer terrific opportunities for progressive organizations, and innovation is become one of the primary means by which companies can achieve sustainable growth. The generation of innovations in a sustainable perspective has brought managers to rethink their innovations strategies, which have often proved to be inadequate to accommodate the highly complex and uncertain nature of sustainability issues. The study and development of innovation in the sustainability ambit has led to the birth of the sustainable development innovation. This strategy integrates the goals of innovation and sustainable development and, in contrast to conventional market-driven innovation, it must incorporate the added constraints of social and environmental pressures as well

as consider future generations (WCED, 1987). In the academic literature many authors acknowledge as a sustainable development requires some fundamental changes in the traditional innovation approach (Senge and Carstedt, 2001). These changes don't regard only the innovation strategy of a company but also technology and markets in order to capture sustainable business opportunity (Hart and Milstein, 1999). In this new innovation process, rethought in order to achieve sustainable development, the academic literature highlights as a wide range of stakeholders assumes a fundamental role in the approach of complex sustainability issues (Hall and Vredenburg, 2003).

Different authors state that today's companies need to innovate by reinventing the way they relate to their multiple stakeholders: employees, customers, suppliers, NGOs/activists, communities, governments, competitors, etc. But at the same time, the actively managed relationships with stakeholders can become an important source of ideas for innovations that address stakeholder expectations and ultimately contribute to the welfare of the social and natural environment (Ayuso et al., 2011). Summarising, through stakeholder engagement companies can anticipate, understand, and respond faster and more easily to changes in the rapidly changing business environment. Dialogue with stakeholders also brings opportunities for generating new creative solutions, beneficial for both the company and the stakeholders. The academic literature presents research works about stakeholder engagement and in general the sustainable innovation within the environmental field (Carrillo-Hermosilla et al., 2010) but there is also a wide body of work focusing on the social aspect of sustainability (e.g., Prahalad, 2005; Prahalad and Hart, 2002; Seelos and Mair, 2005, 2007; Yunus et al., 2010).

Therefore, from a business perspective, there is wide agreement that the challenges of sustainability offer significant potential for innovations and related business opportunities. Sustainability presents a new source of ideas and visions leading to new business opportunities (Hart, 1997; Day, 1998). Indeed, as seen, there is a high number of empirical studies that have identified positive correlations between sustainability and business success (Wagner and Schaltegger, 2003).

1.3 Sectorial system and innovation

During the analysis of academic literature in the innovation development ambit, it has been possible to identify the interesting role played by technological regimes in the orientation of problem solving activities correlated to firm's innovation strategy. The notion of a technological regime is concerned with the technology upon which firms rely in their problem solving activities, given a broadly defined way of doing things (Nelson and Winter 1977). Therefore, a technological regime sets the boundaries to what can be achieved in the problem solving activities associated with a given set of production activities, and the directions along which solutions are likely to be found. From these definitions, it is possible to state that a technological regime thus guides technicians, engineers and scientists involved in innovative activities towards developing and employing certain heuristics, tactics, and objectives to solve a particular problem (Nelson and Winter 1977, 1982).

In the definition above, the system of sources of knowledge specific to a regime contributes to define the technological opportunity conditions in terms of both the general level and structure (Winter 1984). These sources include the various internal functions of the firm, as for example, R&D, production, marketing,

other firms in vertically related industries (as buyers and suppliers), competitors, and institutions outside the industrial system, such as universities or public research labs (Marsili and Verspagen, 2011). This consideration recalls the role of stakeholder engagement in the development of sustainability innovations highlighted by many authors in the academic literature as among others Hall and Vredenburg (2003).

Various authors have empirically tested Nelson and Winter's model of technological regimes by looking at the differences across technologies and industrial sectors in patterns of innovation and competition. In an empirical study of European patents Malerba and Orsenigo (1996) used the concentration of innovative activities across firms, the rate of innovative entry, and the stability over time of the hierarchy of major innovators, based on the number of patents, as indicators of the patterns of innovation in different technologies. They found that distinct patterns of innovation, with characteristics similar to the "entrepreneurial" and "routinised" patterns, emerged in two distinct groups of technologies, resulting relatively invariant across the six advanced countries examined. Instead, in a more recent study, Breschi, Malerba and Orsenigo (2000) have used the model in order to examine the relationship between Schumpeterian patterns of innovation and the characteristics of technological regime. Other empirical studies have started to explore the relationship between Schumpeterian patterns of innovation and patterns of industrial competition. For example in Dutch manufacturing, Van Dijk (2000) found on average statistically significant differences of structures (for example, market concentration) and performance (for example, profits margin) between industries classified into a Schumpeter Mark I group and a Schumpeter Mark II group according to Malerba and Orsenigo's definition.

Subsequently, due to the limitations of a distinction into only two alternative regimes, Marsili and Verspagen (2011) have enlarged the distinction of technological regimes in five categories in light of the large empirical variety in technological performance and properties of innovative processes. The five defined categories are: science-based regime; fundamental-processes regime; complex (knowledge) system regime; product-engineering regime; continuous-processes regime. The two authors on the base of this classification, defined through some criteria that after will be explained, have analysed and classified the main industrial sectors of the market.

While these studies provide useful insights into the importance and significance of the concept of technological regimes in the development of innovation, on the base of applications executed by the authors of this research ambit it is possible to imagine the integration of technological regime concept in the sustainability field. In particular, this perspective could to improve the understanding of sustainability innovation development taking into account the role played by stakeholder collaborations and innovation drivers.

2 Sustainability innovation drivers

The well-known Brundtland Commission's definition of a sustainable development (WCED, 1987) does not provide clear guidelines for companies (Pujari, 2006; Petala et al., 2010). Thus organizations often find it difficult to identify their roles within that perspective (Shrivastava, 1995). However, the increasing importance of sustainability issues within the firm's strategy has transformed the commitment to sustainability in a fundamental variable of the current competitive scenarios. This has encouraged many companies to initiate voluntary transformations to bring themselves nearer to sustainability principles. Such behaviour has brought to the following question: what leads companies to develop sustainability strategies? Or, in other words, what are the determinant factors of a stronger sustainability implication and commitment?

Several authors have approached these questions and have studied the role played by diverse variables that stand as main determinants or predictors of sustainable development. Through the analysis of academic literature one determinant factor stands out as fundamental and central to all the others: the pressure exerted by the company's different stakeholders. The stakeholder pressure is evaluated in its turn considering other variables that vary within the research works on such argument. Indeed, to explain the adoption of sustainable practices some authors emphasize strategic drivers, such as competitive advantage, differentiation strategy, entrance to market, positive corporate image and reputation, and product and service quality (Berry and Rondinelli, 1998; Bhaskaran et al., 2006; Bhattacharya and Sen, 2004; Carlson et al. 1996; Castka and Balzarova, 2008; McWilliams and Siege, 2001). Other authors emphasize monetary drivers such as cost saving, greater efficiency, and increasing profit (Berry and Rondinelli, 1998; Bhaskaran et al., 2006; Marshal et al., 2005; Munilla and Miles, 2005; Porter et al, 1995). The considered drivers can be divided in two different categories as internal and external drivers. External drivers are, on the other hand, linked to customers' demand for such products, pressures from investors, community groups, and the public, as well as competitors and compliance with regulations. Instead, internal drivers are typically linked to managerial attitudes, employees' demands, organizational culture, internal pressure on business managers, and social development activities (Berry and Rondinelli, 1998; Bhattacharya and Sen, 2004; Bjorner, 2004; Haigh and Jones, 2004; Marshall et al., 2005; Tullberg J, 2005; Chahal and Sharma, 2006). Among the numerous possible determinants, it is interesting to underline as for many authors the character of the considered industry determines some of these drivers. For instance, a business sees product quality as necessary to maintain or increase competitiveness. Other drivers can stem from the considered industry's effect on the external environment (Abreu and David, 2004), such as use of natural resources, landscape transformation or waste production (Crowther and Rayman-Bacchus, 2004). Instead, in other industries, the focus on environmental performance can bring advantages such as better quality, reduced costs, improved image and the opening of new markets (Corbett and Klassen, 2006; Hart, 1995; Maxwell et al., 1997; Porter and van der Linde, 1995). This important aspect that affect

the definition of sustainability drivers cannot be neglected, therefore it will be analysed within the technological regime ambit.

From the analysis of academic literature, it has been possible to note as the identification of drivers for the development of sustainability practices has been mainly executed within the environmental field, neglecting the most accepted definition of sustainability that is specified by the triple-bottom-line (TBL) of economic profitability, respect for the environment, and social responsibility (Elkington, 1997; Dyllick and Hockerts, 2002). Naturally, the statements made for the sustainability ambit are valid also for the only environmental component of sustainability. Indeed, also for the environmental practice development many variables have been studied as relevant factors in the literature. But from the analysis it has been possible to select those that have received the main attention from researchers and that have been considered in a larger number of papers.

As just said, one determinant factor stands out as fundamental and central to all the others: the stakeholder pressure. Such driver has been studied as outcome of other different factors within two main different approaches. In the first case, the stakeholder pressure has been identified by many authors as the result of internal and external factors that determinate the company sustainability strategic position driver of sustainable innovations (González-Benito J. and González-Benito O., 2006, 2008; Gabzdylova et al., 2009; Gmelin and Seuring, 2010). Instead, in a second approach the stakeholder pressure is directly linked to the past company's performance in terms of sustainability (Berrone et al., 2013).

2.1 Company sustainability strategic position

Over the last two decades, public opinion, governments and regulators have forced executives of corporations to improve their sustainability performance and, for this reason, to consider the sustainability as a significant competitive priority. Such growing concern about the sustainability issues and the enhancing of pressure from public opinion, regulators, governments, NGOs and internal drivers related to the change of employees' sustainability awareness have led firms to include the sustainability into the overall process of strategy formation. On this base, the sustainability strategy can be seen for a company as a set of guidelines to respond to current internal and external pressure or to anticipate future evolution of the competitive environment.

As known, the definition of a strategy represents the synthesis of a complex process in which many factors exert their influence. Naturally, also for the development of a sustainability strategy, it is necessary to take into account different factors defined through the analysis of internal and external context. As seen within the academic literature, the factor that plays a central and fundamental role in the definition of a sustainability strategy is the stakeholder pressure (González-Benito J. and González-Benito O., 2006). Regards corporate social responsibility and, in particular, environmental responsibility, stakeholders demand integrity, respect, standards, transparency and accountability (Waddock et al., 2003). The factor

identified as stakeholder pressure has been mainly studied in the environmental ambit. Indeed, in the academic literature it is recognized as the environmental consciousness of a company implies harmonizing environmental performance with stakeholders' expectations (Gupta, 1994). Thus, the company acts conditioned by the pressure that it receives and perceives from its stakeholders.

Several authors point out the importance of this pressure for the development of proactive environmental strategies (Winsemius and Guntram, 1992; Jennings and Zandbergen, 1995; Fineman and Clarke, 1996; Maxwell et al., 1997; Berry and Rondinelli, 1998). The different research works executed in the academic literature has brought to the identification of different typologies of pressure linked to different considered stakeholder. For example, the results of Henriques and Sadorsky (1999) support the idea that environmental proactivity is associated with higher pressure from those they call organizational stakeholders (customers, suppliers, employees and shareholders) and community stakeholders (e.g. non-governmental organizations, social groups). At the other extreme, environmental reactivity is associated with higher pressure from regulatory stakeholders (e.g. governments, trade associations) and the media. In addition, Buysse and Verbeke (2003) introduced the distinction between internal primary stakeholders (employees, shareholders and financial institutions) and external primary stakeholders (customers and suppliers) and observed that only the former group motivates environmental proactivity. This result was explained by arguing that the sample studied consisted of producers of intermediate products and had scarce consumer contact. Álvarez et al. (2001) also observed that the implementation of environmental practices in the hotel industry responds to a higher stakeholder pressure. The study of Klassen and Whybark (1999) included external stakeholder influence as a contextual variable that was measured by two constructs: public interaction, which assessed to what extent managers gather opinions from and provide environmental information to the public, and awareness of environmental regulation, which assessed to what extent plant personnel are informed regarding environmental regulation and evaluated on regulatory compliance. Both constructs showed positive effects on the degree of environmental proactivity.

From the results provided by the academic literature, it is possible to understand as different stakeholders generate different typologies of pressure on firms leading them to the definition of different environmental strategies. In such contest, it is necessary to introduce the concept of perception of pressure. Indeed, the stakeholder pressure is perceived in different ways according to internal and external factors that influence the behaviours and vision of a firm (González-Benito J. and González-Benito O., 2006, 2010; Gabzdylova et al., 2008). The analysis of academic literature brings to understand that the environmental strategy of a firm depends on the internal and external pressure from stakeholder and from the perception about such pressures.

Many authors in the environmental ambit have tried to define the perception of a company to the stakeholder pressure on the base of different factors. The factors to which the academic literature has

dedicated more attention are grouped in the definition of strategic attitude (González-Benito J. and González-Benito O., 2006, 2010; Gabzdylova et al., 2008; Azzone et al., 1997, 1998). In the environmental ambit, the strategic attitude of a company defines the degree of priority that must be attributed to environment-related issues. Therefore, in the same competitive environment and under the pressures of the same market forces, a company could decide to attribute a different priority to environmental issues just in relation to its strategic orientation. Azzone et al. (1997) understand this attitude as the way in which the company reacts or proacts to market stimuli and they consider it as a key variable for classifying environmental strategies. In a later paper, Aragón-Correa (1998) empirically confirmed that a greater strategic proactivity, understood as the company's tendency to initiate changes in its strategic policies before they are demanded, is positively related to a greater environmental proactivity. This might be due to the fact that the strategically proactive companies are used to modifying their products, to developing new markets and, in summary, to undertaking new initiatives with less information and confidence about the possible effects; count on more flexible technologies and are prepared to change them and have organizational structures that facilitate innovation (Aragón-Correa, 1998). In the same line, González-Benito and González-Benito (2003) empirically confirmed that manufacturing proactivity, understood as the company's interest in adopting new developments and leading practices in the production and operations area, is a significant predictor of the voluntary implementation of environmental management practices.

The strategic attitude of a firm in the environmental context is included between two extreme positions: environmental reactivity, typical of companies that only implement the minimal compulsory changes to meet regulations, and environmental proactivity, typical of companies that voluntarily take measures to reduce their impact on the natural environment (see, e.g., Hunt and Auster, 1990; Roome, 1992; Winsemius and Guntram, 1992). In general terms, two categories of papers can be distinguished according to the way they view the path from reactivity to proactivity: one-dimensional and multi-dimensional studies. Conceptual works such as those of Hunt and Auster (1990), Roome (1992) and Winsemius and Guntram (1992) establish a number of progressive stages ranging from reactivity to the highest proactivity, that is, assuming a single and linear path that companies follow when developing their commitment to the natural environment. In other words, one more step in the way of proactivity is associated with a higher implementation of voluntary environmental management practices, but little is said about whether or not the emphasis on particular sets of voluntary practices gives rise to different proactive environmental strategies. This one-dimensional behaviour has been empirically registered in the papers of Sharma and Vredenburg (1998), Henriques and Sadorsky (1999) and Buysse and Verbeke (2003). All these studies start from a list of environmental practices and observe that the implementation of all of them can be reduced to a single factor (Sharma and Vredenburg, 1998) or that those companies with high levels of implementation of one of the practices tend to show high levels of implementation of the whole set of practices (Henriques and Sadorsky, 1999; Buysse and Verbeke, 2003). Because of this, the last two papers also identify several progressive stages along a one-dimensional path from reactivity to proactivity.

Other researchers have adopted a multidimensional and contingent view, that is, they consider that there is no single path (a single linear succession of stages) towards proactivity and that the diversity of existing environmental management practices gives rise to different manifestations of strategic proactivity. Papers such as those of Vastag et al. (1996), Azzone et al. (1997) and Klassen and Angell (1998) propose two-dimensional classifications of environmental management strategies. Bansal and Roth (2000) identify different motivations that lead to a higher environmental proactivity and consider that each motivation induces the implementation of a different portfolio of environmental practices. These papers suggest that environmental proactivity does not necessarily imply the generalised implementation of any environmental management practice. Rather, it can be manifested in different ways through different sets of practices. This multi-dimensionality in the implementation of environmental practices is empirically registered by Aragon-Correa (1998), who identifies three orthogonal dimensions after subjecting the implementation measures of a set of environmental management practices to principal components analysis. Klassen and Whybark (1999) consider three factors determining the environmental management orientation of an organization, each of them characterised by a particular set of practices. A confirmatory factor analysis proves a good fit of data to this multidimensional scheme. All these papers reveal that there are different types of proactive initiatives and practices, and that they might not always be reduced to a single dimension. Furthermore, there is no conclusive evidence about how voluntary environmental practices group into dimensions and what these dimensions are.

2.1.1 Sustainability drivers

The review of literature has allowed identifying the strategic attitude of a firm to environmental issues as driver for developing environmental practices and innovations. The same considerations executed for the environmental component can be reported in the sustainability ambit (Gabzdylova et al., 2008). Therefore, it is possible to measure sustainability proactivity on the base of different factors that are able to identify the strategic attitude of a firms to the sustainability issues. As seen in the environmental ambit the degree of proactivity is included in a range among the definition of a reactive company, which only implements the minimal compulsory changes to meet regulations, and the definition of a proactive company, which voluntarily take measures to reduce their impact on the natural and social environment (Hunt and Auster, 1990; Roome, 1992; Winsemius and Guntram, 1992). Following the example of Azzone et al. (1997), it is possible to identify an intermediate level among reactive and proactive companies. Such level includes the so called active companies, which act reacting to external pressures perceived as constraints. This level allows making a distinction among reactive companies that act only to be compliant with regulations and proactive companies that according to a long-term oriented perspective by considering the expected evolution of the competitive environment and of future customers' requirements, aim at introducing proactive programmes anticipating significant external pressures.

Among the various drivers identified in the academic literature for their influence on the strategic attitude to sustainability of a firm, I decided to take into consideration those factors has received attention in

different and important research works. The considered factors define the strategic attitude to sustainability taking into consideration the external context in which a company operates and the firm's internal configuration. The main features characterizing the company's external context represents a crucial step in the definition of the taxonomy since strategies can be considered as a response to pressures resulting from main external actors or as a managerial tool supporting executives in the anticipation of future market requirements. To this end, a company has to define relationships with a wide set of stakeholders, such as regulators, customers, suppliers, banks, insurance companies, governments, etc., that, in some cases, force the company to adopt specific sustainability actions. Regards the internal context, it describes factors which are related to the firm's internal configuration and which affect the process of environmental strategy formation. Therefore, in this sense it is possible to identify the variables that could lead the company's strategic attitude towards the sustainability.

External context:

- Stakeholder pressure: the pressure generated by external stakeholders can be a fundamental factor for leading a firm to develop sustainability initiatives (Foster & Green 2000; Paraschiv et al. 2012; De Marchi 2012; McKinsey Global Survey Results 2010; McKinsey Global Survey Results 2011; MIT Sloan Management Review with BCG 2013; Accenture report 2012). The academic literature associates the sustainability commitment with higher pressure from external stakeholders (Winsemius and Guntram, 1992; Jennings and Zandbergen, 1995; Henriques and Sadorsky,1999)
- Other external pressure: these typologies of pressure can be linked to the market in which a company operates and to the lack of available resources to generate a competitive advantage in the sustainability ambit (Paraschiv et al. 2012; MIT Sloan Management Review with BCG 2013).

Internal context:

- Compliance: as seen in the models aimed to the definition of degree of proactivity of a company, the first factor that pushes a company to adopt sustainability initiatives is the need to be in compliance with regulatory and norms in order to maintain the license to operate. Indeed, different authors use this factor as base to define a reactive company, i.e. this factor allows identifying a company with a reactive approach to sustainability. (De Marchi 2012; Ekins 2010; Foster & Green 2000; Accenture report 2012; Paraschiv et al. 2012; Carroll and Shabana 2010; McKinsey Global Survey Results 2010; McKinsey Global Survey Results 2011; MIT Sloan Management Review with BCG 2013).
- Opportunity and competitive advantage: as seen from the analysis of academic literature today sustainability is perceived as a source of opportunity and competitive advantage. To sustain such statement, enough to cite the numerous companies that have integrated the sustainability in their strategic objectives because retain that sustainability is an engine for the growth of the company

(Carroll and Shabana 2010; McKinsey Global Survey Results, 2010; McKinsey Global Survey Results, 2011; MIT Sloan Management Review with BCG, 2013; Accenture report, 2012).

- Voluntariness and top management commitment: the support and commitment of top management is considered an essential factor for the development of proactive sustainability strategies on the basis of two arguments: the resources required for the implementation of sustainability practices will be more easily available if the major person responsible for these resources supports the plans and many sustainability initiatives require the collaboration and coordination of different departments and divisions and this is easier to manage when such initiatives are endorsed from the top (Hunt and Auster, 1990; Berry and Rondinelli, 1998; Quazi et al., 2001; Del Brio et al., 2001). Indeed, depending on the managers' beliefs, expectations, perceptions and opinions, the company will become inclined to implement a certain set of sustainability practices (Fineman and Clarke, 1996; Cordano and Frieze, 2000; Flannery and May, 2000; Banerjee, 2001).
- Recruiting: as indicated in the academic literature given the unprecedented rise of public attention to sustainability, companies tend in a lower way to develop sustainability initiatives in order to attract the attention of young and talent employees (MIT Sloan Management Review with BCG, 2013; McKinsey Global Survey Results, 2010). Naturally, this is the weaker motivation that leads a company to a sustainable development and it is viewed as motivation for company characterized by a high level of proactivity in the sustainability ambit.

Such factors have been used in the research in order to define the company sustainability strategic position among reactive, active and proactive approach because allow to evaluate the strategic attitude of a firm to sustainability.

2.2 Past performance

Through the analysis of academic literature, it has been possible to identify different drivers for the engagement in sustainability practices. Previously, it has been analysed as possible determinant, the company sustainability strategic position, which, as seen, is strongly linked to the internal and external pressures generated by the different stakeholders of a firm. Such pressure, in particularly the external pressure, can be analysed in function of firm's past performance. In such context, the pressure generated by external stakeholders can depend on the firm's past performance. This relation has been studied in the literature in the ambit of Institutional theory (DiMaggio and Powell, 1983; Meyer and Rowan, 1977; Scott, 1995, 2005).

Institutional theory focuses on how social influence toward conformity shapes organizations' actions. Organizations are assumed to seek approval and thus are susceptible to social influence. One of the main theses of institutionalists is that organizations try to enhance or protect their legitimacy (Deephouse, 1999; Scott, 1995). Concern over legitimacy, in turn, induces firms to adopt practices that are socially

valuable within an institutional field. Institutional theory does not research into efficiency issues nor the impact of strategic choices on firm performance, because financial considerations are not the primary driver of socially compliant managerial practices (Berrone and Gomez-Mejia, 2009).

This feature has made the theory particularly attractive to environmental management researchers, since green investments often cannot be financially justified, at least in the short term (Bansal, 2005; Bansal and Clelland, 2004; Hoffman, 1999, 2000). Several studies during the past decade or so illustrate this intellectual tradition. For example, Hoffman (1999) examined the chemical and petroleum industries from 1960 to 1993 and reported that these industries had changed in response to mounting institutional pressures for better environmental performance even though he could not uncover any financial gains as a result of these changes. More recently, Berrone et al. (2010) showed that family firms are more sensitive to environmental institutional pressures and exhibit better environmental performance, even though there is no evidence of financial benefits to the firm as a result of these environmental responses. Most of the research noted above is driven by the assertion that, in their quest for legitimacy, firms become more alike as institutional pressures increase.

In the academic literature, the research work of most interest has been published by Berrone et al. (2013) in the ambit of study relative to firms' response to environmental institutional stimuli. The authors have argued that strong regulatory and normative institutional pressures make environmental innovation more attractive to firms, especially to those displaying greater deficiency gaps, and the availability and specificity of a firm's resources facilitate the implementation of these risky practices. This research work was inspired by the statements of Scott (1995) about the Institutional theory. The author has identified three basic pillars that structure and provide meaning to organizational behaviour: regulative, normative, and cognitive. Regulation provides explicit guidance to organizations through rules, controls, rewards, and sanctions. Norms guide behaviour through a less explicit system of standards and values. Cognition includes cultural elements that govern choice often without receiving conscious thought. Although Scott recognized that all institutions combine the three elements, he suggested in a subsequent review of institutional theory (Scott, 2005) that the regulatory and normative dimensions deserve special attention from researchers considering institutional pressures. Although the three elements are often at work simultaneously, they display varying degrees and their relevance is context-specific. In the case of environmental sensitive industries, a significant amount of research has shown that both regulatory agents (e.g., governmental agencies) and normative agents (e.g., professional non-governmental organizations) are relevant actors in shaping the institutional field (Buysse and Verbeke, 2003; Henriquesriques and Sadorsky, 1999; Kassinis and Vafeas, 2006).

Within the Institutional theory ambit and considering the Scott's statements, Berrone et al. (2013) have focused their attention to the role of different agents defined by Scott in influencing a firm's environmental innovation efforts. Therefore following this example, it is possible to enlarge the

application of the Institutional theory to the sustainability ambit in order to study as firm's sustainability past performance can lead the behaviour of a company in the development of sustainability initiatives.

The objective is to verify if companies sensitive to sustainability issues, due to their insufficient sustainability performance, pushed by institutional pressures assume specific behaviours in the development of sustainable practices.

3 Sustainability innovation

The academic researches show as sustainability is a mother lode of organizational and technological innovations that yield both bottom-line and top-line returns. The application of initiatives aimed to the sustainable development allow to reduce costs and to generate additional revenues from better products or enables companies to create new businesses (Nidumolu et al., 2009). The goals reached through sustainability, highlighted by numerous authors in their research works, are attributable to goals of corporate innovation. In fact, for this reason it is possible to observe as smart companies now treat sustainability as innovation's new frontier.

This new innovation model has led to the definition of term sustainability innovation, which indicates the development or more in general the change of processes, products, management and organizational practices that include the sustainability among the objectives of the initiative. On this base a sustainability innovation has to be able to generate improvements relative to economic, social and environmental spheres of sustainability, as defined through the triple bottom line concept.

The introduction of the sustainability perspective in the development of corporate innovation has led companies to change the way they think about products, technologies, processes, and business models. Indeed, by treating sustainability as a goal today, early movers will develop competencies that rivals will be hard-pressed to match. This behaviour will generate a competitive advantage, which will stand them in good stead, because sustainability will always be an integral part of development (Nidumolu et al., 2009). The achievement of these possible competitive advantages is not so easy precisely because of different goals linked to sustainability. Indeed, aggregating economic, ecological and social effects inevitably leads to trade-offs and is limited due to current methodological constraints (Callens and Tyteca, 1999; Rennings, 2007).The evaluation of a sustainability innovation within the three spheres of sustainability has generated high complexity in the classification of such innovations. This high level of complexity has been visible during the analysis of academic literature, in which the sustainability innovations are classified on the base of different dimensions.

An interesting classification of sustainability innovations has been introduced by Nidumolu, Prahalad and Rangaswami (2009). The three authors have based their classification on the implementation phases of sustainable development process. Their research work has split the sustainable development process in five stages that are able to map the road of companies to sustainability in efficient and effective way. Such classification includes an implicit categorization of sustainability innovations on the base of grade of impact, area of impact and object of innovation. Specifically, the process of sustainable development, described by Nidumolu et al. (2009) begins with the phase of compliance to normative linked to sustainability objectives and proceeds through the implementation of innovations aimed to make sustainable the supply chain of a company and gradually also products and services of the firm. The

defined process brings till to the development of more complex innovations relative to the creation of new business models and next practice platforms.

Another important and more practical classification of sustainability innovations has been introduced by Hansen, Grosse-Dunker and Reichwald (2009) through their generic model denominated “Sustainability Innovation Cube”. The three authors have classified the sustainability innovations on the base of the generated effects according to three interrelated dimensions. For the first dimension, by following the concept of sustainability development from a business perspective, the authors have taken into consideration the triple bottom line concept differentiating economic, environmental and social effects. In addition, in order to embrace effects of products and technologies within the different phases of their physical life cycles (Klöpffer, 2008; Saling et al., 2002), the authors have introduced the so called life cycle dimension. The last dimension considered in this classification is the innovation type that allows enlarging the content of innovation from a technological level to higher service contingents. To summarize, the model is able to classify a sustainability innovation assessing the effects generated on the base of different criteria. The target dimension distinguishes among economic, environmental and social effects. This dimension of assessment is completed considering the phase of life cycle to which the innovation is addressed, which distinguishes into manufacture, use or end of life. While, the last considered dimension allows to classify the initiative according to the innovation type splitting the innovation object in technology, product-service system and business model.

In addition to the different classifications relative to sustainability innovations, from the analysis of research works, it has been possible to identify that a fundamental aspect that characterize the identification of a sustainability innovation is the triple objective to which is addressed the development of the initiative. Indeed, in the academic literature has been underlined more times as a sustainability innovation has to generate social, environmental and economic improvements for a firm. The economic contribution, that associates the sustainability innovation to the technical corporate innovation, is also a common factor between social and environmental innovations identified in the sustainability ambit. Some authors as Epstein and Roy (2003) classify the sustainability innovation distinguishing between social and environmental actions considering the economic objective as base for the development of such typologies of innovation. Indeed, the sustainability innovation is closely linked to the principles of Sustainable Development, which calls on corporations not just to look at profits or dividends when making decisions, but also to consider the immediate and long-term social and environmental consequences of their activities (Asongu J., 2007).

Another important aspect to which the academic literature has dedicated attention is the degree of impact relative to the implementation of sustainability innovations. This dimension divides the sustainability innovations between incremental and radical initiatives. Incremental innovations are close to existing practices, and may therefore be realized more easily than radical innovations, which need

adaption of systems of production and consumption or the development of new technologies (Nooteboom B, 2000) and therefore meet resistances from inside, as well as outside, the organization (Chakravorti B, 2004). Radical innovations are occasionally needed to renew the core business and to deal with discontinuities caused by pressures from outside the industry or by technological change (Utterback JM, 1996). The development of any radical innovations can be a particularly difficult task, irrespective of sustainability innovations, because it usually involves a departure from the present knowledge base (and is thus competency-destroying) and may also require vastly different organizational, administrative and infrastructure requirements. Companies often prefer an incremental (or competency-enhancing) approach, because it allows them to continue profiting from their proven technology and organizational competency base (Anderson and Tushman, 1990).

According to this wide concept of sustainability innovation, innovative companies are thinking and act in terms of a "triple bottom line" ethic, which goes well beyond the drive to maximize shareholder value by incorporating environmental quality and social justice considerations into their business decisions. To refuse the challenge implied by the triple bottom line is to risk extinction (Larsen & Peck, 2001).

Therefore, given the fundamental role played by sustainability innovation, which is recognized by researchers and corporations, in order to understand potentially outcomes derived by the implementation of sustainability innovations, it is necessary to develop a framework in which such innovations can be identified and then exploited to the company's advantage. As previously highlighted, the main classification adopted in the academic ambit distinguish between social and environmental innovations assessing the nature of the effect generated by the firm in the system in which operates. For this reason such distinction has been used to analyse sustainability innovations in more specific way.

3.1 Environmental innovation

In the academic literature, there exist various definitions of environmental innovation. One such definition asserts that 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). Such concept of environmental innovation, which is most commonly acknowledged in the research ambit with the term eco-innovation, has been analysed from the perspective of the "target" of innovation (Schumpeter, 1934). This perspective has brought to the broader definition of sustainable innovation or eco-innovation, which is considered as the process of developing new ideas, behaviour, products and processes that contribute to a reduction in environmental burdens or to ecologically specified sustainability targets (Rennings, 2000). A similar definition has been given by Blättel-Mink (1998), who has emphasized that eco-innovations may include the development and introduction of new products (environmental technologies), new markets and new systems (e.g. of transportation) as well as very broadly the introduction of ecological dimensions in economic strategies.

According to these broad definitions, one of the most important aspects that allows to identify an eco-innovation is the reduction of environmental impacts derived by the implementation of such initiatives at business and community level. This aspect is underlined, for example, by Peter James, who defines eco-innovation as "new products and processes which provide customer and business value but significantly decrease environmental impacts" (James 1997).

A further definition that highlights such aspect is provided by Denmark's government, which defines eco-innovation as innovation leading to an eco-efficient technology in the white paper "Promoting Eco-efficient Technology - The Road to a Better Environment". Eco-efficient technology means all technologies which directly or indirectly improve the environment. It includes technologies to limit pollution, more environmentally friendly products and production processes, more effective resource management, and technological systems to reduce environmental impacts.

Considering the technology perspective, it is possible to enlarge the concept of environmental innovation because according to ETAP (the European Commission's Environmental Technologies Action Plan), environmental technologies encompass technologies and processes to manage pollution (e.g. air pollution control, waste management), less polluting and less resource-intensive products and services and ways to manage resources more efficiently (e.g. water supply, energy-saving technologies). Therefore, environmental technologies are technologies whose use is less environmental harmful that relevant alternatives.

This last definition of environmental technology allows noting that an eco-innovation no longer requires to be aimed at reducing environmental harm. So as made by Kemp and Foxon (2007), it is possible to propose to not restrict eco-innovations to those innovations whose purpose is to reduce environmental harm, by enlarging the concept of eco-innovation to the following working definition:

"Eco-innovation is the production, application or exploitation of a good, service, production process, organisational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resources use (including energy use) compared to relevant alternatives (Kemp and Foxon ,2007)."

3.1.1 Environmental innovation classification

During the years environmental innovations have been treated by different authors and consequently have been classified on basis of different dimensions. A classic division coheres with Joseph Schumpeter's key notion for which innovation is the result of novel combinations created by the entrepreneur. Schumpeter's concept of combinations suggests possible areas of application, including in this way the now well-known separation of innovation into product ('new good') or process ('new method of production'), which can be usefully applied on environmental innovation.

These basic, Schumpeterian categories may in turn be subdivided in a number of ways. A useful distinction can for example be made between incremental and radical innovation, referring to the newness of the offering, i.e. a technology or process can be significantly or only marginally different from its predecessors or alternatives (Freeman and Soete, 1997). From the considerations of different authors, it is possible to observe that the emphasis on process innovation and efficiency gains has led to an orientation towards incremental rather than radical innovation. At the same time it has been argued that an industry will face decreasing marginal returns on its incremental eco-efficiency efforts, in terms of sustainability and financial improvements, and that it is therefore pertinent to regularly generate radical eco-innovation in order to push the technological system up to a new equilibrium (Murphy and Gouldson, 2000). Thus in the long run incremental eco-innovation cannot be sustained without radical innovation.

Another distinction that is useful for understanding eco-innovation is between architectural and component innovation, sometimes referred to as systemic and modular innovation (Henderson and Clark, 1990). Component innovation takes place when one or more modules nested within a larger system are replaced, while the system itself stays intact. An architectural innovation on the other hand entails changing the overall system design and hence the way that the parts interact with each other.

These three classifications provide a basic distinction linked to the object and to the entity of an innovation that can be adapted to the environmental context. In the academic literature different authors have proposed more punctual classifications and theories about this ambit.

The first theory, well known and widely adopted in the literature, is the Natural resource based view, which is proposed by Hart in 1995. The natural-resource-based view has been developed considering the connection between the environmental challenge and firm resources. The theory is an evolution of the Resource based view of the firm and it is based on the concepts of key resource requirements and sustained competitive advantage. Researchers in the field of strategic management have long understood that competitive advantage depends upon the match between distinctive internal capabilities and changing external circumstances (Andrews, 1971; Chandler, 1962; Hofer & Schendel, 1978; Penrose, 1959). However, it has only been during the past decade that the resource-based view of the firm, has emerged, articulating the relationships among firm resources, capabilities, and competitive advantage. Afterwards, Hamel and Prahalad (1989, 1994) have emphasized the importance of "competing for the future" as a neglected dimension of competitive advantage. According to this view, the firm must be concerned not only with profitability in the present and growth in the medium term, but also with its future position and source of competitive advantage. The resource-based view takes this thinking one step further and posits that competitive advantage can be sustained only if the capabilities creating the advantage are supported by resources that are not easily duplicated by competitors. In other words, firms' resources must raise "barriers to imitation" (Rumelt, 1984). Over the next decade, businesses will be challenged to create new concepts of strategy, and it seems likely that the basis for gaining competitive

advantage in the coming years will be rooted increasingly in a set of emerging capabilities such as waste minimization, green product design, and technology cooperation in the developing world (Gladwin, 1992; Hart, 1994; Kleiner, 1991; Schmidheiny, 1992). Therefore for the Natural resource view of the firm, it is necessary to embrace and internalize the challenge created by the natural environment, developing strategies and competitive advantages that are linked to capabilities that facilitate an environmentally sustainable economic activity.

The conceptual framework, proposed by Hart (1995) in the ambit of Natural resource based view of the firm allows classifying the environmental innovations through three interconnected strategies: pollution prevention, product stewardship, and sustainable development.

The first strategy, defined as Pollution prevention, seeks to reduce emissions using continuous improvement methods focused on well-defined environmental objectives rather than relying on expensive "end-of-pipe" pollution-control technology (Imai, 1986; Ishikawa & Lu, 1985; Roome, 1992). Such a strategy is people intensive, and it depends upon tacit skill development through employee involvement (Cole, 1991; Lawler, 1986) and work in "green" teams (Makower, 1993; Willig, 1994). Pollution prevention should thus afford opportunity for a sustained competitive advantage through the accumulation of tacit resources embedded in large numbers of people. Furthermore, because pollution prevention is people intensive, rather than technology intensive, firms should realize simultaneous reductions in both emissions and capital spending for pollution control (Buzzelli, 1994). However, there appear to be limits to a strictly internal pollution-prevention strategy. Increasingly, local communities and external stakeholders are demanding that corporate practices become more visible and transparent (Bozeman, 1987; Freeman, 1984; Roberts & King, 1989).

Product stewardship, unlike pollution prevention, implies an organizational ability not only to coordinate functional groups within the firm, but also to integrate the perspectives of key external stakeholders, such as environmentalists, community leaders, the media, regulators, into decisions on product design and development (Welford, 1993). In fact, as noted previously, pollution prevention focuses on new capability building in production and operations. However, activities at every step of the value chain, from raw material access, through production processes, to disposition of used products, have environmental impacts, and these will almost certainly need to be internalized in the future (Costanza, 1991; Daly & Cobb, 1989). Product stewardship thus entails integrating external stakeholder perspectives into product design and development processes (Allenby, 1991; Fiksel, 1993). For a firm to realize product stewardship, a minimum requirement would seem to be that LCA be integrated into the firm's product-development process (Keoleian & Menerey, 1993). LCA is used to assess the environmental burden created by a product system from "cradle to grave" (Keoleian & Menerey, 1993). For a product to achieve low life-cycle environmental costs, designers need to minimize the use of non-renewable materials mined from the earth's crust, avoid the use of toxic materials and use living resources in accordance with their rate of

replenishment (Robert, 1995). Also, the product in use must have a low environmental impact and be easily composted, reused, or recycled at the end of its useful life (Kleiner, 1991). It thus seems reasonable to conclude that firms in the developed markets will be driven increasingly to minimize the life cycle environmental costs of their product systems. Therefore, through product stewardship, firms can exit environmentally hazardous businesses, redesign existing product systems to reduce liability and develop new products with lower life-cycle costs.

The last considered strategy is the sustainable development, which appears to have significant implications for firms, particularly large multinational corporations. For a firm, pursuing a sustainable development strategy implies both substantial investment and a long-term commitment to market development. Creating such a shared vision of the future appears to require strong moral leadership (Bennis & Nanus, 1985; Selznick, 1957) and an empowering social process, reaching deep into the management ranks (Campbell & Yeung, 1991; Hart, 1992; Senge, 1990). Given the difficulty of generating such a consensus about a purpose, shared vision is a rare firm-specific resource, and few companies have been able to establish or maintain a widely shared or enduring sense of mission (Hamel & Prahalad, 1989). Commitment to sustainable development might raise a firm's expectations for future performance relative to competitors, reflected by such measures as price earnings or market to book ratios. Sustainable development will likely require a concerted effort and a long-term vision to leverage an environmentally conscious strategy into the developing world that includes low impact technology and products as the basis for market entry and development (Schmidheiny, 1992).

In addition to the classification proposed by Hart (1995), it has been possible to identify in the academic literature other largely adopted categorizations as that derived by the research work of Hayes, Wheelwright and Bowen's (1985) about the operation functions. In particularly, Kleindorfer et al. (2005), introducing the term sustainable operation management, have reformulated the Hayes-Wheelwright-Bowen's framework in the context of sustainable operations through the definition of the following four strategies:

1. The current internal strategies, to improve internal operations with continuous process improvements related to sustainability, such as, employee involvement, waste reduction, energy conservation, and emission control.
2. The current external strategies, to improve ex-tended supply chains by analysing upstream supply chains to make trade-offs in the choice of materials and processes and pursuing closed-loop supply chains for remanufacturing and safe disposal.
3. Internal strategies for the future include investing in capabilities to recover pollution-causing chemicals during manufacturing, to develop substitutes for non- renewable inputs, and to redesign products to reduce their material content and their energy consumption during manufacturing and use.

4. External strategies for the future include developing core capabilities in products, processes, and supply chains for long-term sustainability and pursuing strategies to facilitate it. (Kleindorfer et al., 2005)

A further classification of the eco-innovation has been defined by Kemp and Foxon (2007), inside their punctual discussion aimed to the definition of eco-innovation typologies. In seeking to develop a typology of eco-innovation, the two authors have argued that it may be useful to distinguish between environmental technologies, organisational innovation, product and service innovation with environmental benefits, and green systems changes.

1. Environmental technologies
   - ✓ Pollution control technologies including waste water treatment technologies Cleaning technologies that treat pollution released into the environment
   - ✓ Cleaner process technologies: new manufacturing processes that are less polluting and/or more resource efficient
   - ✓ Waste management equipment
   - ✓ Environmental monitoring and instrumentation
   - ✓ Green energy technologies
   - ✓ Water supply
   - ✓ Noise and vibration control
2. Organisational innovation for the environment: The introduction of organisational methods and management systems for dealing with environmental issues in production and products.
   - ✓ Pollution prevention schemes: aimed at prevention of pollution through input substitution, a more efficient operation of processes and small changes to production plants (avoiding or stopping leakages and the like)
   - ✓ Environmental management and auditing systems: formal systems of environmental management involving measurement, reporting and responsibilities for dealing with issues of material use, energy, water and waste
   - ✓ Chain management: cooperation between companies so as to close material loops and to avoid environmental damage across the value chain (from cradle to grave)
3. Product and service innovation offering environmental benefits: New or environmental improved products and environmentally beneficial services
   - ✓ New or environmentally improved products (goods) including eco-houses and buildings
   - ✓ Environmental services: solid and hazardous waste management, water and waste water management, environmental consulting, testing and engineering, testing and analytical services
   - ✓ Services that are less pollution and resource intensive. An example is car sharing
4. Green system innovations

- ✓ Alternative systems of production and consumption that are more environmentally benign than existing systems: Examples are biological agriculture and a renewables-based energy system.

Perhaps the most important aspect of this classification scheme is that eco-innovation is not limited to new or better environmental technologies. In fact, every environmentally improved product or service and organisational change for the environment counts as an eco-innovation.

3.1.2 Radical vs. Incremental

One of the main distinctions related to environmental innovations regards the differentiation between incremental and radical innovations. This classification, which has been introduced to complete the Schumpeterian distinction between product and process innovation, subdivides the environmental innovations considering the entity of innovation. Therefore, it is necessary to evaluate the newness of the offering, i.e. technology or process can be significantly or only marginally different from its predecessors or alternatives (Freeman and Soete, 1997). In order to be able to make this evaluation, it is necessary to understand the innovation theory related to technological change involving eco-innovations. Analysing the wealth of literature that studies technological change involving "normal" innovations, it is possible to observe some industrial dynamics involving eco-innovations. First of all eco-innovations, or environmental innovations, compete in the market with all other products and services. In that regard, a technological transition involving an eco-innovation experiences the same fundamental industrial dynamics as would any other innovation. However, eco-innovations fundamentally differ from other new technologies in that they necessarily provide a reduced environmental impact when compared to the dominant design (Rennings, 2000). Additionally, the environmental benefits of eco-innovations are not exclusive to the owner, so society as a whole reaps rewards from their use. Talking about technological transition, one of the fundamental elements, that it is necessary to take into consideration is how an innovation compares to the conventional technology. In this way, innovations are often understood to be incremental if they reinforce existing technology or radical if they require new expertise or knowledge (Tushman and Anderson, 1986). In the industry life cycle literature, the focus is on the evolution of industry structure and on the emergence of a dominant design. In this ambit, once the dominant design has emerged, an era of incremental change takes place in which organizations focus on incremental improvements of the dominant design (Klepper, 1996), instead the radical innovations are implemented at the end of dominant design era.

Turning back to the specific environmental field, it is possible to note as in the academic literature the environmental innovations as waste management, eco-efficiency, reduction of emissions, recycling, eco-design or any other action implemented by firms to reduce their environmental footprint include both incremental and radical improvements (De Marchi, 2012). In particular, it is recognised as pollution prevention initiatives typically require more radical technological innovation, with significant changes to products or processes (Jones and Klassen 2001). Instead, pollution control practices tend to rely far more heavily on incremental innovation, where existing products and processes change little (De Marchi, 2012).

The academic literature recognizes as in order to achieve the emissions targets implied in truly sustainable development it will not be enough to improve existing technologies gradually. Rather, technological products and systems must be significantly reconstructed, that is, radical innovation is necessary (Huesemann, 2003). However, most innovation takes place in the incremental mode, and eco-innovation is no exception.

3.1.3 The economic impact of environmental innovations

As the new economic order unfolded, people recognized that profits and profitability were only one element in the long-term success of companies and the economies (Hay, Stavins, and Vietor, 2005). Also important are the future of people, internal and external to companies, and the future of planet Earth. On the base of such awareness, strategy and public-policy experts debate the ultimate cost and benefits of environmental regulations. Many early discussions about sustainable technologies focused on trade-offs between sustainability and economic competitiveness. Parkinson (1990), Porter (1991), and Makeower (1993) challenged the view that trade-offs were inevitable. Focusing on the environmental field, contrarily Porter (1991) argued that the conflict between environmental protection and economic competitiveness is a false dichotomy based on a narrow view of the sources of prosperity and a static view of competition. He argued that tough environmental standards can trigger innovation and upgrading of sustainable technologies, noting: “Properly constructed regulatory standards, which aim at outcomes and not methods, will encourage companies to re-engineer their technology. The result in many cases is a process that not only pollutes less, but also lowers costs or improves quality. Processes will be modified to decrease use of scarce or toxic resources and to recycle wasted by products” (Porter 1991). Porter and van der Linde (1995) have linked this view to the concept of resource productivity and to the environment, innovation, and competitiveness. They used examples from several companies to show that environmental improvements can lead to improved process, products, and profits. Now throughout the world, the public and its political representatives have been demanding improved performance on environmental, health, and safety issues. The question for companies has become not whether to commit to a strong environmental, health, and safety record, but how to do so in the most cost-effective manner. In this situation opportunities to invest in sustainable technologies, operations, and supply chains to increase rapidly. Today, it is largely accepted the fact that improved environmental performance can aid plant-level productivity efforts (Klassen 2001) and increase revenues and market share (Delmas, 2001). To gain these positive results, the firm must establish management systems and tools that integrate environmental metrics with other process metrics within the company and across the supply chain (Bowen et al., 2001). To support of the positive relation between environmental innovations and economic performance of a firm there are many research works as those ones of King and Lenox (2001) or Rothenberg, Pil, and Maxwell (2001), which have examined the links between lean manufacturing and green manufacturing founding some synergies.

3.2 Social innovations

The term social innovation has been introduced for the first time by Schumpeter in 1912 within his publication of "Theory of economic development". He has highlighted as the necessity of social innovation occurring in tandem in both the economic arena as well as in culture, politics and a society's way of life in order to guarantee the economic efficacy of technical innovations.

The mention of social innovation in literature after Schumpeter is rare and only marginal (Moulaert et al., 2005) and the concept of social dimension related to innovation has been introduced in the last years. This dimension appears in the Green Paper on Innovation (E. Cresson, M. Bangemann 1995), a document created by the European Commission to identify the factors on which innovation in Europe depends and to elaborate proposals to foster innovation capacity in Europe. In it, innovation is described as "being a synonym for the successful production, assimilation, and exploitation of novelty in the economic and social spheres", and the social element of innovation is highlighted in the document saying that "Innovation is not just an economic mechanism or a technical process. It is above all a social phenomenon. By its purpose, its effects, or its methods, innovation is thus intimately involved in the social conditions in which it is produced".

From that first appearance, other authors have treated and defined the social innovation in different contexts. Dawson and Daniel (2010) have deeply analysed the concept of social innovation describing it as the development of new concepts, strategies and tools that support groups in achieving the objective of improved well-being. Social innovations attempt to resolve economic, social and environmental challenges rather than simply provide market rewards, what is defined as a social goal is itself shaped within social collectivities and by socio-political processes (Dawson and Daniel, 2010). A similar definition has been provided by Mulgan (2010), who states that the social innovations are new ideas that work to meet pressing unmet needs and improve people's lives, so a social innovation refers to new ideas that work in meeting social goals. Instead, on base of the working definition from Kesselring and Leitner (2008) social innovations are defined as elements of social change that create new social facts, namely impacting the behaviour of individual people or certain social groups in a recognizable way with an orientation towards recognized objects that are not primarily economically motivated. Observing these three definitions, it is possible to state that a social innovation aims to generate a social change through the involvement of community interested by the shift.

3.2.1 The evolution of a concept

In the last years, the necessity of developing social innovations is become clear at political and economic level. One of the authors that has treated this argue is Hubert (2011), who into its work has highlighted a lesson learned from the crisis, which has shown as many innovations in the financial market have provided a low social value generating a social and economic disaster. For her this is a proof that there is the need to develop innovations that are able to provide a high social value and that aim to solve long term social

problems. The same concept has been expressed by the President of EU Barroso, who in addition to underline the importance of social innovation implementation in the community context, has defined the need to change the innovation policy of EU, stating that: "A successful innovation policy is one that involves all actors in society, innovation is something you do with people, not to them" (Barroso, 2010). From this declaration, it is possible to understand that, if the primary objective is to introduce a social and sustainable change, the main variable on which governments, institutions and enterprises have to act is people's empowerment.

The evolution of social innovation concept is observable analysing the Renewed Social Agenda of EU, indeed, it is possible to note that it contains the most solid policy framework for social innovation. It calls for a reform of social policies by insisting on opportunities, access and solidarity carried in the spirit of empowerment and responsibility which is at the heart of social innovation. It favours prevention policies such as investing in children and youth and reinforcing anti-discrimination regulation and enforcement as the guiding principles along which social policies should reform.

From the analysis of literature, the social innovation appears as the leading actor of a deep change related to the economic system and to the innovation process paradigm.

3.2.2 Social economy

A very interesting analysis of the social economy concept is included in the work of Lévesque and Mendell (2005), who treated an approach adopted by a new generation of researchers that combines micro (enterprise or organization) and macro (State and institutional context) dimensions, trying to redefine the economic and political dimensions of the social economy. In so doing, they link the emergence of a new generation social economy to the crisis of Keynesian regulation, to the reconfiguration of the welfare state and economic restructuring, as civil society established itself as a complementary force to the State and the market (Evers and Laville, 2004). In this analysis, the social economy is defined not only as economic activity with a social purpose but also as activity based on a new, broader concept of the economy and politics (Dacheux and Laville, 2004). This new concept, instead of considering the economy from a formal neo-classical perspective, is originated on the ideas of Karl Polanyi (1944) and defines the economy from a substantive perspective. In this perspective, the social economy organization is distinguished both by its capacity to combine a greater diversity of resources than other types of organizational forms and by its commitment to collective goals and democratic practice (Mendell, 1996). Taking into account all these principles, it is possible to define the social economy on base of three main aspects as a plural economy because of the plurality of principles and resources mobilized (Roustang et al., 1997), as an integral part of a mixed economy of social welfare, to situate the social economy as an intermediary space between the private sector, the State and the domestic economy, thus highlighting both its socio-economic and its socio-political dimensions (Evers and Laville, 2004) and as a third sector which, although separate from the State, private enterprise and the informal domestic economy, overlaps with each of them because of their

blurred boundaries (Pestoff, 1998). It is seen as an integral part of a new system of governance of the public interest in which the resources of the State, the market and civil society are mobilized in new ways (Enjolras, 2004). Thus the social economy is not a sector of civil society, it is part of a plural economy or mixed economy of social welfare.

In addition to the analysis and definition of the concept of social economy, in the work of Lévesque and Mendell (2005) is included the definition of social innovation, which is associated increasingly with those of social enterprise and social economy. For them a social innovation may be defined as "any new approach, practice or activity and/or any new product that has been developed to improve a situation or solve a social problem" and which "has gained support among institutions, organizations and communities" (Bouchard, 1999). Comparing the concepts of social innovation and social economy, it is possible to identify some fundamental common elements. In fact, both for social economy and social innovation is decisive the active involvement of different actors that are able to combine their sources in order to achieve a social purpose or in a broader perspective to generate a social change. These common elements show as the social innovation can be seen as a developing mean for social economy.

3.2.3 Innovation process paradigm

Another interesting structural change, linked to the concepts of social innovation and social economy, regards the innovation process paradigm. The emergence of a new innovation paradigm is supported by the work of Bruland and Mowery (2005). The authors associate the changes that occur in the innovation paradigm to the shift among different phases of industrial revolution. The establishment of a new innovation system leads to far reaching changes in the entire structure of institutions (Bruland and Mowery, 2005). What is highlighted in their work is the importance of broad institutional change, rather than the strategic importance of any single industry or technology, even if the leading industry has tremendous influence on the prevailing innovation mode. In this historical period, the always more importance assumed by the social dimension in the innovation process is related to the social shift from an industrial society to a knowledge and service economy. This change is visible observing the new economic sectors and industries, which are increasingly determining the look of the economy and society and are changing the modes of production and innovation.

The new innovation paradigm is mainly characterized by an opening to society (FORA, 2010). In this model the relevant agents actively involved in the innovation process are other companies, technical schools, research institutes, customers and citizens. The transition from an industrial society to a knowledge and service economy is characterized by the abandonment of the industrial innovation paradigm, focused on technical innovations relating to products and processes (Gillwald, 2000), to a new innovation paradigm, in which the focus is on the social innovations, which aim to generate an extensive change in the leading cultures that influence behaviour and the social practices in the economy and consumption, determining in what sort of world the next generation of the citizens of free societies will be living (Dahrendorf, 2009).

3.2.4 Complete definition

Taking into account the development of a new innovation paradigm and the reestablishment of the social economy concept, it is possible to state that the implementation of a social innovation can be seen as a tool used by firms to satisfy new business opportunities and the global challenges, such as climate change, supply of clean water, demands from citizens for higher quality, more personalized public services, and so on (Mulgan, 2006). Naturally, the main variation in the innovation ambit is related to the introduction of the social dimension, which seems to take place primarily through organizations with social aims. Although this, some authors pointed out that social innovations should go beyond the dichotomizing of the non-profit sector and the for profit sector. The central issue is that innovation should be a response to social problems and should have a real impact on social change and quality life (Lemieux, 2004).

So, come back to social innovation definition, in general, it can be defined as new responses to pressing social demands, which affect the process of social interactions and it is aimed at improving human well-being (Stiglitz, 2009). Analysing the two concepts that compose the term social innovation, it is possible to note as the term "innovation" is referred to the capacity to create and implement novel ideas which are proven to deliver value, while the term "social" is referred to the kind of value that innovation is expected to deliver, so a value that is less concerned with profit and more with issues such as quality of life, solidarity and well-being. An interesting approach, introduced by A. Hubert (2010), provides a complete definition of social innovation integrating the notions of social economy and new innovation paradigm. It defines the social innovations as innovations that contribute to the reform of society in the direction of a more participative arena where empowerment and learning are both sources and outcomes of well-being.

3.2.5 Social innovation and technical innovation

In literature, there are numerous definitions of social innovations that allow us to determine the difference between this type of innovation and the technical innovations. From the previous analysis of social innovation definitions, it has been highlighted as a social innovation is a part of a social change, but not every process of social change is necessarily a social innovation. In fact, social innovation has been frequently presented as a normative instrument used to resolve social problems through the creation of new services or new products (J.L. Klein and D.G. Tremblay, 2010; J.A. Phills et al., 2008; G. Mulgan et al., 2007). This kind of instrumental definition leads to a too narrow view of social innovation for three reasons. First, because an answer to a social problem is not necessarily a social innovation, even technical innovations might be aimed at solving social problems. Second, because it proposes a material dimension of social innovation (product), what is incoherent with the ontological immateriality of the phenomenon as highlighted by Neumeier (2012): "Social innovations are non-material: their material outcomes are solely a supplementary result and they focus not on needs but on asset building". Hence, social innovations are manifested in changes of attitudes, behaviour, or perceptions, resulting in new social practices. Third, social innovation is about social change and this should be the main characteristic to be put in evidence (Neumeier 2012; J. Howaldt, M. Schwarz 2010). Regarding the concept of social change, it

does not take into consideration only variations in the way social agents act and interact with each other, but also changes in the social context in which these actions take place through the creation of new institutions and new social systems.

As just said by other authors, the social innovations are gaining greater importance, also in terms of economic factors, over technical innovations in the face of depth and development of change in modern societies (Giddens, 2009; Hochgerner, 2009). Taking into account a broader definition of social innovation, it is possible to define it as a new combination and/or new configuration of social practices in certain areas of action or social contexts prompted by certain actors or set of actors in an intentional targeted manner with the goal of better satisfying or answering needs and problems than is possible on the basis of established practices (J. Howaldt and M. Schwarz, 2010). Therefore focusing only on the differences among the concept of social innovation and the concept of technical innovation, the aspects considered are two. The main difference among these two types of innovation is related to their purposes, in fact the key driver for technical innovation is commercial and profitability success (P. Dawson, L. Daniel 2010) and instead social innovation brings up social change that cannot be built up on the basis of established practices. Another important distinction, as just said, can be found in the immaterial structure of social innovation, which does not come to fore as a technical artefact, but as new social practices that will ultimately become institutionalized.

These two characteristics allow enlarging the definition of social innovation, in fact how arguing Howaldt and Schwarz (2010), what is meant by social does not relate only to the behavioural practices or the human relationship involved in the process of innovation creation and diffusion, but it has a larger meaning based on the creation of a greater common good.

Analysing the literature, it has been possible to note that some authors consider the concepts of social and technical innovations as two distinctive concepts, while other authors consider the existence of a link among these two types of innovations. The main authors, that support the presence of a link, are MacKenzie and Wajcman (1999), who argue in its work that there is a social shaping of technology in which technology is malleable and shaped by social processes. Instead, Grint and Woolgar (1997) take this relationship further by suggesting that there is no boundary between the social and technical dimensions, with the exception of those boundaries that are socially defined. Among the supporters of the presence of a distinction among the two innovation types, there are Greenhalgh et al. (2004), with a research on the diffusion of innovation in health care-related service organizations, in which the social innovation is defined as “a novel set of behaviours, routines, and ways of working that are directed at improving health outcomes, administrative efficiency, cost effectiveness or users’ experience and that are implemented by planned and coordinated actions”. Collectively this definition and others (Zapf, 1989; Lindhult, 2008; Moulaert et al., 2005) indicate that social innovations are distinct from technical innovations and are an independent and different type of innovation.

3.2.6 Social innovation identification

From the literature review, it has been possible to identify a complex concept of social innovation, which is characterized by variations related to the innovation approach and to more deep changes about the social structure. Regarding to the innovation approach, a new innovation paradigm is emerging to support the shift from the industrial era to a knowledge and service economy.

The development and establishment of the new innovation paradigm in the business's context is bringing the social innovation to assume a broader concept, which results strongly linked to the sustainable development concept. However, from the literature review it has been possible to note that while the environmental innovation is an argument very treated, the social innovation results to be a research field partly unexplored. Today, it is very apparent that the scope of the topics that social innovations and sustainability intersect has expanded in conjunction with the rising acceptance of the need for sustainability and has also become more socio-politically relevant (Schwarz et al., 2010). The topics are no longer simply missions and visions, but also the political, institutional and social requirements and innovations necessary to realize them.

Therefore, taking into account that the social innovation is always assuming more importance and that it is seen as the main mean to achieve the sustainable objectives, it has been possible to analyse different researches to identify the main initiatives of social innovation implemented at business and social level. The analysis has been made taking into account the different research fields, into which various researchers have developed their work about the social innovations.

Taken as such, social innovation is more than product and process innovation, it is a concept which must recognise an essential commitment of the people for whom the change seeks to contribute. Whilst business innovation remains rooted in the world of commerce and competition, social innovation has as a starting point the notion of social well-being and public good and seeks to benefit people in organisations, communities and society through direct and collateral outcomes of achieving greater social good. Dawson and Daniel (2010) suggest that a useful working definition is as follows: "Social innovation refers to the process of collective idea generation, selection and implementation by people who participate collaboratively to meet social challenges". These ideas are owned by people who work together in pursuing social goals that may, but need not, service other organisational, technical, commercial or scientific goals. Defined in this way the term has, potentially, very wide boundaries from new forms of organisation and new concepts of 'family', to new ways of using information and communication technologies, and from new ideas of community to new products or services.

Considering this wide concept of social innovation, through the analysis of the academic literature it has been possible to identify some specific ambits inside which companies tend to develop initiatives and practices.

3.2.6.1 Human resource management

One of the ambits inside which is visible the implementation of social initiatives is the Human Resource Management. The importance of human resources is understandable taking into account the resource based view, which suggest that firms are able to generate sustainable competitive advantages controlling and manipulating their resources and/or capabilities that are valuable, rare, cannot be perfectly imitated, and for which no perfect substitute is available. So, the human resource activities, including those that improve employee attitudes on workplace quality, are seen as fulfilling these four characteristics (Ballou et al., 2003; Fulmer et al., 2003; Wright et al., 2001). Human resource activities can thus assist in creating a competitive advantage by developing a skilled workforce that effectively carries out the firm's business strategy, leading to improved financial performance.

From a social point of view, these practices can have positive effects on employees' motivation and morale as well as on their commitment and loyalty to the firm. Socially responsible employment practices such as fair wages, a clean and safe working environment, training opportunities, health and education benefits for workers and their families, provision of childcare facilities, flexible work hours and job sharing, can bring direct benefits to a firm by increased morale and productivity while reducing absenteeism and staff turnover (Branco et al., 2006). In the academic literature the positive contribution derived by the adoption of socially responsible employment practices has been acknowledged by different authors.

On the base of these considerations, corporate social practices may be an organizational resource that provides internal or external benefits, or both. Internally, investments in corporate social practices may help firms develop new competencies, resources, and capabilities which are manifested in a firm's culture, technology, structure, and human resources (Barney 1991; Russo and Fouts 1997; Wernerfelt 1984). Especially when corporate social practices is pre-emptive (Hart 1995) and a firm's environment is dynamic or complex, corporate social practices may help build managerial competencies because preventive efforts necessitate significant employee involvement, organization-wide coordination, and a forward-thinking managerial style (Shrivastava 1995). Thus, corporate social practices can help management develop better scanning skills, processes, and information systems, which increase the organization's preparedness for external changes, turbulence, and crises (Russo and Fouts 1997). These competencies, which are acquired internally through the corporate social practice process, would then lead to more efficient utilization of resources (Majumdar and Marcus 2001).

Howaldt and Schwarz (2010), analysing the development of systems that are able to form, spread and combine knowledge defined within the stakeholder management ambit, have cited as examples of social innovations related to the human resource management the development of new forms of working and organization in companies and the creation of inter-organizational cooperation and learning networks.

Similar considerations have been made by Moulaert et al. (2005), who have promoted the development of social innovations linked to the labour market, educational system and cultural working environment.

It is broadly recognised as new management and labour practices are one of the social innovations more treated in academic literature and it is possible to identify them in different research works. One of the more important aspects, that it is necessary to highlight about these initiatives, is the wide impact that can generate within a company. These initiatives, which are mainly developed with the aim to improve the social capital, can subsequently lead to better-working organizations and thereby generate positive effects in terms of social innovation. So, putting new innovation management into effect and the resulting changes and adjustments in companies signify a far-reaching social innovation (Howaldt and Beerheide, 2010). This aspect is also underlined in the international study FORA (2010), which explains that new management and labour practices are social innovations because allow to develop a new internal knowledge inside the company, which will become a base for future deeper social changes. New knowledge is required to deal with new forms of innovation. Knowledge about co-creation of value and exploring user understanding are necessary, and skills for working in multidisciplinary innovation teams will be crucial.

In the broadest sense, social innovations extend across improving working conditions and investing in human capital. In fact, a social innovation related to management and labour practices is seen as the most valuable resource in the innovation process (BMWi and BMBF, 2002) to the wide-reaching complex social change and reforming the welfare state.

Taking into consideration the stakeholder theory, which state that the companies are responsible to various groups of stakeholders and the survival of the company depends on the fact that it contributes in an adequate degree to the welfare of these stakeholders (Freeman, 1984), Longo et al. (2005) have drawn up a scheme which associates each stakeholder with some social innovations that satisfy their expectations. The stakeholders taken into consideration are employees, customers, suppliers and community.

3.2.6.2 Employees

Starting from employees, the importance given by them to the value received will depend, naturally on other than their economic remuneration, on their being satisfied with the principal intangible needs of the scale of Maslow (1943): development of competence and professionalism, climatic conditions of the working environment, consideration given to ideas and their proactivity (Troina, 2001). Standing (1996, 1999), in his model termed ‘‘Human Development Enterprise’’, maintains that a business that is socially responsible in the twenty-first century must guarantee within its structure those mechanisms that can ensure the development of collaborators, in terms of opportunities to improve and multiply their skills,

health and safety programmes, discrimination-free social equity, economic equity (security and equity regarding earnings) and democracy (correct and secure representation, opportunity for workers to voice their feelings). On the basis of these considerations, Longo et al. (2005) have defined four value classes, which can be traced within the wider category of new management and labour practices previously analysed. The four value classes take into consideration initiatives related to:

1. Health and safety at work linked for example to the implementation of the systems ISO 9000, Emas/ISO 14000, SA 8000.
2. Development of workers' skills, as training programmes.
3. Well-being and satisfaction of the worker and quality of work. This is achieved by privileging the various services and facilities the company offers its collaborators, such as the canteen, areas workers use during their work breaks, opportunities regarding management of money and leisure, assistance and facilities for employees with children, flexibility policies for the workforce and the use of part-time contracts.
4. Social equity. The company must ensure that there exist no discriminatory practices related to sex, race and disability.

Some examples of social innovations, cited by Longo et al. (2005), are detectable in the work of Epstein and Roy (2003). The two authors, in the health and safety ambit, have reported the initiative of P&G, which has developed a Construction Safety Network programme with the aim to enhance its health and safety performance. The network establishes and documents best work practices, delivers construction safety management training, provides a construction safety audit team, analyses incident information and monitors system results. In addition through the analysis of companies' reports, they have asserted as the companies acknowledge that diversity brings a richness of skills, ideas and talents.
Considering the social innovations addressed to employees of a company, it is interesting to underline the research work of Branco and Rodrigues (2006), who have analysed the positive effect that the implemented social innovations have on the behaviour of potential and current employees. In fact, empirical research shows that firms' social responsibility actions matter to its employees (Albinger and Freeman, 2000; Backhaus et al., 2002; Greening and Turban, 2000; Peterson, 2004; Turban and Greening, 1997). Firms perceived to have a strong social responsibility commitment often have an increased ability to attract better job applicants, retain them once hired, and maintain employee morale. This leads to reduced turnover, recruitment, and training costs.

Several studies have attempted to analyse the relationship between firm performance and employee attitudes on workplace quality. Particularly relevant is the research grounded on resource based perspective, such as that of Fulmer et al. (2003) and Ballou et al. (2003). Both these studies present results suggesting workplace attitude as a source of competitive advantage that leads to a valuable intangible asset which contributes to the enhancement of financial performance. These studies provide evidence

consistent with the prediction that human resource activities can be a source of competitive advantage and result in improved financial performance. Besides allowing firms to attract and retain workers, improved social performance, may lead to more efficient processes, improvements in productivity, lower costs of compliance and new market opportunities (Goldstein, 2002; Hart, 1995; Howard-Grenville and Hoffman, 2003; King and Lennox, 2002; Klassen and Whybark, 1999; Porter and Van der Linde, 1995; Russo and Fouts, 1997; Thorpe and Prakash-Mani, 2003; Wagner and Schaltegger, 2003). Substantially, these authors contend that social innovation builds the resources of organisational commitment and learning, cross-functional integration, and increased employee skills and participation within the firm. Consequently, this atmosphere leads to increased productivity by attracting high-skilled workers with superior management strategy.

3.2.6.3 Customers

The second typology of stakeholder that Longo et al. (2005) has taken into consideration is represented by customers. The customer, final or intermediate, requests above all to be protected from a qualitative point of view. The quality must not relate to the product alone, with regard to its characteristics and period of use, in order to guarantee its safety, but also to the relationship with the company by means of an organization that focuses on facilitating a good rapport and on giving customers the opportunity to forward proposals, suggestions and complaints (Aem, 1999). The consumers, moreover, want not only to purchase products that are correct and safe, but also to know that these have been manufactured in accordance with socially responsible criteria.
The four value classes are therefore:

1. ‘‘Product quality’’. Implementation of systems ISO 9000, ISO 14000.
2. ‘‘Safety of customer during use of product’’.
3. ‘‘Consumer protection’’. This is obtained after the setting up of analysis procedures referring to the satisfaction of customers, for instance call centres and customer complaint services.
4. ‘‘Transparency of consumer information on product’’. Product labelling systems like, for example, Ecolabel and Transfair.

3.2.6.4 Suppliers

Regarding the supplier management from a social innovation point of view, suppliers need to be stimulated to improve the products and services for the company buying them. The researchers in the academic literature underline mainly two typologies of initiatives: quality programmes and selection policies (Longo et al., 2005). The social innovations aimed to generate quality improvements allow to create a close relation between company and supplier through the sharing of quality goals according to standards adopted and agreement on the quality control procedures for materials and comakership. The latter typologies of social initiative addressed to suppliers aims to create a selection and analysis system able to produce benefits to company and incentives for improvements to suppliers.

3.2.6.5 Community

Regarding the community, for Longo et al. (2005) this term means people and the environment. In contemporary social sciences, above all in sociology and anthropology, the term ‘‘community’’ is synonym of ‘‘local community’’ that Parsons (1951) defines as a specific type of collectivity whose members share a territorial area as an operation base for their daily activities. According to this vision of community, Longo et al. (2005) have defined the two following value classes in order to identify possible social initiatives directed to this stakeholder. The two value classes are:

1. ‘‘Creation of added value for the community’’. The company contributes to local employment which brings with it the creation of added local value and economic well-being. It is obtained by means of company policies that favour the selection of personnel and suppliers that belong to the community where the company operates.
2. ‘‘Environmental safety and protection’’. This area refers to the physical acceptation of the community, intended as territory. Growing sensitivity regarding environmental issues and the possible negative consequences that industrial activity can produce has caused many companies to invest huge resources into controls on environmental impact. The creation of this value for the community is obtained by implementing monitoring policies for the emission of industrial pollutants, specific policies geared to energy efficiency, refuse collection and disposal, and so forth.

The concept of social innovation addressed to the improvement of communities’ well-being has been enlarged by different authors in the academic literature. For example, considering the report on social innovation provided by the European Union (“Empowering people, driving change-Social Innovation in the European Union”, A. Hubert, 2011), it is possible to note among the proposed initiatives of social innovation the socio economic sustainable development of rural areas in a competitive and knowledge based economy through the setting-up of rural development programmes. These typologies of social innovations have mainly been argued in two research field highlighting the higher complexity of initiatives addressed to community development.

The first one is the network management field, the research findings in the 90s have made it increasingly clear that innovations involve a complex social process in which the network-like interaction between multiple parties in the process of innovation plays a central role. Networks qualify as being superior to other coordination and management mechanisms for the processes of innovation (Rammert, 1997) and seem to become an elementary building block of a new innovation paradigm (Bullinger, 2006; Howaldt et al., 2008). The visible change about the role of network in the innovation process is one of the aspects that have brought to the necessity to develop a new innovation paradigm. As affirmed in the stakeholder theory and through the RBV, the creation of a network with different stakeholders allows to a company to facilitate a social innovation definition.

Some practical examples, about the role assumed by the network inside the innovation process, have been provided by Freeman (1987). He has introduced the definition of national innovation system (NIS) as "a network of institutions in the private and public sector whose activities and interactions engender, modify and spread new technologies". NIS are systems of forming knowledge, spreading knowledge and the combination of knowledge, be it internal, implicit, or external, they are structures for dealing with knowledge. This example put in evidence the capacity of this practice to spread and share the knowledge, fundamental element for shifting from an industrial economy to a social and service economy. The social system of agents and institutions considered in this model are: R&D departments of companies, technical schools, extra-university research institutes, technology infrastructure institutions, ministries and in a broader sense these include education, the school system and professional development institutes, banks, industry associations. Starting from the NIS, numerous empirical investigations suggest that "Regional Governance Structures in a Globalized World" (Braczyk et al., 1998), that establish relationships with the spatial grouping of companies and forms of regional cooperation that have emerged in certain regions are strategically better than the nation's underlying system (Renn and Kastenholz, 1996).

The second wide research field is the community economic development (CED), which has been treated into many publications and into a number of university research programs that have brought to the definition of new social innovation initiatives. CED is often defined as "a process by which communities initiate and implement their own solutions to economic problems to build long-term community capacity and foster the integration of economic, social and environmental objectives" (Ross and McRobie, 1989). CED gives priority to a holistic approach to economic development, in its commitment to business development as well as employability, to job creation as well as the social integration of excluded people, and to economic activity as well as to housing and proximity services. It also differs from traditional approaches to economic development in that it solicits civil society's participation in such matters as local governance and the implementation of development tools to serve the community (Fontan et al., 2003; Morin et al., 1994). Also in this case in order to be able reaching a community economic development through the integration of economic, social and environmental objectives, it is necessary to involve the civil society in terms of institutions, private companies and NGOs. Inside the definition of Community Economic Development, it is possible to find an important factor that characterizes the social innovation, which is the active involvement of social actors in the process of social innovation development. From this perspective, the emergence and evolution of social innovation can be studied as part of a process of social change and social movements, and the creation and diffusion of social inventions and new social practices (Coleman, 1970, 1988; Conger, 1974; Henderson, 1993; Levesque, 2005).

4 Stakeholder collaborations

Stakeholder collaboration is defined as a process of interactive learning and empowerment that enables stakeholders with common goal to be collectively innovative and resilient when faced with emerging risks, crises and opportunities of a complex and changing environment. Such definition introduced within the sustainability context identifies the establishment of stakeholder collaboration as instrument to face environmental and social problems with the aim to generate a sustainable development for the involved actors. With the integration of sustainability into companies' strategic objectives, the sustainability issues have become critical for the future success of a business (Lacy et al., 2010). The acknowledgement of such criticality has brought to the enhancing of stakeholder collaborations' role in the development of sustainability innovations. The importance of collaborations with external actors in the sustainability management has been highlighted in a recent global survey of CEOs of the largest companies in the world conducted to investigate challenges and benefits of the integration of sustainability into companies' strategies (Lacy et al., 2010). In particular, CEOs realize that sustainability challenges are too broad and complex to be faced by single companies and highlight that partnerships and collaborations represent a key issue in their approach to sustainability. Such aspect has also been underlined by some other authors that retain as the complexity of sustainability issues requires that firms embracing sustainability into their strategies and activities collaborating with a wide range of external stakeholders that can be a source of knowledge and competencies outside the firm's main domain (Arts, 2002; De Bruijnand Tukker, 2002; Hartman and Stafford, 1997; Seuring and Müller, 2008; Srivastava, 2007).

4.1 Theoretical approaches

Although the need to be open to external sources of insights and competency seems almost self-evident, there has been very little research about the relevance of stakeholder dialogue for sustainable innovation, and only few practical experiences have been documented and commented on so far (Sabapathy et al., 2002; The Conference Board of Canada, 2002). The theme of stakeholder collaboration has been studied most prominently outside the sustainability concept within the general ambit of innovation. The two theoretical approaches that have made interesting contributions to the analysis of the relationship between stakeholder engagement and innovation are the stakeholder theory and resource-based view (RBV) of the firm.

Initially, the engagement with stakeholders has been studied through the stakeholder theory approach. The theory, on which is based such approach, can be traced back to the seminal work of Freeman (1984), who articulated a new conceptual model of the firm that must address the interests of its stakeholders, who are groups and individuals that can affect or are affected by the organization's purpose. This model extends managers' attention beyond the traditional interest group of shareholders, towards employees, customers and suppliers and widely disparate groups such as local community organizations, environmentalists, consumer advocates, governments, etc. Analysing the management literature, the

stakeholder theory has been developed and justified on the basis of its descriptive accuracy, instrumental power, and normative validity. These three aspects of the theory have been examined in the work published by Donaldson and Preston (1995), in order to clarify the confusion about nature and purpose of stakeholder theory due to its application.

Considering the descriptive use of the stakeholder theory, it is applied to report, and sometimes to explain, specific corporate characteristics and behaviours. The model, presented by the theory, describes the corporation as a constellation of cooperative and competitive interests possessing intrinsic value. But according to the statements of Donaldson and Preston, this theory goes well beyond the descriptive observation that "organizations have stakeholders". In fact, the stakeholder theory is also instrumental and it, in conjunction with descriptive-empirical data where available, is used to identify the connections, or lack of connections, between stakeholder management and the achievement of traditional corporate objectives. Although the previous aspects result significant for the stakeholder theory, its fundamental basis is normative and involves acceptance of two main ideas about stakeholder definition (Donaldson and Preston, 1995). Stakeholders are defined as persons or groups with legitimate interests in procedural and substantive aspects of corporate activity and their interests are of intrinsic value (E. Garriga and D. Mele 2004).

Taking into account the firm's perspective through the application of stakeholder theory, it has been possible to highlight as firms can benefit financially from establishing positive relationships with stakeholders (Donaldson and Preston, 1995; Jones, 1995; Jones and Wicks, 1999) and that the management of stakeholders' interests can become a practice to maximize the firm's performance (Agle et al., 1999; Berman et al., 1999; Welcomer et al., 2003). In addition, the implementation of the theory has brought scholars to classify the stakeholders into primary and secondary groups (Clarkson, 1995; Hall and Vredenburg, 2003; Post et al., 2002; Waddock et al., 2002). The primary or core stakeholder group refers to stakeholders who are essential for the business itself to exist and have some kind of formal contract with the business (owners, employees, customers and suppliers). The secondary stakeholder group includes social and political stakeholders who play a fundamental role in achieving business credibility and acceptance of its activities (NGOs/activists, communities, governments and competitors).

Ultimately, the stakeholder theory provides a suitable theoretical framework to analyse the relationship between business and society from a sustainable development viewpoint, since it emphasizes values such as participation, inclusion and mutual dependence (Wheeler et al., 2003). And at the same time, it suggests that strengthened stakeholder relationships can result in significant competitive advantages in form of trust reputation and innovation (Rodrıguez et al., 2002). However, stakeholder theory can only explain how to identify and engage with stakeholders for specific collaboration. In order to align stakeholders' interests and create long-term value, organizations have to develop, apply and maintain the necessary management competences and capabilities to deal with stakeholder concerns over time.

Therefore in this sense, stakeholder engagement can be seen as an organizational capability framed within the theoretical stream of the resource-based view (RBV) of the firm. The RBV of the firm contends that a firm's ability to perform better than the competition depends on the unique interplay of human, organizational and physical resources over time (Wernerfelt, 1984). In fact, the resource-based view (RBV) conceptualizes a firm as a set of resources and these resources are heterogeneously distributed across competing firms (Amit and Schoemaker, 1993; Mahoney and Pandian, 1992; Penrose, 1959; van Huijstee and Glasbergen, 2008). Firms which own resources that are valuable, rare, inimitable, and non-substitutable are able to achieve competitive advantage (Barney, 1991; Conner and Prahalad, 1996; Nelson, 1991).

Researchers highlight as collaborations and partnerships can be vehicles to acquire knowledge to forge new capabilities and achieve performance improvements (Flynn et al., 2010; Kale and Singh, 2007; Mowery et al., 1996; Teece and Pisano, 1994). The role that collaborations and partnerships can assume in the development of innovations, able to provide a competitive advantage, is also underlined in two extensions of the RBV. Indeed, through the dynamic capability approach stakeholder collaboration can be defined with the concept of dynamic capability as the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments (Teece et al., 1997, p. 516). Instead, considering the second extension of RBV, that is the relational view (Dyer and Singh, 1998), researchers argue that linkages with partners outside the firm can be a source of competitive advantage, because these relationships can enable firms to access additional resources such as financial, intellectual and human capital. Thus, a firm's critical resources may cross firm boundaries and be embedded in inter-firm resources and routines (Dyer and Singh, 1998; Flynn et al., 2010; Mesquita et al., 2008). According to this perspective, a firm's competitiveness not only arises from internal resources, but also depends on inter-firm sources of advantage (Dyer and Singh, 1998; Lavie, 2006). Therefore, considering the stakeholder engagement as an organizational capability which allows the firm to build strategic relevant relationships with their stakeholders, the firms that engage in proactive relationships with their stakeholders will also be able to integrate the gained stakeholder insights into their process of organizational innovation from a sustainable development viewpoint (Ayuso et al., 2006).

More specifically, several scholars highlight the importance of relationships and interactions for knowledge transfer both within and across organizational boundaries. There exists an extensive literature on the use of alliances, joint ventures and networks by firms to acquire new knowledge for innovation processes (Blomqvist et al., 2004; Caloghirou et al., 2004; Chang, 2003; Macpherson et al., 2004). However, conducted studies have focused so far on traditional knowledge generating organizations (other firms, universities, R&D institutions and governments) and have not considered the full range of firms' stakeholders. Combining the insights from the reviewed theoretical approaches, both stakeholder engagement and knowledge management (KM) are considered as relevant elements of an organizational

capability that deals with stakeholder-related innovation in the context of sustainable development (Ayuso et al., 2006).

4.2 Environmental stakeholder collaboration

In the academic field leaving out the social component from the concept of triple bottom line (TBL) related to sustainability, it is possible to observe different application of the RBV and relational view into the environmental sustainability context. Since the pioneering study of Hart (1995), who expanded the RBV of the firm to include the constraints and opportunities given by the natural environment and proposed a natural RBV of the firm, a relevant research stream used the RBV to study the strategic management of environmentally related issues (Christmann, 2000; Rugman and Verbeke, 1998; Russo and Fouts, 1997). A significant part of this literature highlighted the links between environmental strategies, capabilities development, and competitive advantage (Aragon-Correa, 1998; Aragon-Correa and Sharma, 2003; Sharma et al., 2007; Sharma and Vredenburg, 1998). Within this theoretical perspective Lee and Klassen (2008) defined the concept of environmental management capabilities (EMCs) as "organizational abilities or skills that enable firms to improve their performance on environmental issues", and highlighted that externally oriented EMCs refer to the development and exploitation of external relationships with direct and indirect stakeholders. These include stakeholder integration (Sharma et al., 2007; Sharma and Vredenburg, 1998), supply chain EMC, and relationship EMC (Lee and Klassen, 2008).

In the academic literature, many authors have showed as the need for a company to look outside their boundaries for environmental knowledge and competencies and collaborate with external actors depends very often on the complexity of environmental issues and to the fact that such issues are not related to core activities. In fact, internal development of such knowledge and competencies may be too costly, inefficient, and time-consuming for most companies (Rondinelli and London, 2003). A recent study drawing on the dynamic capabilities theory and on the relational view, points out that inter-firm relationships represent a capability that supports a firm's effort to become 'greener' (Hofmann et al. forthcoming). Any formal or informal collaboration between two or more organizations which is aimed at developing common solutions to environmental problems can be referred to as environmental collaboration and might be established between any combination of commercial organizations, government organizations, and NGOs (Crane, 1998). These types of collaborations, which are crucial to solve tough social problems and reach beneficial community outcomes (Bryson et al., 2006), also allow an organization to obtain several benefits, such as acquiring environmental knowledge and competencies, accessing environmental technologies, or having both presence in green markets and higher credibility of green claims (Crane, 1998). Several actors can represent a source of environmental knowledge and competencies outside the firm's main domain: suppliers, customers, other companies outside the supply chain, non-governmental organizations, governmental agencies, universities and research institutions (Foster and Green, 2000).

From the analysis of different research works it has been possible to identify and define the main typologies of collaborations established between a firm and its external stakeholders.

4.2.1 Suppliers and customers

Environmental collaboration with suppliers, or customers, can be defined as the direct involvement of a company with its suppliers, or customers, in jointly planning for environmental management and finding environmental solutions to reduce pollution or other environmental impacts. This kind of collaboration, which mainly relates to the wider area of green supply chain management, aims at reducing the environmental impacts due to material flows in the supply chain and is based on the exchange of information and the sharing of technical know-how (Vachon and Klassen, 2008). Such a type of collaboration is getting more and more common, and both the academic and corporate interests in green supply chain management has increased significantly in recent years (Seuring and Müller, 2008; Srivastava, 2007). In the literature, several studies highlighted that environmental collaborations within the supply chain lead to environmental benefits. For example, Hall (2000) showed that buyer-supplier relationships play an important role in stimulating environmental innovation, while Zhu and Sarkis (2004) found that green supply chain practices, including collaborations, have a positive effect on both environmental and economic performance. Further, the study by Rao (2002) showed a positive link between the degree of dissemination of environmental knowledge in the supply chain and companies' environmental performance. Similarly, Vachon and Klassen (2008) found a strong link between environmental collaborations along the supply chain, with both suppliers and customers, and environmental performance. In fact, products impact the natural environment at many stages of the supply chain, from raw material extraction to waste management. The environmental impact is thus the result of interrelated decisions made at different supply chain stages. Since companies are not directly involved in all of these stages, collaboration among the various companies in the supply chain is essential to reduce products' environmental impact and improve companies' environmental performance (Roy and Whelan, 1992).

4.2.2 Other companies

The academic literature defines inter-firm collaborations as voluntary collaborations between two or more firms involving the exchange, sharing, or co-developing of resources and capabilities as part of a project or business operation (Dussauge, Garrette and Mitchell, 2000; Gulati, 1999). Other than with companies upstream and downstream in the supply chain, the so called vertical collaboration, environmental collaborations can take place with companies of the same supply chain stage, defined as horizontal collaborations (Seuring, 2004), or even with companies belonging to different supply chains (Heuer, 2011). An interesting example of such typology of collaboration has represented by the collaboration project among IBM, Honda, and Pacific Gas & Electric Company, which has been reported by Albino et al. (2012) within their research work called "Do inter-organizational collaborations enhance a firm's environmental performance?". The project aimed at demonstrating an electric vehicle's ability to receive and respond to charge instructions based on the states of the power grid and the vehicle's battery. In this way, energy

providers will have the ability to manage charging process during peak hours more effectively and to create consumer-friendly programs to encourage the use of electric vehicles. Environmental collaborations among companies are generally devoted to reduce the environmental burden of a product or economic activity, through jointly exploiting opportunities and neutralizing threats in the market environment (Chan, Kensinger, Keown and Martin, 1997; Hagedoorn and Schakenraad, 1994). Firms increasingly implement inter-firm environmental collaborations to combine economic and environmental objectives (Ammenberg and Hjelm, 2003; Amundsen, 2000; Andersen and Lund, 2007; Glasbergen and Groenenberg, 2001; McEvily and Marcus, 2005). Indeed, alliances that develop more environmentally sustainable products fall into this category, seeking to create economic value by exploiting new market opportunities while simultaneously seeking to generate positive environmental impacts. Although such a positive environmental impact provides public benefits (i.e., reduced carbon emission), traditional inter-firm alliance research has focused mainly on the common and private benefits accruing to alliance partners (Khanna, Gulati and Nohria, 1998) with much less attention paid to the potential public benefits. To conclude, ECs implemented through inter-firm collaborations can be seen as vehicles to realize economic value through addressing environmental problems.

4.2.3 NGOs

Firm-NGO collaborations are voluntary, formal, and informal collaborative arrangements between firms and NGOs concerning a broad range of environmental issues (Austin, 2000; Berger, Cunningham, & Drumwright, 2004, 2006; Le Ber & Branzei, 2010; Rivera-Santos & Rufin, 2010; Sagawa & Segal, 2000; Seitanidi & Crane, 2009; Selsky & Parker, 2005). The objectives of firm-NGO collaborations involve environmental and economic value creation with private economic benefits accruing to partners and public benefits accruing to actors that are beyond traditional organizational boundaries (Waddock, 1988). As showed through the literature review, during the past few years collaborative partnerships between business and environmental NGOs have become increasingly popular (Arts, 2002; King, 2007; Kumar and Malegeant, 2006; Peloza and Falkenberg, 2009; Rondinelli and London, 2003; van Huijstee and Glasbergen, 2008). Since these two types of organization own complementary resources, collaborations among them make possible a more effective use of knowledge and capabilities of both, which is useful to better protect the environment and achieve a higher corporate profitability (Rondinelli and London, 2003; Stafford et al., 2000). These collaborations thus represent away for companies to integrate environmental responsibilities with market goals. In particular, they help companies to develop environmentally friendly programmes and, at the same time, reduce costs and achieve differentiation advantage. They also foster environmental innovation resulting in higher operational efficiency as well as new technologies or new green products (Stafford et al., 2000), and represent a source of knowledge about creative ways to rethink operational activities as well as to address stakeholder concerns (Rondinelli and London, 2003). A further aspect highlighted by different authors in the academic literature, underlines as collaborations with environmental NGOs may help firms to obtain higher credibility than that they would achieve through self-

developed policies. Therefore, such collaborations can prevent attacks from third parties, such as the media, environmental groups, and the government. Consequently, the development of collaborations with environmental NGOs can help enhance corporate green image (Hartman and Stafford, 1997; Kumar and Malegeant, 2006; Stafford and Hartman, 1996).

4.2.4 Governments

Government, term that includes central government, local governments, or government agencies, represents another important actor with which companies can establish environmental collaborations. These collaborations may be devoted to diverse environmental aims, including the definition of new environmental standards and new rules. Indeed, Delmas and Terlaak (2001) define a firm-government environmental collaboration as collaborative arrangements between firms and regulators whereby firms voluntarily commit to actions that might improve their environmental performance through programs designed by policy makers to associate private benefits with the voluntary provision of public goods. As just underlined, firms engage in collaborations with government organizations for a number of reasons, including signalling positive environmental behaviour to stakeholders, reducing regulatory pressures, and learning new skills. Therefore, firm's scope ranges from pre-empting regulatory threats to shaping future regulations (Delmas & Marcus, 2004; Delmas and Terlaak, 2001). Such collaborations frequently aim to influence government policy and norms through proactive collective political action (Delmas & Montes-Sancho, 2010; Oliver & Holzinger, 2008).

Such typology of collaboration is recognized in the academic literature as an effective approach when certain environmental issues challenge firm boundaries (Delmas & Terlaak, 2001). Indeed, research work has found that firm-government environmental collaborations occur both at regional (Ammenberg & Hjelm, 2003; von Malmborg, 2004) and industry levels (Amundsen, 2000). In the ambit of environmental development addressed beyond boundaries often firm-government environmental collaborations occur as multi-partner alliances, and participating firms demonstrate three different types of behaviours: non-cooperation and free riding (Delmas & Keller, 2005), symbolic cooperation, and substantial cooperation (Delmas & Montes-Sancho, 2010). Government actors participate in these environmental collaborations as a way to build environmental capabilities and strengthen regional inter-firm environmental networks or clusters (von Malmborg, 2003, 2004). In this typology of collaboration is highlighted the presence of local authorities, which can play critical supporting roles for inter-firm learning and knowledge transfer and becoming knowledge repositories that firms can leverage to improve their own actions over time (Gombault & Versteege, 1999; von Malmborg, 2003, 2004, 2007).

To conclude, from the literature review it is possible to affirm as the involvement of this key external stakeholder into product design and development processes as well as into the management of end-of-life products might provide a means to improve environmental performance and increase firm's environmental reputation (Hart, 1995; Roy and Whelan, 1992).

4.2.5 Knowledge leaders

Over the last fifteen years, the cooperation between industrial firms and knowledge leaders as well as the research interest towards this subject has considerably increased (Lee, 2000; Meyer-Krahmer and Schmoch, 1998; Siegel et al., 2003). Firm-knowledge leader collaborations are agreements between firms and research organizations (public or private) focused on collaborative R&D, contract research and consulting, development and commercialization of technology through a firm owned partly by the academic inventor, employee training, and transfer of university-generated intellectual property to firms (Agrawal, 2001; Perkmann & Walsh, 2007).

Even though few studies specifically address the topic of environmental collaborations between companies and universities and research institutions, the literature suggests that collaborations with these actors may play an important role when firms conduct environmental projects and develop green innovations, since they represent sources of environmental and technological expertise (Foster and Green, 2000; Noci and Verganti, 1999; Seuring, 2004). One example, provided by Wassmer et al. (2012), is the "2008 BP-University of California-Berkeley alliance" to develop renewable energy solutions. The BP-UC Berkeley example demonstrates that firm-university environmental collaborations are similar in nature to inter-firm environmental collaborations except that one partner comes from the higher education sector.

4.3 Social stakeholder collaboration

An important distinctive aspect for a social innovation than the other typologies of innovation is the active involvement of a network of actors in the innovation process development. From a developing perspective, social innovation can be interpreted as a process of collective creation in which the members of a certain collective unit learn, invent and lay out new rules for the social game of collaboration and of conflict or, in a word, a new social practice, and in this process they acquire the necessary cognitive, rational and organizational skills (Crozier, Friedberg 1993).

The spreading and the enhancing of importance of social innovations, in the enterprise context, can be in part explained by the lessons learned from both the Lisbon Strategy for Growth and Jobs and the financial crisis, which have revealed structural weaknesses and presented the social dimension of Europe in a new light. In fact, the long held belief that economic growth creates employment and wealth that goes on to alleviate poverty has been disproved by recent events, and the time has now come to try new ways of bringing people out of poverty and promoting growth and well-being not only for, but also with citizens (A. Hubert, 2010). The old economic system and with it also the innovation process has been failed and the new system, which is able to support and improve the social well-being, is based on the active involvement of citizens.

From a business's perspective, the advantage generated by the involvement of different actors in the development of social innovations can be linked to the sharing of different resources owned by the

various actors into the developing process, which allow developing new capabilities. The importance of the role assumed by the sharing resources of diverse involved actors is been underlined by Lévesque and Mendell (2005), who has defined the social innovation as something that emerges both to respond to new, urgent social problems that especially affected certain communities and social groups and to meet the demands of new social movements as the community movement, environmental groups, local communities, cultural communities, and so on. In this definition it is possible to note, as in the previous ones, that the development of social innovation requires the involvement of a social network composed by public and private actors. Indeed, one of the main typology of collaborative engagement established in the social field is partnerships among business, government, and civil society, i.e. the three main societal sector, that address social issues and causes (Austin, 2000; Gray, 1989; Sternberg, 1993; Stone, 2000;Young, 1999). In these partnerships, organizations jointly address challenges such as economic development, education, health care, poverty alleviation, community capacity building, and environmental sustainability.

4.3.1 Social collaboration identification

The main problem relative to social collaborations is linked to the identification of such typologies of partnership. Indeed social collaboration is treaded into various disciplines such as organization studies, public policy and administration, economics, non-profit management, health care, education, and the natural environment. The academic review demonstrates that researchers in these disciplines use different theories and approaches because when actors from different sectors focus on the same issue, they are likely to think about it differently, to be motivated by different goals, and to use different approaches.

Taking into account that my research is addressed to social collaborations established within a business ambit, the more interesting field of study is represented by management and organization researches. In this research ambit, social collaborations have been studied within two analytic platforms: resource dependence and social issues.

4.3.1.1 Resource dependent platform

The first analytical platform is based on the principle for which organizations collaborate because they lack critical competencies and they cannot develop on their own or in a timely fashion (Child and Faulkner, 1998) and because their environments are more uncertain. Such statement brings to see social collaborations as new ways for organizations to acquire expertise and access to needed resources (Barringer & Harrison, 2000; Gomes-Casseres, 1996; Trist, 1983), to cope with turbulence in their environments (Emery & Trist, 1965; Gray, 1985; Selsky, 1991), and to gain competitive advantage (Andriof & Waddock, 2002; Pasquero, 1991). The source of the social partnership idea in this literature on collaborative inter-organizational relations is that businesses become more socially responsible to address stakeholder demands and develop or sustain a competitive advantage. Therefore, social collaborations

here are conceived in a narrow, instrumental, and short-term way as a way to address organizational needs with the added benefit of addressing a social need.

4.3.1.2 Social issues platform

The second analytic platform is defined on the analysis of the literature relative to the social issues management (Austrom and Lad, 1989; Dutton & Dukerich, 1991), which explores the nature and evolution of social issues. This includes early work on social problem solving (e.g., McCann, 1983) as well as stakeholder literature focused on institutional fields, social issues, or policy sectors. In this literature, organizations and interest groups are seen as stakeholders of issues, not of organizations (Waddell, 2005). This also includes literature on collaboration and corporate social responsibility that explores why and how businesses should contribute resources toward addressing larger social or public issues (e.g., Andriof &Waddock, 2002; Gray, 1989; Waddock &Post, 1995). Many authors highlight as external pressures from interest groups and public opinion can encourage or force managers to pay attention to these issues (Andriof and Waddock, 2002; Greening and Gray, 1994; Oliver, 1991). Collaboration in this literature is defined as "a temporary social arrangement in which two or more social actors work together toward a single common end requiring the transmutation of materials, ideas, and social relations to achieve that end" (Roberts & Bradley, 1991: 212). The partners intend to retain organizational autonomy while joining forces to tackle a shared social problem. In the social issues literature, the source of the social collaboration idea is that environmental turbulence generates unintended consequences and some of these consequences are seen as social issues that exceed the scope of single organizations (Chevalier, 1966; Trist, 1983; Westley & Vredenburg, 1991). Therefore, such issues require multi-institutional collaborative endeavours (Gray, 1989; Trist, 1983; Waddell, 2005) that can improve the chances of addressing them successfully. Collaboration also helps the stakeholders to shape and steer a social issue more efficiently (Levy and Oviatt, 1989).

To summarize, the above two platforms, defined within the organizational literature, treat the social collaboration through two different approaches. In the resource dependence platform, organizations voluntarily partner primarily to serve their own interests (e.g., acquire needed resources) and secondarily to address a social concern. Instead, in the social issues platform, the issue is paramount, collaboration is either mandated or voluntary, and the collaboration is designed to be issue focused. Increasingly in business-NGO and business-government collaborations, issues are selected because they are, or are shaped to be, strategic, that is, supporting the core mission of the corporate partner (Elbers, 2004; Utting, 2002).

Inside the two previous analytical platforms, it has been possible to identify three main typologies of social collaborations defined on the base of stakeholders involved.

4.3.1.3 Firm-NGO collaboration

The social collaboration between firms and NGOs is mainly defined in response to growing within-sector competition for resources (Weisbrod, 1997; Young, 1999) and public calls for accountability (Lawrence & Hardy, 1999; Waddock & Smith, 2000). In this typology of social collaboration NGOs tend to be altruistic in terms of goals (Milne et al., 1996), while businesses partner to pursue self-interests (Iyer, 2003) like enhancing corporate image (Alsop, 2004; Zammit, 2004), garnering social capital and accessing existing networks (Millar, Choi, & Chen, 2004); selling products (Burlingame & Young, 1996); and attracting, motivating, and retaining desirable employees (Lewin & Sabater, 1996). Indeed, many authors sustain that partner and individual reasons to partner often involve a mix of self-interest and altruism (Agle, Mitchell, & Sonnenfeld, 1999; Hutchinson, 2000; Sharma, Vredenburg, & Westley, 1994).

4.3.1.4 Firm-Government collaboration

The social collaboration between firms and governments, that in the academic literature is also indicated with the general term public-private partnership (Linder & Rosenau, 2000), is defined as a set of working arrangements based on a mutual commitment between a public sector organization with any organization outside of the public sector (Bovaird, 2004). Some authors argued that this typology of collaboration can be undertaken to facilitate development and transfer of new strategies and technology (Milliman and Grosskopf, 2004). But regarding the social collaboration between the private sector and government entities, the academic literature shows divergent considerations and results.

4.3.1.5 Multi-stakeholder collaboration

Through the analysis of the academic literature, it has been possible to note as in the social ambit many authors have highlighted the fundamental role played by multi-stakeholder collaboration in the treatment of social issues. Also for this typology of collaboration partner motivations are identified as a blend of self-interest and altruism (Pasquero, 1991;Warner&Sullivan, 2004;Westley&Vredenburg, 1991).However ,in this specific case, that shows the simultaneous participation of more than one stakeholder, recent research suggests that a major motivation is partner awareness of the growing number of complex and multi-layered social problems that cut across societies (Pasquero, 1991) combined with the desire of organizations in all sectors to contribute to global problem solving (Warner and Sullivan, 2004). It is evident in this literature that the social problem or issue has stakeholders. Often the most important stakeholders are organizations whose leaders have come to believe that improvement of complex social challenges will most likely come from joint action (Brown, Khagram, Moore and Frumkin, 2000; Domask, 2003; Murphy and Bendell, 1999; Warner and Sullivan, 2004). The main distinguishing feature of multi-stakeholder collaboration is the frequent presence of bridging organizations to convene or manage the cross-sector relationships (Brown, 1991; Cook, Dodds and Mitchell, 2003; Waddock, 1991). Indeed, observing the multi-stakeholder collaborations defined in the social ambit, it has been possible to identify

governments or more in general public entities in the role of coordinator for the development of a social collaboration addressed to solve a complex social issue (Waddell, 2000).

5 Technological regime

Through the analysis of academic literature, it has been possible to identify and recognize the influence that different factors exercise on the technological response of firms in the development of sustainability innovations. The factors analysed in this research work as determinants of sustainability innovations are company sustainability strategic position and firm's sustainability past performance. However, in order to achieve a better understanding about the development of sustainability innovations, as highlighted by various stream of research, it is necessary to integrate the considered determinants into a sectorial approach. Indeed as just underlined, the academic literature recognizes that the rate and type of innovation and the determinants of innovative activities greatly differ across sectors. A huge empirical literature on sectorial case studies provides a rich set of empirical evidence on the features of sectors, on their technologies, production and innovation conditions. In order to bring the attention on the innovation process itself and on its features and determinants at the industry and firm levels providing a multidimensional, integrated and dynamic view of sectors, it is possible to take into consideration the evolutionary literature on technological regimes (Malerba, 2005). The application of technological regime approach for the examination of sustainability innovation process allows obtaining a better understanding of the knowledge bases and of the learning processes that underlie the development of sustainability innovations, bringing new insights on the sources of innovation, determinants and on the directions of the resulting technological trajectories. Such approach provides a useful tool for a descriptive analysis of the structure and boundaries of sectors, for the identification of the factors affecting innovation and competitiveness of firms. As highlighted in the academic literature, the use of the evolutionary literature on technological regimes enables to put the study of sustainability innovations in an industrial dynamics perspective contributing in this way to a more complete understanding of innovation patterns and drivers.

5.1 Technological regime concept and evolution

Various streams of research have tried to examine patterns and determinants of innovations but in order to take into account learning conditions, sources of innovation, mechanisms of appropriability and the technological context in which innovation takes place in sectors, the ambit of study more adopted is the technological regime approach.

The notion of technological regime dates back to Nelson and Winter (1977, 1982) who have suggested that the dynamics of innovation and market structure is driven by processes of market selection and by the nature of technology, which differ greatly across sectors. Technological regimes set the boundaries of what can be achieved in firms' problem solving activities and identify also the natural trajectories along which solutions to these problems can be found. After Nelson and Winter, various authors, as Gort and Klepper (1982), Levin et al., (1985), Cohen and Levin (1989) and Audretsch (1995) among others, have pointed out that, more than firm size or demand, opportunity and appropriability conditions appear as the most relevant factors affecting the dynamics of market structure and innovation. The notion of

technological regime provides a synthetic way of representing some of the most important economic properties of technologies and of the characteristics of the learning processes that are involved in innovative activities. Thus, it identifies some fundamental structural conditions that contribute to define competencies, incentives and dynamic properties of the innovative process. In this line of research, Malerba and Orsenigo (1990, 1993) have proposed that a technological regime is a particular combination of some fundamental properties of technologies: opportunity and appropriability conditions; degrees of cumulativeness of technological knowledge and characteristics of the relevant knowledge base. They empirically study how these factors shape the innovative patterns of firms and so the properties of the industrial dynamics. Using patent data the authors show that the patterns of innovative activities differ systematically across technological fields, while remarkable similarities emerge across countries for each technological field. These results strongly suggest that technological imperatives, and so the characteristics of technological regimes, play a major role in determining the patterns of innovative activities. Taking into account the sources of innovation and the mechanisms of appropriability, which differ across sectors, the main references are the work by Rosenberg (1976, 1982) on the various sources of technological change across a wide variety of sectors, Levin et al. (1987) on appropriability conditions, Nelson (1993) on universities, Mowery and Nelson (1999) on various industries, Pavitt (1984) on sectorial taxonomies of the sources of innovation and the appropriability mechanisms.

The first definitions of technological regimes have seen the authors to distinguish between two types of technological regime: the entrepreneurial regime, characterized by an innovative base which is continuously enlarging through the entry of new innovators and the erosion of the competitive and technological advantages of the established firms in the industry; and the routinised regime, based on the dominance of a few established firms which are continuously innovative through the accumulation over time of technological capabilities. Subsequently, by extending the previous taxonomic exercises (Malerba and Orsenigo, 1995; Pavitt, 1984), and by focusing more on the role of technological barriers to entry, Marsili (2001) proposes a new typology of regimes which distinguishes five industrial technological regimes: science-based, fundamental processes, complex systems, product engineering and continuous processes. This typology provides a more detailed framework especially regarding the characteristics of the knowledge bases and the sources of barriers to entry. Each regime is defined by a specific combination of technological opportunities, technological entry barriers, inter-firm diversity in the rate and directions of innovation, diversification of the knowledge base, external sources of knowledge, links with academic research and nature of innovation. By collecting empirical data, Marsili (2001) identifies and characterizes the industries composing each regime.

5.2 Technological regime approach

As affirmed by Malerba (2005), a technological regime could be seen as a composition of three main building blocks: knowledge and technology; actors and networks; and institutions. Thus in a technological regime perspective, innovation is considered a process which involves systematic interactions among a

wide variety of actors for the generation and exchange of knowledge relevant to innovation. Interactions include market and non-market relations that are broader than the market for technological licensing and knowledge, inter-firm alliances, and formal networks of firms. Naturally, agents' cognition, actions and interactions are shaped by institutions, which include norms, routines, common habits, established practices, rules, laws, standards and so on.

All these three elements highlighted by Malerba (2005) can be analysed in a technological regime perspective through the application of the framework introduced by Marsili (2002). Such framework, as previously seen, allows to identify five different technological regimes defined on the base of a variety of dimensions: level of technological opportunity, technological entry barriers, cumulativeness of innovation, inter-firm diversity in the rate and directions of innovation, intensity and directions of diversification of the knowledge base, relevance of various external sources of knowledge, links with academic research, and nature of innovation (i.e. products and processes). The specific combination of such characteristics has allowed defining the five regimes: science-based, fundamental processes, complex systems, product engineering and continuous processes.

- The science-based regime, in pharmaceuticals and electrical-electronics industries, is characterised by a high level of technological opportunity, high technological entry barriers especially originating in the high industry-specificity of the knowledge base, and high cumulativeness of innovation. Firms are homogeneous in their rates and directions of innovation, which are focused on closely related technologies. Innovative activities are principally devoted to product innovation and benefit from the direct contribution of scientific advances in academic research.
- The fundamental-processes regime, typified by the chemicals and petroleum industries, displays a medium level of technological opportunity, high technological entry barriers especially related to scale advantages in innovation, and strong persistence of innovation. Innovation is mainly process innovation and, although affiliated firms and users represent the main external sources of knowledge, it benefits from the quite important and direct contribution of scientific advances in academic research.
- The complex (knowledge) system regime, in aerospace and motor vehicles industries, is still characterised by medium-high levels of techno- logical opportunity, entry barriers in knowledge and scale, and persistence of innovation. The distinctive feature of this regime is in the high degree of differentiation of technological competencies developed by firms, especially in upstream production technologies, and of external sources of knowledge, including an important, although indirect, contribution of academic research.
- The product-engineering regime is characterised by a medium-high level of technological opportunity, low entry barriers to innovation and not very high persistence of innovation. This regime, which represents in particular non-electrical machinery and instruments, is distinguished

by the high diversity of technological trajectories explored by firms. Innovation in products benefits from external contributions of knowledge, mainly from users.

- The continuous-processes regime includes a variety of production activities such as metallurgical process industries, chemical process industries, food and tobacco. It is generally characterised by low technological opportunity, low technological entry barriers, and rather low persistence in innovation. Firms are technologically heterogeneous and their knowledge base is, on the whole, fairly differentiated among technical fields. Innovation in processes benefits from upstream sources of capital-embodied knowledge.

By collecting empirical data, Marsili (2001) identifies and characterizes the industries composing each regime. Among the considered industrial sector the author has also included the two sectors selected for my research work. Indeed, he has analysed the automotive sector and the electrical and electronic sector.

- ✓ The automotive sector corresponds to a complex system regime. The detailed description of this regime gives new insights on the patterns of innovative activities in the automotive industry. According to (Marsili, 2001, 2002), the complex system regime is characterized by medium-high levels of technological opportunity, high entry barriers in knowledge and scale, and high persistence of innovation. The distinctive feature of this regime is the high degree of differentiation of the knowledge base of firms, especially in upstream technologies, but also the role of external sources of knowledge. The author emphasizes that, in a complex system regime, firms are active in a wide range of technical fields along similar search trajectories, but with a certain variety in their ability to exploit technological opportunities strongly related to R&D activities. This pattern of knowledge diversification is an important feature of the technological regime of the automotive industry which may contribute to explain the innovative strategy of automotive firms. Marsili also argues that the complexity of the knowledge base is the main source of technological entry barrier. Even if suppliers represent important sources of external knowledge, and therefore potential sources of innovative entry, their contribution has to be integrated within a complex system of external sources in which other actors, such as public institutions, users and competitors are of considerable relevance. As a consequence, although suppliers belonging to other technological regimes and sectors, particularly to the mechanical and electrical-electronic area, do acquire competencies in transportation technologies, they are not likely to enter the transportation sector. This complex set of relationships between suppliers and producers in the production of knowledge and technology should be taken into account when analysing the innovations developed by the automotive industry.

- ✓ The electrical and electronic sector corresponds to a science-based regime. According to (Marsili, 2001, 2002), the science-based regime is characterised by a high level of technological

opportunity, high technological entry barriers especially originating in the high industry-specificity of the knowledge base, and high cumulativeness of innovation. Firms are homogeneous in their rates and directions of innovation, which are focused on closely related technologies. Innovative activities are principally devoted to product innovation and benefit from the direct contribution of scientific advances in academic research. The main characteristic of the technological regime relative to the electrical and electronic industry is the low differentiation of the knowledge base. Such feature is linked to the high knowledge specificity that reflects the fact that for this typology of technologies, new knowledge can be applied to a limited variety of products and production processes. According to Marsili (2002), this property of knowledge can be better described as technological richness and it is typical of technologies that are direct applications of scientific findings because of the generic nature of scientific knowledge. Consequently, under these conditions, as underlined by the author, innovation is likely from academic research (Marsili, 2002). The high level of specificity also affects the external source of knowledge, that unlike to the automotive sector, are mainly defined by public institutions and joint ventures, demonstrating a low need of different competences for innovating.

TECHNOLOGICAL REGIMES	Electrical-electronics industries	Motor vehicles industries
	Science-based regime	*Complex system regime*
Diversification of the knowledge base	INDUSTRY SPECIFICITY	VERY HIGH
External sources of knowledge	Low involvement of external stakeholders with low diversification in terms of typology of engaged actor.	High involvement of different typologies of external stakeholders due to the high knowledge complexity that requires different competences.
Links with academic research	Direct and frequent involvement of knowledge leaders.	Indirect involvement of knowledge leaders characterized by high benefits..
Nature of innovation	Mainly product innovations	Both product and process innovations with a propensity to generate more complex innovation as combination of product and process innovations or business innovations.

Table 1 - Summary of technological regime differences

The identification of technological regimes that include automotive and electrical and electronic sectors executed through the classification of Marsili (2002) allows enhancing and improving the understanding of sustainability innovation pattern and technological trajectories explored by firms of the sample. Therefore, the technological regime approach could constitute an essential variable for the study of sustainability management since each industry has a different sustainability attitude and is subject to different controls and pressures from stakeholders (González-Benito and González-Benito, 2006). In particular, these industrial differences are empirically confirmed within the environmental ambit. An

interesting example of such genre, it is provided by the oil, chemical and paper industries, which are the sectors associated with the poorest environmental performance and the greatest environmental risk. In fact, statistics reveal that these sectors devote the highest volume of their resources to pollution abatement, at least in the USA (US Department of Commerce, 1996). At the other extreme, service industries usually represent a reduced environmental impact and the lowest environmental risk. This led to think that in each sector there will be different motivations and postures as regards environmental management. These industrial differences are empirically confirmed by Barnerjee (2002), who observed significant divergences in the way each sector perceives the importance of environmental issues. Vastag and Melnyk (2002) also registered differences as regards the expected and perceived effects of ISO14001 certification within different industrial sector proved that different factors linked to the industry's features affect the behaviour and attitude of firms to environmental issues.

Thus, on the base of what is affirmed in the academic literature, it is reasonable to suppose that the intensity of stakeholder sustainability pressure will be greater in those industrial sectors with higher potential for or actual impact on the sustainability ambit, considering both environmental and social sides. Thereby, companies that compete in sectors of high sustainability impact and risk perceive greater stakeholder sustainability pressure than do companies that compete in other sectors. Through these considerations, it is possible to apply the technological regime approach in order to understand the different behaviours of companies in the development of sustainability innovations on the base of belonging to specific technological regime.

6 Theory and research objectives

The research work is placed inside an already explored study ambit, which provides some based assumptions and fundamental point from which it is possible to start to propose innovative concepts. The insertion of the research in a determinant theoretical model allows contributing to the enlargement of such ambit of study and to justify the necessity and importance of the research itself.

6.1 Theoretical background

Within the academic literature, various authors have analysed different aspects of corporate sustainability through the development of theoretical framework. Given the nature of such research work, my attention has been addressed towards the theoretical models aimed to the analysis of aspects relative to the general concept of sustainability and more specifically to the study of stakeholders and drivers in the innovation sustainability ambit.

The reference theories aim to analyse the forces that lead a company to develop a specific sustainability innovation patterns, focusing the attention on the role of external stakeholders in such process within a sectorial perspective. The theory which is the basis of the study of the drivers for the sustainability innovation development is the Institutional theory. Such theory tries to explain which forces lead companies to operate in a determined way or develop certain strategies focusing on external drivers. The Institutional theory is widely adopted in academic literature for interpreting how the company approaches to sustainability, mainly in relation to the pressures that come from the outside. For this reason, it is useful and diffusely used to study and interpret the sustainability initiatives of firms (Sarkis, Zhu and Lai, 2011).

Inside the context of the Institutional theory, Berrone et al. (2013) have introduced the concept of firm's past performance as possible aspect that can influence the operative and strategic decisional process of a firm in the environmental sustainability ambit. The authors have identified the past performance as a possible source of external pressure. Indeed, starting from the Institutional theory, they have proposed that unsatisfying performance could make a firm more sensitive to normative and legislative pressures towards the adoption of sustainability initiatives. In this perspective, the sustainability innovation became attractive due to the external pressures in particular for those companies characterized by a marked performance gap. Therefore, the firm's past performance, seen as source of external pressure, can be included as possible driver for sustainability innovation modifying the classical application of the Institutional theory.

As said, the Institutional theory provides a theoretical base that allows investigating and explaining different firm's strategic choices and initiatives taking into account the only exogenous forces. However, from the analysis of academic literature, it has been possible to note as different research studies bring out the fundamental importance of internal drivers and pressures in addition to the external pressures. The simultaneous consideration of internal and external drivers for the definition of a firm's strategy, it

has been treated in an interesting way in the research work of Azzone et al. (1997). The authors have analysed in the environmental ambit as internal and external pressures affect the strategic attitude of a firm to the environmental issues. The strategic attitude, which substantially defines the perception and orientation of environmental issues for a firm, is the result of the assessment of the external context and the strategic orientation of a firm. Other authors, as J. González-Benito and Ó. González-Benito (2006, 2008), have analysed the determinant factors of strategic attitude relative to environmental issues including both internal and external factors. In particular, they have evaluated the firm's environmental proactivity considering the pressures generated by internal and external stakeholders. Starting from these examples defined within an environmental ambit, my intent is to analyse the firm's strategic attitude to sustainability including both internal and external drivers, in order to extend in this way the domain and the literature associated to the Institutional theory. To summarize, starting from the Institutional theory that allows to explain and investigate different strategic decisions and initiatives of a firm, extending the domain of this theory also to internal forces and including the factor identified by the firm's past performance, it is possible to argue the relation among these drivers and the sustainability innovation .

As highlighted by the academic literature, one of the more studied aspects relative to the innovation ambit is the role played by external stakeholders in the innovation process development. The reference theoretical approaches that have made interesting contributions to the analysis of the relationship between stakeholder engagement and sustainable innovation are: Stakeholder theory and Resource based view (RBV).

The fundamental theory behind the studies in the field of innovation, stakeholder collaboration and sustainability is the Stakeholder theory. Stakeholder theory can be traced back to the seminal work of Freeman (1984), who articulated a new conceptual model of the firm that must address the interests of its stakeholders. This stakeholder model extends managers' attention beyond the traditional interest group of shareholders, towards employees, customers and suppliers and widely disparate groups such as local community organizations, environmentalists, governments (Ayuso et al., 2011). From a practical point of view, this theory suggests that firms can benefit financially from establishing positive and close relationships with stakeholders (Donaldson and Preston, 1995; Jones, 1995; Jones and Wicks, 1999) and that these collaborative relationships can be an important resource in terms of knowledge and a tool for innovation (Rodríguez et al., 2002). In this sense, stakeholder engagement can be seen as an organizational capability framed within the Resource based view of the firm. Such theory conceptualizes a firm as a set of heterogeneous resources and competencies (Amit & Schoemaker 1993; Mahoney & Pandian 1992; Penrose 1959; van Huijstee & Glasbergen 2008). The RBV of the firm contends that a firm's ability to perform better than the competition depends on the unique interplay of human, organizational and physical resources over time (Wernerfelt, 1984). Therefore, firms that are able to accumulate resources and capabilities that are rare, valuable, non-substitutable, and imperfectly imitable will lead to enduring firm variation and above-normal rates of return (Barney, 1991).In this context, several authors

have pointed out that engage in proactive relationships with their stakeholders can represent a key means to acquire new resources and capabilities and thus open up the possibility to achieve better performance (Albino et al. 2012). By relating the insights from the RBV to stakeholder interests and sustainable development, it is possible to consider stakeholder engagement as an organizational capability which allows the firm to build strategic relevant relationships with their stakeholders (Ayuso et al, 2011). Strengthened stakeholder relationships can become thus a significant source of competitive advantage in form of trust, reputation and innovation (Rodríguez et al., 2002).

Considering the extension of RBV, that is the Relational view (Dyer and Singh, 1998), researchers argue that linkages with partners outside the firm can be a source of competitive advantage, because these relationships can enable firms to access additional resources such as financial, intellectual and human capital. Thus, a firm's critical resources may cross firm boundaries and be embedded in inter-firm resources and routines (Dyer and Singh, 1998; Flynn et al., 2010; Mesquita et al., 2008). According to this perspective, the RBV sustains the idea that a firm's competitiveness not only arises from internal resources, but also depends on inter-firm sources of advantage (Dyer and Singh, 1998; Lavie, 2006). In this sense, the RBV emphasizes not only how different actors outside the company represent a valuable source of unique and inimitable resources and capabilities, but also as the capability of the company to establish lasting and profitable relationships with these entities represents an engine for innovation and a potential source of competitive advantage. As described so far places the RBV in the general context of the enterprise. Subsequently, the theoretical approach has been enriched by the contributions of several authors who have used it as a theoretical basis for numerous studies in the field of operations and performance, as well as in the field of sustainability. As said, such theory has also been studied and adapted to the specific context of sustainability. The first contribution in this sense can be traced back to Hart, who proposed an expansion of RBV in the 1995. The theory proposed by Hart (1995) is called Natural Resource Based View (NRBV) and includes in the context of previous RBV aspects and opportunities related to the concept of sustainability. The NRBV was taken by a large body of literature as a reference for subsequent research in the field of strategic management of sustainability issues (Albino et al. 2012).

The focus of this research work is not so much on the demonstration that innovation practices lead to sustainable competitive advantage, but rather on the definition of how the sustainable innovation is characterized and developed. The resources and skills critical to develop such initiatives can go beyond the boundaries of a firm and may well-established in the inter-firm relationships of collaboration. In this perspective, company's competitiveness does not come only from inside of a company. Indeed, taking into account the relation between RBV and the relational view within the Stakeholder theory, it is possible to state that a company obtains a competitive advantage through resources and capabilities relative to the sustainability ambit and that the collaboration with stakeholders contributes to their development.

Therefore, through the consideration of theoretical approaches seen above, first of all it is possible to propose a framework in order to classify the sustainability innovation in an overall way, i.e. taking into account both environmental and social components. In addition on the basis of RBV, it is possible to consider the sustainability innovation as a firm's capability that combine the ability to establish and manage long term stakeholder collaborations and the ability to integrate their resources and competences to generate social and environmental innovations (Ayuso et al., 2011; Ayuso et al., 2006; Yarahmadi, 2012). The final goal is to analyse the relation between the collaborations established with external stakeholders and sustainable innovation orientation.

In the academic literature different authors have highlighted as the rate and type of innovation and the organization of innovative activities greatly differ across sectors. Various streams of research have tried to examine patterns and determinants of innovation process, but in order to put the analysis of sustainability innovations in an industrial dynamic perspective the theory more adopted is the technological regime approach. The technological regime concept provides a description of the technological environment in which firms operate (Nelson, R. R. and S. Winter, 1982). It defines the modal properties of learning processes, sources of knowledge and nature of knowledge bases that are associated with the innovation processes of firms active in distinct sectors of production activities (Dosi, G., 1982).

As said, a part of the academic literature recognizes the structure and dynamics of an industry sector as a relevant factor for the development of innovations. This statement can be assessed also in the sustainability ambit (Marsili, 2001; Malerba et al., 1996; Malerba and Orsenigo, 1995; Oltra and Saint Jean, 2009). The reference model, defined to analyse the firm's innovation processes within the sustainability ambit, is an evolution of technological regime concept introduced by Nelson and Winter (1982) and derived from two different traits of the innovative firm proposed by Shumpeter in "The theory of economic development" (1934) and into "Capitalism, socialism and democracy" (1942). Such model proposed by Marsili (2001) is more detailed especially regarding the characteristics of the knowledge bases and the sources of barriers to entry. Each regime is defined by a specific combination of technological opportunities, technological entry barriers, inter-firm diversity in the rate and directions of innovation, diversification of the knowledge base, external sources of knowledge, links with academic research and nature of innovation. The author, by collecting empirical data, has identified identifies and characterizes the industries composing each regime allowing in this way to understand the differences in the innovation development behaviour among the various industrial sector.

Such identified differences can be used in order to highlight and explain the innovation behaviours assumed within the two industrial sectors of this research work. The belonging and the differences linked to the technological regimes defined by Marsili (2001) act as base to enhance the understanding of the role that drivers and collaborations assume in the development of sustainability innovations.

6.2 Research gaps of academic literature

The analysis of academic literature regards the theme of sustainability has brought to identify a specific aspect of this macro-argument that is fundamental for the future complete implementation of sustainability objectives in the firm's strategies: the sustainability innovation. As recognized by numerous authors, only firms that will integrate sustainability as a real goal will be able to achieve relevant competitive advantages. Therefore, this objective is achievable only through the development of a sustainability innovation process that allows the review of business models, as well as products, technologies and processes (Nidumolu et al. 2009).

Despite, the relevance of sustainability innovation has been widely discussed, in my opinion there are some fundamental aspects that the academic literature has not yet treated in a complete and exhaustive way. The main limitation identified in the academic literature is the study of sustainability innovation process within an industrial sector perspective. Indeed, in the academic literature there are different research studies that aim to analyse the behavioural differences in the innovation trajectories within different industrial sectors but neither of these researches focus on the study of innovation in the sustainability ambit. As seen, the influence of features and structure of an industry in the shaping of innovation pattern is acknowledged and it is manly study through the technological regime concept (Gabzdylova et al., 2009; González-Benito and González-Benito, 2008, 2006; Geels, 2004; Malerba, 2005). The application of technological regime classification introduced by Marsili (2001) has allowed understanding the characteristics of the two industrial sectors analysed in the research. The identification of the technological regime has been executed in terms of level of technological opportunity, technological entry barriers, cumulativeness of innovation, inter-firm diversity in the rate and directions of innovation, intensity and directions of diversification of the knowledge base, relevance of various external sources of knowledge, links with academic research, and nature of innovation. Such factors have highlighted differences relative to the two considered industrial factors, which are used as basis to explain different behaviours in the development of sustainability innovations.

In addition to the introduction of industrial sector perspective, the literature analysed in the field of sustainability and sustainable innovation highlights with great insistence the importance of collaboration with actors outside the company in order to benefit from the complementary expertise and resources. Competences and resources that otherwise would not be available to the individual company. (Vachon & Klassen 2006; Holt, 2004; Albino et al.2012; Yarahmadi 2012; Ayuso et al. 2006; Hansen 2009; Ayuso et al. 2011; Yarahmadi 2012; Sharfman 2009; Nidumolu 2009). Previously, I presented in detail the treatment of various authors regarding the role of different stakeholders in the field of sustainability and sustainability innovation. Despite several research works have allowed to identify which are the actors who play a major role in this context, the research has not yet identify what might be the specific relations between the various stakeholders and the different types of sustainable innovation. Therefore, it is possible to consider this issue as a substantial gap in the academic literature. This research, through the analysis of relation

between sustainability innovation development and the establishment of stakeholder collaborations, is oriented to highlight the relevance of collaboration in the implementation of sustainability innovations going to bring out the links among different types of innovation, the involvement of various stakeholders and the belonging to a specific technological regime.

Another concept related to sustainable innovation and collaboration with the various stakeholders that deserves to be investigated is the strategic approach that the company takes on the issues of sustainability. Starting from the contributions of the Institutional theory, it is possible to identify the external forces that lead companies to act in terms of sustainability. From the analysis of academic literature, the sustainability is increasingly considered as a viable opportunity for growth and profit (Carroll & Shabana 2010; McKinsey Global Survey Results 2010; McKinsey Global Survey Results 2011; MIT Sloan Management Review with BCG 2013; Accenture report 2012). According to this perspective, some authors have underlined the need to enlarge the domain of Institutional theory for the study of sustainability including not only the external forces, but also the internal ones that lead a firm to adopt a particular strategy. Therefore, this research work seeks to evaluate the drivers that lead a firm to deal with sustainability considering both external and internal factors and placing the analysis in an industrial sector perspective with the introduction of technological regime concept.

6.3 Objectives and research questions

Downstream of the considerations presented in the previous paragraphs, it is necessary to summarize and schematize the overall goal of this research work. In this context, the present research work aims to investigate both aspects that motivate the decisions of companies in the development of sustainability innovations and the role of stakeholder collaborations in their development. Subsequently, such aspects have been also analysed within a technological regime perspective thanks to the introduction of technological regime approach.

As seen before, the main goal of this research is to expand the literature on the subject of corporate sustainability with a focus on the concept of sustainable innovation. Although sustainability is a subject studied for several years by a number of researchers around the world, it has been possible to identify some aspects still unclear that deserve to be further investigated. First of all, it has been necessary to investigate the determinant factors for the development of sustainability innovation. The academic literature uses the Institutional theory for analysing the factors that lead firms to take specific strategic decisions, also in the sustainability ambit (Yarahmadi 2012; Hartman 1999). In this context, numerous authors have highlighted the role of different strategic approaches. According to the academic literature the present research work aims to support and extend the theoretical framework of Institutional theory including the concept of strategic attitude. Indeed, this theory is focalized on the external factors that bring a firm to act in a specific way, in this case to develop sustainability innovations. Therefore, the goal in this situation is to include within the analysis in addition to the external factors also the internal ones

that affect the firm's decisions about the implementation of sustainability innovations and programs, both in the environmental and social contexts. Furthermore, considering the considerations of some authors, as Berrone et al. (2013), it has been also possible to underline the role of firm's past performance in the development of sustainability innovations. On this basis, it has also been possible to include this variable as possible factor linked to the implementation of different typologies of sustainability innovations.

The second stream of research of this work aims to contribute to the support of the argument for which a collaborative approach between a firm and stakeholders is necessary to face in a profitable and better way the challenge of sustainability. In particular, within this research work, it is relevant the study of relation between different types of sustainability innovation and the various identified stakeholders. As previously seen, the theoretical framework that support this research work in this ambit is composed by the Stakeholder theory and the Resource based view. These two theories are fundamental to place the arguments and concepts analysed in the research, which aim to extend and support these theoretical approaches. In particular, in the analysis of sustainability innovations and the stakeholder collaborations, it has been possible to support and extend the knowledge relative to the Resource based view, which sustains that a firm to obtain a relevant competitive advantage has need to exploit specific and not replicable competences and resources. For several authors, the collaborative attitude of a firm identifies a resource of competitive advantage. This research aims to extend the knowledge about the Resource based view towards this direction. Very interesting in this development context is the Natural resource based view, proposed by Hart. This theory is perfect as theoretical basis for a research work focused on corporate sustainability. According to the NRBV, the firm's capability to propose and develop sustainability projects and programs is a resource not easily replicable and therefore it is able to generate a competitive advantage. Naturally, the research work introduced by Hart is addressed to the sphere of environmental sustainability. This research work aims to extend the domain of NRBV of Hart (1995) to the totality of corporate sustainability also including the social sphere of sustainability.

In order to improve and enhance the understanding of the relations described above, it is possible to introduce an industrial sector perspective. This introduction derives by the fact that in the academic literature numerous authors have underlined the relevant influence that the structure and the features of an industrial sector have on the development of innovation. This statement can be assessed also in the sustainability ambit (Marsili, 2001; Malerba et al., 1996; Malerba and Orsenigo, 1995; Oltra and Saint Jean, 2009). Through the application of technological regime approach of Marsili (2001), it has been possible to identify the features of the two industrial sectors included in this research work. The comparison of such characteristics, mainly relative to knowledge basis and learning process that underline the development of sustainability innovations may bring new insights on the sources of innovation and on the directions of the resulting technological trajectories. The application of technological regime approach allows obtaining a better understanding of the knowledge bases and of the learning processes putting more attention on the innovation process itself and on its features and determinants at the industry and firm levels.

In conclusion, the research model, which incorporates the concepts discussed above, is the following:

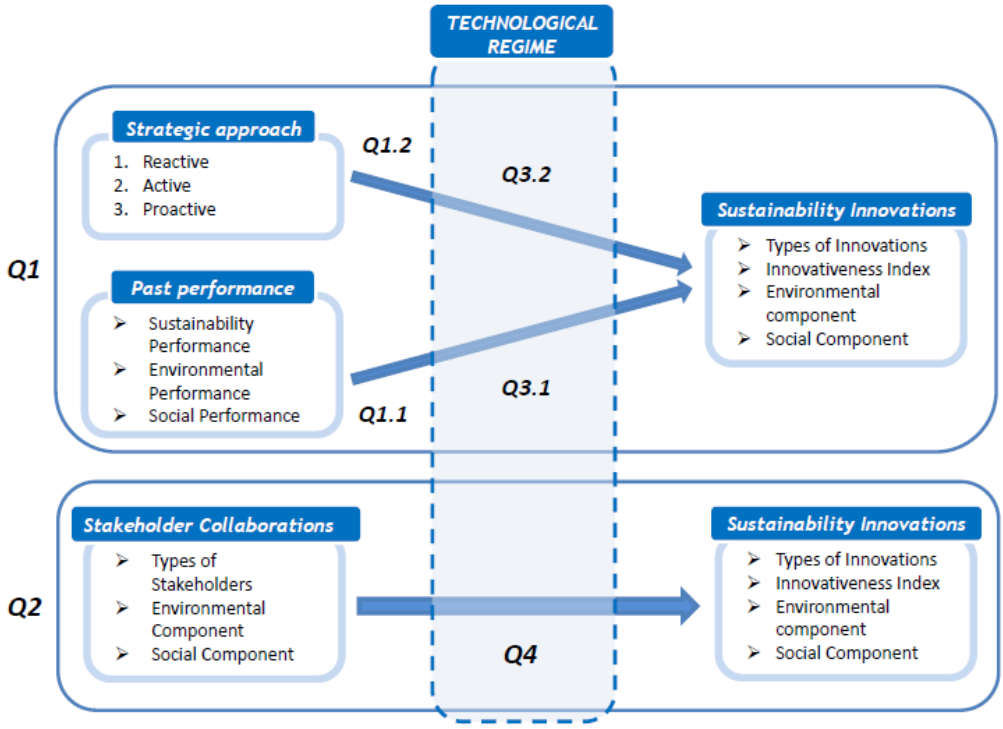

Figure 3 - Research framework

To summarize, I list the research questions to which I would like to answer through this research work:

Q1: Which are the drivers of sustainable innovations?

> **Q1.1:** Are past performance drivers of sustainable innovations?
> **Q1.2:** Is the company sustainability strategic position driver of sustainable innovations?

Q2: Which stakeholder collaborations impact on sustainable innovations?

Q3: Does the technological regime of the industry impact on the relationship between drivers and sustainable innovations?

> **Q3.1:** Does the technological regime of the industry impact on the relationship between past performance and sustainable innovations?
> **Q3.2:** Does the technological regime of the industry impact on the relationship between the company sustainability strategic position and sustainable innovations?

Q4: Does the technological regime of the industry impact on the relationship between stakeholder collaborations and sustainable innovations?

7 Reference models

The research work has been developed on the base of two reference models, which are used to classify the sustainability innovations and to analyse the considered industrial sectors in the technological regime perspective. The reference model used for the classification of sustainability innovations has been introduced by Benaglia and Cola (2013) in their research work "Innovazione Sostenibile: il ruolo dei driver strategici e della collaborazione con gli stakeholder". Such model allows the classification of innovations in the sustainability ambit taking into consideration both the social and environmental components of sustainability. Instead, the second model has been introduced by Marsili (2001) to allow the identification of technological regime to which belong the two industrial sectors relative to the considered samples. Such technological regime model has allowed defining the features of the considered industrial sectors in order to assess and justify the different behaviours in the sustainability innovation development.

7.1 Sustainability innovation classification

The model introduced by Benaglia e Cola (2013) aims to propose a complete and comprehensive classification framework relative of sustainability innovation enriching it through the joint consideration of sustainable innovations developed in the social and environmental ambits. Indeed, the sustainability innovation is a concept that includes both the environmental and social spheres of sustainability, although in the academic literature contributions are today much richer on the environmental side of the Triple Bottom Line and this means that most of the references are derived from the literature on this field.

7.1.1 Dimensions of analysis

The dimensions of analysis and consequently the categories of sustainable innovation have been structured taking as reference the contributions of the academic literature on the subject. In order to complete the framework some indications and aspects have been taken into considerations consulting the sustainability reports of companies included in the test sample involving in this way those aspects that the academic literature omits or does not deal in some detail.

The dimensions of analysis of this framework are:

- Nature of innovation
- Degree of innovation
- Object of innovation
- Impact area of innovation

7.1.1.1 Nature of innovation

The first considered dimension of sustainability innovation classification is a transverse dimension that allows dividing the analysed innovations on the base of Triple bottom Line concept in:

- ✓ Environmental innovations
- ✓ Social innovations

7.1.1.2 Degree of innovation

A second fundamental dimension that distinguishes the sustainable innovation is related to the degree of innovation of implemented initiatives. The model distinguishes between incremental innovations and initiatives classified as radicals. This distinction is historically linked to the discussion of innovation projects. The academic literature about environmental sustainability has always distinguished between initiatives that involve minimal changes and on the contrary others that lead the companies to propose highly innovative solutions. For example, many authors have emphasized the dichotomy between initiatives of Pollution Control and Pollution prevention. Despite, this classification suggests a high level distinction of sustainability innovation, so it is able to provide some basic elements.

The interest in distinguishing between incremental practices and radical ones derives from the thesis, shared in the literature, that in order to facilitate the transition towards real sustainable firms and supply chain, it is necessary to propose and invest in radical innovations rather than focusing on incremental initiatives that are not really able to change the firm's ecosystem (Hellström 2007; Van Kleef & Roome 2007; Pagell & Wu 2009; Hall & Vredenburg 2003; Shevchenko & Pagell 2013). In this context, several authors have showed as in reality the major part of companies tend to develop incremental innovations rather than radical ones. This behaviour is linked to the complexity and more efforts required to develop the radical innovations (Hellström 2007). This demonstrates as it is appropriate to consider the dimension related to the degree of innovation in this framework.

7.1.1.3 Object of innovation

The third dimension taken into consideration in the definition of the framework regards the object of innovation. The academic literature highlights as the sustainability innovation is not limited to individual areas or aspects of corporate change.

On the contrary, a sustainability innovation can take form on processes, products, services, even on entire business model. Therefore, it has been fundamental the use of a classification model relative to sustainability innovation that takes into account a dimension able to define the ambit on which the innovation is generated. As underlined in the academic literature, various authors propose different classifications of sustainability innovations on the base of the innovation object (Klassen & Vachon 2003; Klassen & Whybark 1999; Hellström 2007; Ekins 2010; Tseng et al. 2013; Hansen, Grosse-Dunker, Reichwald 2009; Kemp & Foxon 2007). This model distinguishes among four different typology of innovation within this dimension: process innovations, product innovations, innovation relative to combination of products and processes and business innovations.

The process innovation regards sustainability initiatives that are able to modify, in a more or less invasive way, the processes of a company. Instead, the product innovations are relative to the introduction of a new product or the design modification of an existing one, such as the replacement of a material. It is interesting to emphasize that not necessarily the sustainable innovations on products are radicals. But such initiatives can be relative to incremental changes of a product in order to reduce, for example, the environmental impact. A third level is identified by innovations that impact not on individual products or processes but that simultaneously lead to changes on both or even on a part of company's business. Although the dimensions of the framework are invariant to the environmental and social side, the innovations that have as their object a combination of processes and products are relative to the environmental sphere while those that see as object a company's business are focused on the social. This distinction derives from the nature of innovations developed by companies. Therefore, in the case of environmental innovations the changes are relative to a combination of products and processes, instead in the case of social innovations, it is the business of the company that is subject to the change such as entering in a new market.

7.1.1.4 Impact area of innovation

The last analysed dimension concerns the area where the innovation generates the impact in terms of environmental and social sustainability.

Necessarily, a sustainability initiative has not to generate a benefit within the firm's processes of a company. On the contrary, the impact is often generated outside the boundaries of a company, through the supply chain or on the final customer during the usage of the product. Therefore, it is fundamental to identify and distinguish the sustainability innovations on base of the area on which generate an impact in terms of sustainability. In the academic literature, for example, the concept of Product stewardship helps to understand as it is not possible to approach the sustainability only from an internal process point of view. For a company the real challenge in terms of sustainability is to make the own products sustainable within their entire life cycle, extending in this way the firm's impact beyond its boundaries. Indeed, it is interesting to underline the enhancing attention towards initiatives linked to the concept of green logistic or closed loop supply chain (Vachon & Klassen 2008; Kemp & Foxon 2007; Hellström 2007; Tseng et al. 2013; Pagell & Wu 2009).

In the academic literature, the main distinction is between innovations relative to internal processes and aspects of a firm and innovations that generate an impact outside the company, on external process that involve customers and suppliers. In addition to this distinction, it is necessary to introduce a category that includes those innovations able to produce an impact outside the traditional supply chain or that generate the impact inside the traditional supply chain but also beyond it. For example, this category includes those innovations able to generate an impact during the usage of the product by the final customer. Such category is not widely treated in the academic literature relative to sustainability innovation but finds

space in different ambits as life cycle management, green product design or design for sustainability (Hellström 2007; Tseng et al. 2013; Hansen, Grosse-Dunker, Reichwald 2009; Vachon & Klassen 2006; Hart 1995; Hart 1997; Vachon & Klassen 2008; Kemp & Foxon 2007; Ekins 2010; Foster & Green 2000).

Regarding the social sphere, the argument relative to the impact area of innovation is lightly different. The social innovation has been distinguished from various authors on base of the objective actor of the initiatives following the diffused Stakeholder theory. Typically, the social initiatives are oriented towards employees, suppliers, customers and the community as a whole (Jamali, 2008; Longo et al., 2005). In the case of innovations with impact within the company are employees to benefit from this type of initiatives. Instead, innovations classified as external are addressed to suppliers and finally those in the extended category are initiatives that generate positive social impacts on society, including end customers and communities.

7.1.2 Typologies of environmental innovation

This section describes the categories of sustainability innovations defined within the environmental field on the base of the object of innovation, treating in a separate way process innovations, product innovations and innovations relative to combination of products and processes.

7.1.2.1 Process innovations

	INCREMENTAL	RADICAL
INTERNAL SC	**Pollution control** 1) Treatment system for VOC	**Process redesign**
	Energy efficiency and renewable energy innovations and initiatives 1) Employees mobility/work-style 2) Facilities' management 3) Use of energy from renewable resources 4) Green IT 5) Other initiatives	
	Equipment redesign or upgrade or change	
	Water management processes 1) Water treatment innovation or initiatives 2) Water recycling innovation or initiatives	
	Waste management processes 1) Recycle/Reuse 2) Waste treatment 3) Other initiatives	**Process redesign**

EXTERNAL SC	**Material and resource management** 1) Material Data System 2) Material Flow Management System	**Green Logistics Principles** 1) Modal shift for transportation 2) Intermodal transportation 3) New multi-modal logistics centre
	Logistics optimization initiatives 1) Logistics routes optimization 2) Increase in low-emission transport 3) Optimization of transport capacity 4) Reduced use of packaging and protective materials. 5) Logistics flows optimization	
EXTENDED SC		

Table 2 - Process innovations in the environmental ambit

Most of the innovations included within such category are incremental initiatives and mainly oriented to generate an impact inside the firm, although there are some exceptions.

The categories of incremental innovations addressed to internal processes are:

- ✓ Initiatives of *Pollution control,* represented by installation of filters or other devices that are aimed to solve an environmental problem downstream of a process, once the damage has been generated (Gavronsky, Klassen and Vachon, 2012; Klassen and Vachon, 2003; Klassen and Whybark, 1999; Ekins, 2010; Tseng et al., 2013; Hart, 1997).This category mainly allows to avoid sanctions and has received great feedbacks from the academic literature (Gavronsky, Klassen and Vachon, 2012; Klassen and Vachon, 2003; Klassen and Whybark, 1999; Ekins, 2010; Tseng et al., 2013; Hart, 1997).
- ✓ Energy efficiency and renewable energy innovations and initiatives, these are initiatives oriented to the energy efficiency of the processes (Kemp & Foxon 2007; Klassen & Vachon 2003; Ekins 2010; Paraschiv et al. 2012; Chen, Chang, Wu 2012; Tseng et al. 2013). In addition to classic innovations linked to the exploitation of renewable energy or facility management, inside this category can be also included innovations relative to the work-style and mobility of employees.
- ✓ Equipment redesign or upgrade or change, these are initiatives aimed to the reduction of the environmental impact in terms of energy, waste, input or waste generation (Kemp & Foxon 2007; Klassen & Vachon 2003; Ekins 2010; Paraschiv et al. 2012; Chen, Chang, Wu 2012; Hellström 2007; Tseng et al. 2013).
- ✓ Water management processes, in this category are included interventions in the management of water used for the internal processes of the company. In this case, the initiative is not referred to simple installations of an end-of-pipe but to more sophisticated initiatives aimed to improve the acquisition, management and recycling of water (Kemp & Foxon 2007; Klassen & Vachon 2003; Ekins 2010; Paraschiv et al., 2012; Chen, Chang, Wu, 2012; Tseng et al. 2013).

- ✓ Waste management processes, this category includes interventions aimed to improve the generation and management of waste derived from internal processes (Kemp & Foxon 2007; Klassen & Vachon 2003; Ekins 2010; Paraschiv et al., 2012; Chen, Chang, Wu, 2012; Tseng et al. 2013).

Regarding the environmental innovations able to generate impacts outside the firm's boundaries, the process innovations include initiatives relative to logistic processes and the supply chain management (Kemp & Foxon 2007; Klassen & Vachon 2003; Ekins 2010; Paraschiv et al. 2012; Chen, Chang, Wu 2012; Vachon & Klassen 2008). Within these innovations, it is possible to distinguish between incremental initiatives linked to the optimization of logistic processes and more radical innovations that imply the rethinking of the distribution network through the use of different logistics carriers with different impacts on the environment. An example of such initiative is the "modal shift", i.e. the shift of road transport to the logistics by sea or rail which are extremely less polluting. The external initiatives include another last category of innovations linked to the material and resource management. In this category the main initiatives are represented by the implementation of new material data system or new material flow management system that allows reducing the environmental impact linked to the material management.
An additional category of sustainability innovation relative to internal process is linked to the development and change of the main firm's production processes in order to minimize their environmental impact. This category called process redesign is defined within the radical innovations and means to reshape the firm's production processes to make it more environmental friendly (Hansen, Grosse-Dunker and Reichwald, 2009; Kemp and Foxon, 2007).

7.1.2.2 Product innovations

	INCREMENTAL	RADICAL
INTERNAL SC		
EXTERNAL SC	**Product reformulation** 1) Use of recycled materials in product 2) Reduction of hazardous substances 3) Design for standardization/common design 4) Development of alternative materials 5) Reduction of rare materials 6) Reduction of weight/materials used 7) Other initiatives	
EXTENDED SC	**Environmental product adaptation** 1) Design for energy efficiency 2) Adoption or development of new or next generation technology 3) Eco supporting device	**Green products** 1) Product with alternative system (propulsion system)

Table 3 - Product innovations in the environmental ambit

The product environmental innovations are mainly oriented to generate an impact outside the firm's boundaries through the supply chain and the usage of the product.

These initiatives are not simply defined as the development and introduction of new products but also include less radical changes to existing products with the intention of solving environmental problems making in general the firm's product more sustainable. A consistent part of the academic literature focuses on the concepts of green product and design for sustainability, which include all the innovations aimed to propose new products to the market that are explicitly designed to have a lower impact on the environment than previous or competitive ones (Kemp & Foxon 2007; Ekins 2010; Hansen, Grosse-Dunker, Reichwald 2009; Tseng et al. 2013; Hart 1997; Foster & Green 2000; Hellström 2007).

However, the environmental innovation on products does not only regard the development of new solutions for customers but also the incremental change of existing products in order to make them more sustainable. Some examples of such initiatives are the substitution of polluting or dangerous materials, the reduction of raw material input, the introduction of recyclable materials and the reduction of product weight (Klassen and Vachon, 2003; Ekins, 2010). Some modifications on existing products are executed in order to reduce the product environmental impact during the usage (Gavronsky, Klassen and Vachon 2012; Klassen and Vachon 2003; Klassen and Whybark 1999; Ekins 2010; Tseng et al. 2013; Hart 1997).

7.1.2.3 Product and process innovations

	INCREMENTAL	RADICAL
INTERNAL SC	**Products changes which affect company manufacturing processes** 1) New global modular platform	
EXTERNAL SC		
EXTENDED SC		**Life cycle assessment** 1) LCA applied to testing innovative and recycled materials
		Products take back and recycle programs 1) Design for disassembly 2) Design for remanufacturing 3) Design for recycling 4) End of Life vehicle information system

Table 4 - Product and process innovations in the environmental ambit

In some cases the innovations implemented by the companies generate changes on both the innovation object. An example is provided by product innovations that also require the change of some fundamental production processes of the firm. In addition to this incremental innovation relative to the combination of products and processes, it is possible to identify initiatives more radical initiatives. The academic literature in the ambit of environmental innovation give attention to the concept of closed loop supply chain (Vachon & Klassen 2008; Kemp & Foxon 2007; Hellström 2007; Tseng et al. 2013; Pagell & Wu 2009). Inside this category of innovations, it is possible to include the numerous products take back and recycle programs implemented by firms. In addition to this category, there is the so called life cycle assessment, which includes all the projects addressed to the evaluation of environmental impact of a product within its overall life cycle (Hellström 2007; Tseng et al. 2013; Hansen, Grosse-Dunker, Reichwald 2009; Vachon & Klassen 2006; Hart 1995; Hart 1997; Vachon & Klassen 2008).

7.1.3 Typologies of social innovation

This section describes the categories of sustainability innovations defined within the social field on the base of the object of innovation, treating in a separate way process innovations, product innovations and business innovations.

7.1.3.1 Process innovations

	INCREMENTAL	RADICAL
INTERNAL SC	**Health and safety** 1) Health and safety standard/certification 2) Internal audit, safety and risk assessment/evaluation 3) Health and safety training, studies and conferences	
	Well being 1) Ergonomics studies and changes in the workplace layout 2) Work-life balance 3) Staying fit, healthy and safe programs 4) Financial and social benefits 5) Code of conduct/human rights policy and training 6) Diversity programs and internal audit	
	Vocational education and training 1) Talented employees management 2) Skills training programs 3) Developing graduates 4) Establishment of an own training academy	
	Work relations and involvement initiatives 1) Individual appraisal system 2) Employee satisfaction assessment 3) Ideas management tool 4) Work relations and conditions of work	

EXTERNAL SC	**Suppliers** 1) Suppliers code of conduct 2) Suppliers development and training programs 3) Suppliers diversity program 4) Risk management process	
	Network 1) Training programs 2) Skills assessment and certification 3) Supporting tools 4) Environmental and health & safety certifications	
EXTENDED SC	**Conflicted minerals issues activities**	
	New safety verification of product	

Table 5 - Process innovations in the social ambit

The totality of social process innovations are classified as incremental innovations, indeed the considered initiatives don't consider relevant changes to the resource management of a firm but rather the introduction of procedures and practices aimed to improve the different social aspects of company's operations.

In the model, it is possible to distinguish four typologies of process social innovations able to generate an impact within the firm's boundaries.

- ✓ Health and Safety, this category includes social initiatives aimed to guarantee the safety of employees in the workplace including the adoption of standards and certification procedures and the development of training courses for employees (Longo et al., 2005; Klassen and Vereecke, 2012; Spiller, 2000).
- ✓ Well-being, this macro category includes various typologies of initiatives for the improving of employees' well-being. Among these innovations, it is possible to identify the availability of additional services for employees as the construction of ancillary facilities (gym, nursery school, etc.) or even certifications related to human rights and programs of work-life balance (Longo et al. 2005; Spiller 2000).
- ✓ Vocational education and training, such initiatives regard the individual growth of corporate employees, in particular these initiatives are addressed to develop leadership and managerial capabilities (Longo et al. 2005; Spiller 2000).
- ✓ Work relations and involvement initiatives, in this category are included those initiatives oriented to the assessment and improvements of workplace relations and conditions.

An additional typology of social process innovation regards initiatives of different nature addressed to the management of suppliers and distribution network. In this case the impact of such initiatives is relative to

the processes of interface between company and supplier or distribution network. These practices concern the obligation to adopt codes of conduct, but also the development of training and diversity programs (Longo et al., 2005; Klassen and Vereecke, 2012; Spiller, 2000; Halme and Laurila, 2008).

Instead, the categories relative to "conflict minerals" and "new safety verification of product" include the consideration of initiatives able to generate an impact in term of sustainability beyond the traditional boundaries of a firm. In particular, the social impact in this case is addressed to the final customers and to the society in general.

7.1.3.2 Product innovations

	INCREMENTAL	RADICAL
INTERNAL SC		
EXTERNAL SC		
EXTENDED SC	**Product adaptation for customer safety reason** 1) Adoption of safety devices for consumer health and safety	**Social product** 1) Product with innovative safety systems 2) Product equipped with designed systems for disabled people 3) Product equipped with designed systems for old people

Table 6 - Product innovations in the social ambit

The product social innovation includes only two typologies of innovations:

- ✓ Product adaptation for customer safety reason, companies must ensure at all times the safety and quality of its products. For example, these innovations involve the introduction of eco-label to ensure transparency of information to consumers and the spread of misleading promotions (Longo 2005; Spiller 2000).Such innovations impact till to the end user, therefore several companies propose innovations and projects aimed at protecting the customer with changes or tricks on their products and services.
- ✓ Social product, this typology of innovations has emerged from the academic literature only partially, the concept has been expanded through the data collected from corporate sustainability reports. The development of products with a social purpose has been classified as radical innovation because it assumes the generation of a new product designed specifically for the

resolution of a social problem that the company is forced to face or voluntarily decides to do (Halme & Laurila 2008). Therefore, such initiatives don't regard a simple revision of an existing product. Once again, it is clear that the benefits and thus the impact of these innovations lie outside the boundaries of the traditional supply chain towards the community to which the company addresses the innovation.

7.1.3.3 Business innovations

	INCREMENTAL	RADICAL
INTERNAL SC		
EXTERNAL SC		
EXTENDED SC		**Development of new business sectors** 1) Products, services and platform aimed to achieve social goals 2) Research projects related to future sustainable development of sector in which the company operates
		Participation and development of initiatives linked to company's core business 1) Participation in seminars, conferences and researches about key future areas of the sector 2) Participation in platform for collaboration between industry and higher education 3) Own education initiatives

Table 7 - Business innovations in the social ambit

Business social innovations include a typology of innovations that concerns the development of a new business in order to improve the social conditions of the community to which the innovation is addressed and a typology of initiatives relative to the current business in which the company operates.

In the academic literature several authors have treated the business social innovations and such innovations have been always associated with the highest level of innovativeness. Halme and Lauila (2008) describe the development of a business social innovation as a firm's approach that aims to create a new business to solve a social problem in the community, where in addition to the social objective, it is also clear an economic objective linked to the increasing of business revenues.

7.2 Marsili's technological regime model

The second reference model taken into consideration for the development of this research work is the technological regime approach defined by Marsili (2001). As already said in the previous paragraphs, the author starting from the concept of technological regime has identified five different regimes on the base of fundamental structural conditions that contribute to define competencies, incentives and dynamic properties of the innovative process.

Through the analysis of academic literature, it has been possible to identify and recognize the influence that different factors exercise on the technological response of firms in the development of sustainability innovations. Among these factors, various authors have highlighted the role played by factors relative to the learning conditions and technological context in which innovation takes place in sectors (Gort and Klepper, 1982; Levin et al., 1985; Cohen and Levin, 1989; Audretsch, 1995).

Such factors can be analysed through the notion of technological regime, which provides a way of representing some of the most important economic properties of technologies and of the characteristics of the learning processes that are involved in innovative activities. Thus, it identifies some fundamental structural conditions that contribute to define competencies, incentives and dynamic properties of the innovative process (Nelson and Winter, 1977, 1982; Breschi et al., 2000). To summarize, the technological regimes set the boundaries of what can be achieved in firms' problem solving activities and identify also the natural trajectories along which solutions to these problems can be found (Nelson and Winter, 1977, 1982). In this line of research, Malerba and Orsenigo (1990, 1993) have proposed that a technological regime is a particular combination of some fundamental properties of technologies: opportunity and appropriability conditions; degrees of cumulativeness of technological knowledge and characteristics of the relevant knowledge base. Marsili (2001) starting from this consideration has expanded the evaluation factors and has defined a framework able to define five different technological regimes on the base of a variety of dimensions. The dimensions taken into considerations are:

- ✓ Level of technological opportunity
- ✓ Technological entry barriers
- ✓ Cumulativeness of innovation
- ✓ Inter-firm diversity in the rate and directions of innovation
- ✓ Intensity and directions of diversification of the knowledge base
- ✓ Relevance of various external sources of knowledge
- ✓ Links with academic research
- ✓ Nature of innovation

The specific combination of such characteristics has allowed to define the five regimes:

1. The science-based regime

2. The fundamental processes regime
3. The complex systems regime
4. The product engineering regime
5. The continuous processes regime

On the base of the factors identified and through an empirical research work Marsili (2001) has defined the technological regimes in the following way:

- The science-based regime, in pharmaceuticals and electrical-electronics industries, is characterised by a high level of technological opportunity, high technological entry barriers especially originating in the high industry-specificity of the knowledge base, and high cumulativeness of innovation. Firms are homogeneous in their rates and directions of innovation, which are focused on closely related technologies. Innovative activities are principally devoted to product innovation and benefit from the direct contribution of scientific advances in academic research.
- The fundamental-processes regime, typified by the chemicals and petroleum industries, displays a medium level of technological opportunity, high technological entry barriers especially related to scale advantages in innovation, and strong persistence of innovation. Innovation is mainly process innovation and, although affiliated firms and users represent the main external sources of knowledge, it benefits from the quite important and direct contribution of scientific advances in academic research.
- The complex (knowledge) system regime, in aerospace and motor vehicles industries, is still characterised by medium-high levels of techno- logical opportunity, entry barriers in knowledge and scale, and persistence of innovation. The distinctive feature of this regime is in the high degree of differentiation of technological competencies developed by firms, especially in upstream production technologies, and of external sources of knowledge, including an important, although indirect, contribution of academic research.
- The product-engineering regime is characterised by a medium-high level of technological opportunity, low entry barriers to innovation and not very high persistence of innovation. This regime, which represents in particular non- electrical machinery and instruments, is distinguished by the high diversity of technological trajectories explored by firms. Innovation in products benefits from external contributions of knowledge, mainly from users.
- The continuous-processes regime includes a variety of production activities such as metallurgical process industries, chemical process industries, food and tobacco. It is generally characterised by low technological opportunity, low technological entry barriers, and rather low persistence in innovation. Firms are technologically heterogeneous and their knowledge base is, on the whole, fairly differentiated among technical fields. Innovation in processes benefits from upstream sources of capital-embodied knowledge.

From the analysis executed by Marsili (2001), who has classified the main industrial sectors on the base of its framework, it has been possible to identify the features relative to the electrical and electronic sector and to the automotive sector, which are the two industrial sectors included in the research work.

TECHNOLOGICAL REGIMES*	Electrical-electronics industries	Motor vehicles industries
	Science-based regime	*Complex system regime*
Technological opportunities	HIGH	MEDIUM/HIGH
Technological entry barriers	HIGH *Knowledge specificity; Cumulativeness of innovation*	HIGH *Knowledge complexity; Scale economies; Persistent of innovation*
Inter-firm diversity in the rate and directions of innovation	HOMOGENEOUS	HOMOGENEOUS
Diversification of the knowledge base	INDUSTRY SPECIFICITY	VERY HIGH
External sources of knowledge	LOW	HIGH
Links with academic research	DIRECT CONTRIBUTION	INDIRECT IMPORTANT CONTRIBUTION
Nature of innovation	PRODUCT INNOVATION	DIFFERENTIATION

Table 8 - Summary of main technological regime features

From a comparison of the two sectors, the framework introduced by Marsili allows to highlight the main differences between the two analysed industries. The different knowledge base of the two technological regimes brings to additional differences about the external sources of knowledge, links with academic research and nature of innovation. Following the analysis of Marsili, it is possible to identify two different innovation behaviours between the two sectors:

TECHNOLOGICAL REGIMES	Electrical-electronics industries	Motor vehicles industries
	Science-based regime	*Complex system regime*
Diversification of the knowledge base	INDUSTRY SPECIFICITY	VERY HIGH
External sources of knowledge	Low involvement of external stakeholders with low diversification in terms of typology of engaged actor.	High involvement of different typologies of external stakeholders due to the high knowledge complexity that requires different competences.
Links with academic research	Direct and frequent involvement of knowledge leaders.	Indirect involvement of knowledge leaders characterized by high benefits..
Nature of innovation	Mainly product innovations	Both product and process innovations with a propensity to generate more complex innovation as combination of product and process innovations or business innovations.

Table 9 - Summary of technological regime differences

The framework allows analysing and verifying in a qualitative way the differences revealed between the two considered sectors in the development of innovations within the sustainability ambit. Through this comparison, it is possible to highlight different innovation behaviours due to the belonging of different technological regimes. Therefore, the model could allow attributing the different innovation trajectories developed by the companies in the sustainability innovation ambit to the learning conditions and technological context linked to the industrial sector in which the companies operate.

8 Research methodology

The research methodology adopter for realizing the research work includes different phases. Such phases are summarized in the figure below.

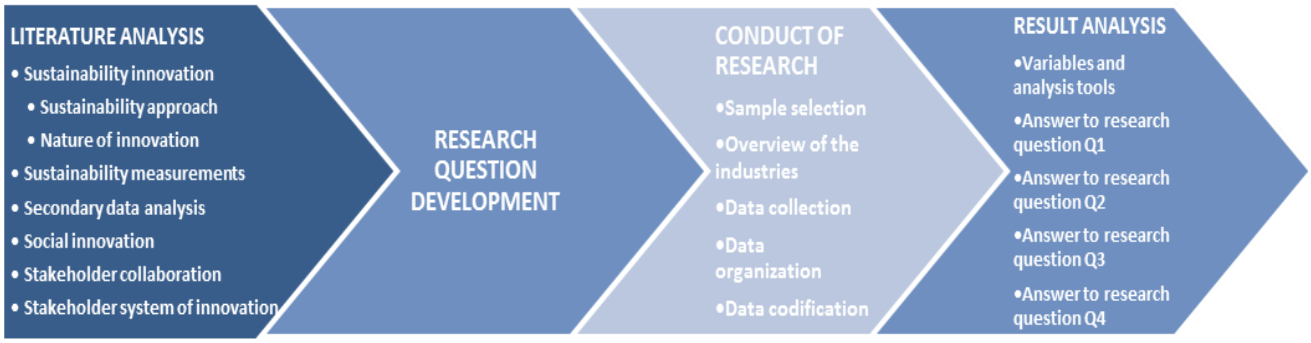

Figure 4 - Detailed stages of research process

The literature analysis constitutes the initial phase of my research work. It allow me to acquire the knowledge required to face the issue of sustainability innovation, which is a topic widely discussed in the academic literature but it is often not clearly defined. In addition, the literature analysis has allowed, On the one hand, to confirm the relevance of the topics under study and their relevance for companies, on the other hand to bring out the gap of the existing literature that have lead the development of research questions and consequently the objectives. The literature research has been mainly executed through the analysis of numerous articles on various scientific journals with the support, albeit to a lesser extent, of articles published in the context of academic conferences and books on the subject. Furthermore, to investigate specific aspects, it has been necessary to analyse some reports of major consulting firms and some master's degree thesis.

8.1 Literature analysis

During the process of literature analysis, the articles of interest for the research have been classified through two supporting tools. In particular, I have used Mendeley during the entire process of analysis for the management of the articles. In parallel, I have created an Excel spread sheet to classify the contributions concerning the first phase of literature analysis, which aimed to investigate the concept of sustainable innovation. Such classification has allowed to have an overall point of view on the sustainability innovation and on the most interesting research ideas. Below, there is the complete list of categories used for the classification of the articles in the Excel spread sheet and then each category will be discussed individually:

1. Journal
2. Year
3. Author
4. Notes
5. Categories in which is treated the innovation divided in operations, product and supply chain

6. Sustainability components divided in Economic, Environmental and Social
7. Industrial sector
8. Sustainability innovation approach

The used categories are:

1. Journal: reports the journal in which the article has been published. The research was not constrained to any specific journal, in particular because the initial objective was to collect all the information available in the academic literature on the topic of sustainability innovation in order then to target the research. The table below shows how the theme of sustainability innovation, and more generally of sustainability, is liable to be applied in different academic disciplines. In addition, the diversification of paper covering the subject is also a symptom of the relevance of the sustainability theme associated to innovation.
2. Year: shows the year of publication of the article. The table, below, shows how the items initially used to frame the macro argument of sustainable innovation reach the maximum values in the last five years with an increasing trend. This, once again, shows the great importance of the current theme in the last decades.

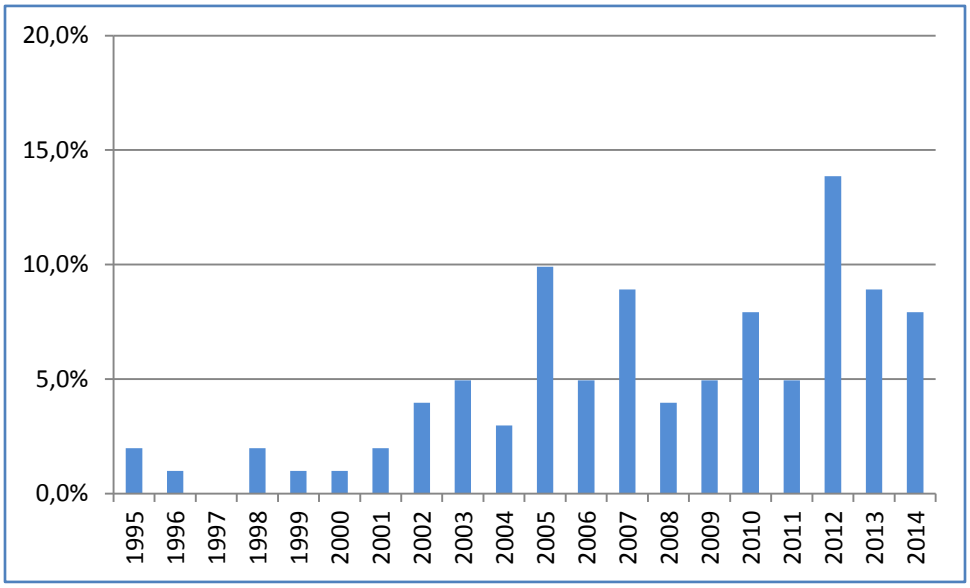

Figure 5 - Chronological distribution of articles

3. Author: reports the author or authors of the article
4. Notes: reports a briefly description of the article in which there are highlighted the most interesting aspects and the conclusions.
5. Categories in which is treated the innovation divided in operations, product and supply chain: the considered articles not necessarily treats one of the arguments included among operations, product and supply chain in the sustainability ambit.

Indeed, the academic literature relative to the sustainability has been focalized on the analysis of firm's products and operations, in particular on the new product development which has been object of numerous research works that have brought to the definition of different techniques of product design with a focus on the environmental sphere. Instead, the supply chain argument has been treated in various articles but in lower way than operations and products.

6. Sustainability components divided in Economic, Environmental and Social: indicates which components of sustainability are to take into consideration into the article.
   The sustainability, as discussed, is characterized by three different aspects: economic, environmental and social sustainability. The most number of considered articles is focused on the environmental sphere of sustainability. The social aspect has been treated only in a second time when the academic environment has recognized its relevance on the firm's sustainability. The economic sustainability is often cited by authors but it is usually treated in association with other aspects of sustainability, i.e. in combination with the social or environmental spheres.
7. Industrial sector: indicates if an article treats a specific sector
8. Sustainability innovation approach: shows if the article treats the sustainability innovation approach and briefly describes the classification of possible approaches.

8.2 Conduct of research

The conduct of research has required the sustainability report analysis of sample firms through the Content Analysis methodology. The main sources of data have been the sustainability report and the institutional website. The collected data are mainly represented by secondary data, which are defined as data collected not with the aim to respond to specific research questions (Cowton 1998). The sustainability corporate reports are internationally recognized and in most cases they are subject to external audit in order to certify the veracity, this ensures the validity of the information that they contain. The primary source of data has been represented by corporate sustainability reports and in some cases it has been necessary to consult institutional websites and research engine in order to verify some specific information described in an unclear way within the reports.

8.3 Sample selection

The executed analysis is the continuation of a previous research work executed on the electric and electronic sector by Benaglia e Cola (2013). Starting from the data collected on the electric and electronic sector, the analysis has been extended to the automotive sector. For the selection of the new sector, it has been possible to take into account the same criteria considered by Benaglia and Cola for the choice of electric and electronic sector. Indeed, both the sectors are characterized by a strong impact in terms of sustainability, which has brought to the definition of a restrictive regulatory that lead the sectors' companies to approach the sustainability theme. In addition, the two industrial sectors own a high innovation rate with products characterized by short life cycle. Given that such research work is focused

on the sustainability innovation development, these two industrial sectors are particularly well suited for the research and for this reason they have been selected.

8.3.1 Electric and electronic sector

The electric and electronic has predominantly emerged in the twentieth century and today operates worldwide. The considerable size of the industry and the use of toxic materials have led it to address a number of issues related to electronic waste. In recent years, some laws have been developed in order to regulate the market. In 2003, it has been implemented the Directive 2002/96 / EC WEEE (Waste Electrical and Electronic Equipment) by European Union in order to reduce the environmental impact of electrical and electronic waste and encourage the separate collection and recycling of these materials. Furthermore, the Directive requires to manufacturers to take financial responsibility for the safe removal of their products from the market. There is another directive called RoHS (Restriction of Hazardous Substances), which restricts the use of hazardous materials in the equipment. Such regulations demonstrate the high impact of the sector to sustainable level and therefore, the attention that results in terms of restrictions.

8.3.2 Automotive sector

Historically, the emergence of automobiles has had a profound effect on people's everyday lives. Indeed, the automotive industry has a key role in the world economy due to its high employment rate in the manufacturing sector and to the high quantity of employed capital. This sector is considered to be highly capital and labour intensive. The major costs for producing and selling automobiles derive by labour and materials. Indeed, while machines and robots are playing a greater role in manufacturing vehicles, there are still substantial labour costs in designing and engineering automobiles. Regarding the materials, the high complexity of the product implies the acquisition of various typologies of materials from steel, aluminium to seats and tires. More aggressive international competition, substantial fixed costs, particularly high prices for raw materials and energy, structural overcapacity, and the resulting restructuring and relocation are causes of concern for manufacturers, workers and consumers. Therefore, it is essential to create a framework for a competitive automotive industry so that it can anticipate and rise to the challenges of competition by responding in a socially responsible and innovative way. At a global level, it has been developed the strategy for the sustainable development of the automotive industry strikes a balance between boosting the global competitiveness of the automotive sector and making constant progress in the field of safety and environmental protection. The environmental research and innovative activities carried out by the automotive industry are driven by multiple objectives. The main objectives are the decrease in primary polluting emissions, the reduction in greenhouse gases, especially CO2 emissions, and the decrease in fuel consumption. Given the difficulty in combining these objectives, some trade-offs are necessary. Within this context, research and innovative activities of automotive firms follow simultaneously different technological trajectories looking for a technological compromise to produce cleaner, quieter and more efficient energy vehicles. From an environmental point of view, it is recognized as motor vehicles are responsible for a significant part of pollutant emissions in

the world. For this reason in the EU, it is therefore vital that the automotive industry abide by the guidelines in the Thematic Strategy on Air Pollution. The main actions to reduce pollutant emissions from motor vehicles currently take the form of Euro 5 and 6 emission limits and the promotion of clean road transport vehicles by public procurement. The integrated approach to reduce CO2 emissions is helping to achieve the Community objective of 120 g/km CO2 by 2012. If vehicle motor technology is to continue to improve in this direction, other technological improvements (air-conditioning systems, etc.) and the increased use of bio-fuels and hybrid vehicles will also help reduce CO2 emissions. In addition, regarding the sustainability environmental side, this sector gives a special attention to the recycling of end-of-life vehicles and motor vehicle noise. Naturally, the automotive sector, given its strong impact on society, has also developed in the EU an effective road safety strategy, which should be based on the interaction between improvements in vehicle technology, road infrastructure, driver behaviour and enforcement of the legislation. Measures such as improving the visibility of heavy-duty vehicles or introducing advanced safety technologies (intelligent vehicles) are already playing their part in achieving the European Commission's objective of a 50% reduction in the number of victims on European roads by 2010. Further efforts are also still required in terms of electronic stability control systems, seat-belt reminders, the obligatory use of daytime running lights, and emergency braking systems.

8.3.3 Sample definition

The research sample is composed by twenty companies belonging to the electric and electronic sector and twenty companies belonging to the automotive sector for a total number of forty companies. The criteria for the selection of the companies are:

- Belonging to the automotive or electric and electronic sector
- Commitment in the sustainability innovation development and in the implementation of sustainability initiatives
- Inclusion in almost one of the sustainability indexes, among DJSI and MSCI World Index, which allows to demonstrate the sustainability commitment of the firms
- Release of sustainability corporate reports

These criteria make the sample relatively circumscribed by limiting the number of companies available for the selection relative to the investigation of this research work. In parallel, the belonging to an index or ranking of sustainability allow to analyse companies that actually engage in this area and that, in theory, represent the "best performer" in the industry. This choice was driven by the need to analyse companies that release a sustainability report and that are sufficiently engaged in sustainable innovation and collaboration with their external stakeholders in order to be really in support of this research work. In the academic literature, there are both studies that use very large samples of companies, as those composed by some hundreds of companies, and studies that simply consider some tens. Given the criteria for the selection of companies and the fact that the analysis is carried out on a sample including two industrial sectors, I believe that the test sample is representative for this developed analysis and appropriate to not lose the focus on the characteristics of each company, which would not be possible increasing the sample

size. In addition, in favour of the validity of the sample, it is possible to make a reference to the work of Jose and Lee (2006), who have conducted a study of cross-sector environmental policies and practices of the two hundred largest companies of the Fortune list, specifically considering inter-sector samples of similar size to the two studied in this research work.

8.4 Data collection

To collect the information about the developed sustainability innovations and the strategic drivers for sustainability has been adopted the Content Analysis. This methodology is used for the analysis of documents and allows researchers to test theoretical assumptions in order to improve the understanding of the data (Elo and Kyngäs, 2008). Several authors have recommended to use the Content Analysis for the analysis of business reports (Cowton, 1998 Jose and Lee, 2006). The table below shows the main information of the companies of test sample. It has been possible to note that in three cases out of forty included in the analysis, the corporate sustainability report was referred to the year 2011 because it was the only available at the time of data collection. This is not a problem because often in the report, the discussed innovations are in in the phase of development or still in progress. Moreover, it was still possible to find the update performance values.

N	Automotive companies	Revenues [M $]	Employees	N	Electric companies	Revenues [M $]	Employees
1	***ASTRA***	15.612	185.580	21	***3M***	29.904	86.557
2	***BMW***	76.848	105.876	22	***ABB***	39.336	146.100
3	***DAIMLER***	114.297	275.087	23	***ALCATEL***	18.827	72.344
4	***FHI***	14.802	27.123	24	***AMD***	5.422	10.340
5	***FIAT***	83.957	68.257	25	***BOSCH***	68.376	305.877
6	***FORD***	133.559	171.000	26	***DELL***	62.071	111.300
7	***GMC***	118.507	213.000	27	***ERICSSON***	35.032	110.000
8	***HONDA***	77.548	187.094	28	***HITACHI***	112.124	323.540
9	***ISUZU***	13.661	24.656	29	***HP***	77.877	331.800
10	***KIA***	32.633	47.104	30	***INTEL***	53.300	105.000
11	***MAZDA***	19.837	37.617	31	***LENOVO***	29.574	27.897
12	***MITSUBISHI***	27.523	68.887	32	***PANASONIC***	91.051	330.767
13	***NISSAN***	91.802	157.365	33	***PHILIPS***	32.306	118.087
14	***PSA PEUGEOT CITROEN***	55.446	204.287	34	***RICOH***	22.080	109.241
15	***RENAULT***	41.270	127.086	35	***SAMSUNG***	201.104	235.868
16	***SUZUKI***	24.511	54.484	36	***SCHNEIDER***	31.209	140.000
17	***TATA***	24.032	29.217	37	***SHARP***	38.983	21.521
18	***TOYOTA***	181.319	325.905	38	***ST MICROELECTRONICS***	8.493	44.713
19	***VOLKSWAGEN***	192.676	549.763	39	***TOSHIBA***	82.541	210.000
20	***YAMAHA***	11.783	53.958	40	***WHIRLPOOL***	18.666	68.000

Table 10 – Sample of selected companies

8.4.1 Content analysis

The application of the Content Analysis has followed the process represented in the figure with some variations required to adopt it to the specific case.

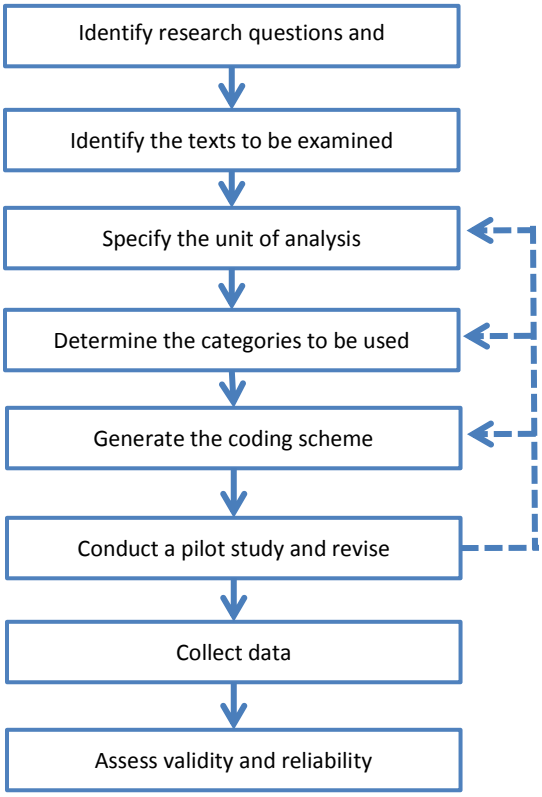

Figure 6 – Content Analysis process (Harris, 2001)

The process is composed by different phases, first of all the definition of the research questions, then the choices of corporate sustainability reports as primary documents for the examination. The unit of analysis represents the base unit of text to be examined (Harris, 2001), in this case I have used whole sentences or single words. The executed analysis is based on the academic literature. Indeed, the categories used for the classification of innovations, described in the previous paragraphs, the external stakeholders and the strategic drivers derive from the wide literature analysis executed. More precisely, for the definition of strategic drivers, it has been necessary to use both scientific articles and some reports of the major consulting companies. Such method is defined as the Content Analysis of deductive typology (Elo and Kyngas, 2008) because the used categories are based on the academic literature.

Subsequently, it has been developed a shared scheme for the codification of data that foresees to classify the collected information in a single category. In the case in which a single sentence includes more information, it has been necessary to distinguish the concepts and then proceeds with two different classifications, one for each portion of sentence. It is has not been executed a real pilot study for the

application of the process but during the execution it has been possible to refine the technique of data collection.

Naturally, the data collection has been executed through different paths in function of the nature of collected information.

Sustainability innovations and involved stakeholders

In the case of sustainability innovations and the involved stakeholders, it has been necessary to read the entire paragraphs of corporate sustainability reports related to the environmental and social aspects.

Strategic approach to sustainability

In the case of strategic driver research, it has been read the paragraphs concerning the declaration of intent, the presentation of company's sustainability strategy and the firm's approach to sustainability. In particular, the definition of strategic approach has been executed according to the following criteria:

- Individuation of motivations that the company provides for the achievement of sustainability
- Research of key words strictly linked to the a specific driver as for example the will to get new opportunities for a company, which is linked to the driver "Opportunity and competitive advantage"

In the case of strategic drivers, it has been possible to use key words in the research. It is necessary to report that the sustainability driver called "compliance" is not usually declared in an explicit way. Therefore, the driver "compliance" has been included when in the corporate report the argument compliance/risk is treated in an extended way in the company's presentation because this is considered as an index of strong inclination to sustainability.

The reliability and effectiveness of data are two relevant arguments for the treatment of such studies. The data effectiveness is guaranteed by the fact that data come from the corporate sustainability reports which are public documents and in the major part of cases such reports are subjected to external audit. The data reliability is mainly linked to the process of data collection. Such characteristic has been controlled through the definition of specific innovation categories, stakeholders and drivers.

Performance data

Regarding the third typology of collected data, that is the economic, environmental and social firm's performance, the collected values are relative to three years 2009, 2010 and 2011. The performance values have been collected through two different methodologies within the two different industrial sectors due to the availability of data.

In particular for the electric and electronic sector the collected performance are relative to the following indicators:

- ✓ ROI: it has been selected the ROI as an indicator of firm's financial performance related to its investments
- ✓ Environmental sustainability: the environmental performances are measured through four different indicators relative to the consumption of resources and generated pollution, in particular the consumption of energy, water and the generation of waste and emissions.
- ✓ Social sustainability: the social performances are measured through the injury rate and a diversity indicator relative to the employees' percentage of women in the firm. The social sustainability includes different aspects relative to the treatment of employees and the management of suppliers. The indicators of the rate of accidents at work and diversity are the most standardized, for this reason has been chosen as the only quantitative social indicators.

The dimensions of performance selected for this investigation are similar to those considered by Corporate Knights, a Canadian company of media and research, for defining the ranking "Global 100: the most sustainable corporations in the world". On the social side, the research institute considers a larger number of performances anyway related to the internal dimension of the enterprise's performance. This shows the real lack of external social performance indicators used and shared among companies, and thus explains the absence of these indicators in our research work. Similar considered dimensions have been used to draw up the "Newsweek green rankings" that evaluates the overall environmental performance of the largest listed companies in the world. The ranking published by the US magazine Newsweek, in collaboration with research institutes Trucost and Sustainalytics, has been used in Albino et al. (2012).

Regarding the sustainability performance data relative to companies' of automotive sector, it has been possible to use the values provided by Sustainalytics, which is a rating company that provides environmental and social disclosure for the companies included in the Bloomberg's platform. In particular, it has been possible to obtain the social, economic and environmental performances through the Bloomberg platform.

- ✓ EV/EBITDA: the ratio between the Enterprise value and EBITDA is a popular valuation multiple used in the finance industry to measure the value of a company. It is the most widely used valuation multiple based on enterprise value and allows to provide an economic performance evaluation.
- ✓ Environmental and social sustainability: the environmental sustainability score defined by Sustainalytics for Bloomberg's companies is based on different indicators among which are also included the indicators used for the evaluation of environmental and social performances relative to electric and electronic companies. In this case, Sustainalytics is able to provide a more complete sustainability scores but although this the sustainability performances of electric and electronic companies can be considered as a proxy of sustainability scores relative to the automotive sector, therefore the two typologies of performance values can be compared.

8.5 Data organization

The data organization has been made through the usage of Excel spreadsheets in which the companies have been entered on the rows while the sustainability innovation data have been collected on the columns. It has been necessary to generate an excel spreadsheet for each typology of collected data. The

sustainability innovations have been collected in different Excel spreadsheets distinguishing among the industrial sector, electric and electronic or automotive sector, and on the base of the nature of the innovation, between social and environmental innovations. In addition to such distinctions, the sustainability innovations have been internally classified in function of other dimensions of analysis. The considered dimensions were the object of innovation, distinguishing among product, process, product+process/business; level of innovativeness, that divides the innovations among incremental and radical; and area of impact, which allows to split initiatives among internal supply chain, external supply chain and extended supply chain. For each innovation it has been necessary to take note of its development in collaboration with stakeholders. The information relative to the typology of stakeholder involved in the innovation development have been entered in four different excel spreadsheets distinguished on the base of industrial sector and nature of innovation.

The firm's strategic approach to sustainability has been defined through the use of two Excel spreadsheets, distinguished on the base of industrial sector, in which, for each company, reported on the rows, have been indicated the drivers that push a company to engage in terms of sustainability. In addition, it has been always possible to report the text parts of the corporate report that led me to choose a driver. This has allowed keeping track during the research work and, at the same time, to ensure data reliability.

Also in the case of the sustainability performance it has been necessary to use two Excel files distinguishing the performances on the base of the industrial sector. The different typologies of indicators have been organized and synthetized within different Excel spreadsheets.

8.6 Data codification

The encoding of the data is a complex process. First of all, it considers the definition of the analysis constructs and then continues with data codification. In order to make this section more clear, it has been necessary to analyse the different typologies of encoding data in a separate way.

8.6.1 Sustainability innovations

The selection of the constructs for the analysis led to identify twenty-four relevant variables relative to the identification of sustainability innovations developed by the companies:

1. Radical innovations: innovations aimed to generate relevant changes
2. Incremental innovations: innovations aimed to generate marginal changes
3. Process innovations: innovations addressed to change or develop a process
4. Product innovations: innovations addressed to change or develop a new product
5. Product+Process/Business innovations: innovations addressed to modify a combination of products and processes or an entire firm’s business
6. Internal supply chain innovations: innovations able to generate internal impacts in the firm
7. External supply chain innovations: innovations able to generate impacts at the level of traditional supply chain

8. Extended supply chain innovations: innovations able to generate impacts in the usage time of final customer or outside the conventional chain.
9. Environmental radical innovations: innovations able to generate relevant changes in the environmental sphere
10. Environmental incremental innovations: innovations able to generate marginal changes in the environmental sphere
11. Environmental process innovations: environmental innovations addressed to change or develop a process
12. Environmental product innovations: environmental innovations addressed to change or develop a product
13. Environmental Product+Process innovations: environmental innovations addressed to modify a combination of products and processes or an entire firm's business
14. Environmental internal supply chain innovations: environmental innovations able to generate internal impacts in the firm
15. Environmental external supply chain innovations: environmental innovations able to generate impacts at the level of traditional supply chain
16. Environmental extended supply chain innovations: environmental innovations able to generate impacts in the usage time of final customer or outside the conventional chain
17. Social radical innovations: innovations able to generate relevant changes in the social sphere
18. Social incremental innovations: innovations able to generate marginal changes in the social sphere
19. Social process innovations: social innovations addressed to change or develop a process
20. Social product innovations: social innovations addressed to change or develop a product
21. Social Product+Process innovations: social innovations addressed to modify a combination of products and processes or an entire firm's business
22. Social internal supply chain innovations: social innovations able to generate internal impacts in the firm
23. Social external supply chain innovations: social innovations able to generate impacts at the level of traditional supply chain
24. Social extended supply chain innovations: social innovations able to generate impacts in the usage time of final customer or outside the conventional chain

It has been decided to limit the analysis of collected data to such constructs of innovation because they are the most relevant for the framework of innovations used in this research work and therefore for sustainability innovations that are really developed in the companies. Specifically, it has been considered the classification of each dimension of the framework, for example, on the degree of innovation, the research work has compared incremental and radical innovations and so on for the other two dimensions that lead to the definition of the first eight variables. Later, maintaining that classification it has been possible to further distinguish between environmental and social innovations.

Downstream of this process, it has been necessary to define other variables that summarize the overall commitment of the company in innovations, distinguishing between environmental and social innovations:

25. Innovativeness
26. Environmental innovativeness
27. Social innovativeness

Operationalization of variables

After the definition of variables for the analysis, it has been possible to codify them in order to identify the innovativeness index relative to the single innovation typology calculated for each for each firm of the sample starting from the data collected within the sustainability reports. The idea has been to take into account both the number of innovations developed in the company for each given typology and the fact that the developed innovations are relative to one or more of several subcategories of the given innovation.

The categories and subcategories of innovations are those of the framework described above. To this end it has been developed an indicator that shows the commitment of a firm in the development of a certain type of sustainability innovations. Such indicator has been defined in the following way:

$$\boldsymbol{INN_{Indxj}} = \frac{N^{\circ}\ of\ categories\ of\ innovation_j covered\ by\ the\ company_i}{Total\ n^{\circ}\ of\ categories\ of\ innovation_j} * N_{ij}$$

- j = Typology of innovation (radical; incremental; process; etc)
- i = Company included in the test sample
- N_{ij} = Number of innovation relative to j type developed by the company i
- N° of categories of innovation j covered by the company i = number of categories in which is divided the innovation typology j in which the company I has developed almost one innovation
- Total n° of categories of innovation j = Overall number of categories in which is divided the typology of innovation i

The twenty-fifth variable has been calculated using the same method considering the sum of all subcategories of innovation and the totality of sustainability innovations developed in the company. The same criteria have been used for the last two variables distinguishing between environmental and social innovations. The described index has been defined for the twenty-seven typologies of innovation and for each company of the sample.

8.6.2 Stakeholder collaborations

For the codification of data relative to the stakeholders involved in the development of sustainability innovations, it has been used a process similar to that described above. Indeed, first of all it has been necessary to define the variables and then it has been executed the data codification.

For each of the twenty-four variables described above it has been necessary to generate other nine variables each one referred to the stakeholder involved in the development of the collaborations. The considered stakeholders identified through the analysis of academic literature are:

- ✓ Customers
- ✓ Suppliers
- ✓ Governments
- ✓ NGO
- ✓ Knowledge leaders
- ✓ Industrial associations
- ✓ Other companies, that include competitors or companies belonging to other sectors not linked with supply or customer relationships to the company if not for the analysed sustainability innovation
- ✓ Communities
- ✓ Multi-stakeholder

Operationalization of variables

The variables linked to stakeholders have been operationalized by calculating the number of innovations type j in which the considered stakeholder has been involved. So for example, the variable incremental innovations-customers identifies the number of incremental innovations developed by the company in a collaborative way with the customer.

In addition, it has been necessary to define other nine variables, one for each typology of stakeholder and the last one relative to the totality of stakeholders. The defined value is equal to the sum of the total sustainability innovations developed in collaboration with a given stakeholder.

8.7 Strategic approach to sustainability

As described above, for each company it has been necessary to collect information about which of the six strategic drivers push the company to deal with sustainability. In order to make such data usable for this investigation, it has been assigned a unique value to the variable strategic approach of each company according to the drivers that characterize it. The variable strategic approach can assume the values 1, 2 or 3 and the increase of the value indicates a more proactivity of the company to sustainability.

The values have been assigned to different combinations of strategic drivers according to the literature on this topic. The strategic driver linked to the pressures from stakeholders has been associated by several

authors to companies with a more reactive approach, which do not act in a voluntarily way but driven by other reasons (Carroll 1979; Murillo-Luna, 2008; Chen & Chang 2012). In the same way also the driver called other external pressure has been linked to a more reactive approach in which the company is oriented to sustainability in order to respond to the work of the competitors (Chen & Chang 2012). Instead, the driver compliance by definition has been associated with a reactive approach in which the company acts simply for a legal requirement in order to avoid sanctions (Carroll 1979; Klassen & Whybark 1999; Murillo-Luna 2008; Tulder et al. 2008; Gimenez et al., 2012; Taylor et al. 2012; Chen & Chang 2012).On the contrary, the will to get opportunities and competitive advantage distinguish the companies more proactive, which consider the sustainability as an engine for the growth (Taylor et al. 2012; Chen & Chang 2012). The driver talent attraction (recruiting) can be considered as part of the one just discussed. The last driver voluntariness and top management commitment has been associated with a proactive approach of a company (Carroll 1979; Murillo-Luna, 2008; Taylor et al. 2012).

Given that the forty sample companies, for the selection criteria are strongly oriented towards sustainability, the value assigned to the strategic approach aims to differentiate between an approach to sustainability more or less proactive. The basic idea for the definition of the value relative to the strategic approach is the following: the voluntariness and the top management commitment and the will to get opportunities and competitive advantage provide the highest level of proactivity, i.e. equal to 3, the presence of the driver pressures from stakeholders or other external pressures reduces the proactivity to 2 and when there is the driver compliance the company's approach is ranked with the lowest level of proactivity, i.e. equal to 1.

The different combinations with the assigned value are:

- 1 = Reactive: combination with the presence of the compliance driver
- 2 = Active: approach linked to stakeholder pressure, awareness in the opportunity and competitive advantage provided by sustainability and voluntariness and the top management commitment. The considered combinations are:
    - ✓ voluntariness and the top management commitment + opportunities and competitive advantage + stakeholder pressures/other pressures
    - ✓ opportunities and competitive advantage + stakeholder pressures/other pressures
    - ✓ voluntariness and the top management commitment + stakeholder pressures/other pressures

- 3 = Proactive: orientation to sustainability generated by awareness in the opportunity and competitive advantage provided by sustainability, will and engagement of the top management and recruiting driver. The considered combinations are:

    - ✓ voluntariness and the top management commitment + opportunities and competitive advantage

- ✓ voluntariness and the top management commitment + opportunities and competitive advantage + recruiting
- ✓ voluntariness and the top management commitment
- ✓ opportunities and competitive advantage

8.7.1 Economic, environmental and social performances

As described above, for each company have been collected the performances over the time frame of three years, from 2009 to 2012, using as sources of information the financial statements, the report of sustainability and in some cases even institutional sites for the companies belonging to the electric and electronic sector, instead for the automotive companies the performance values have been provided by Bloomberg, which is able to provide the sustainability scores thanks to the collaboration of Sustainalytics, a company specialized in the calculation of environmental and social score for the main global companies.

Regarding the electric and electronic sector, the collected data represent absolute values of the performances of each company. Therefore to make such data uniform and comparable between the different companies it has been necessary to relate them to an indicator of the volume of business of each company. The revenue of a company has been selected as a proxy of the size of the turnover of the company to make the values of different companies comparable.

In fact, it happens that large companies have widely worst performance in absolute terms because of their overall size. Furthermore, in order to make those values usable for the investigation, it has been necessary to proceed to encode the data collected. The used process calculates the average values of performance compared to the standard deviation in order to give to each company a performance value that expresses its position relative to other companies in the sample.

The applied methodology is composed by the following steps:

1. Calculation of mean and standard deviation of the performances relative to the forty companies in the sample for each value of performance
2. In order to make the performance data usable for the research, it has been necessary to codify the performance values in five categories on a scale from 1 to 5:
    1. Current performance < Average performance - 1 * Std deviation
    2. Current performance < Average performance - 0,5 * Std deviation
    3. Average performance - 0,5 * Std deviation < Current performance < Average performance + 0,5 * Std deviation
    4. Current performance > Average performance + 0,5 * Std deviation
    5. Current performance > Average performance + 1 * Std deviation

3. Calculation of average performances for the two macro categories that identify the environmental and social performances as average of the values relative to the indicators included in each of the two categories
4. Calculation of the average performances as mean of the economic, environmental and social performances

The thresholds used for the allocation of the performance values are equal to 0.5 and 1 times the standard deviation to make sure to have a relevant diversification of companies that is getting the classes suitable for the sample data. In fact, with broader thresholds the differentiation among the performance values assigned to the companies is very low and does not lead to relevant results.

8.8 Variables and analysis tools

In this section is given an explanation of what are the variables used in the analysis, their characteristics and the most suitable tools to carry out the study. As just said, the research work uses the Content Analysis for the study of corporate sustainability reports of the sample companies. Given the nature of the variables studied and the typology of research questions, it has been necessary to execute some quantitative tests, taking the necessary precautions at the level of statistical significance. The trade-off that emerges is relative on the one hand to the need of a sample large enough to justify quantitative analysis and on the other hand to a size of the sample not too high, in order to avoid to lose the details of the analysed individual company, which allows to support the quantitative analysis of data with examples relative to the sample companies. The possibility to provide real and practical examples, in fact, makes up for the analytical difficulties and allows validating and giving strength to the results.

It has been necessary to introduce the nature of the variables considered in the research work. The constructs have already been introduced in the previous chapters and now it is necessary to define the statistical nature of the variables in order to justify what are the tests used to study the different relations.

The variable “strategic approach” needs to be treated in more detail because is the only categorical variable. Therefore, it requires to be examined from a different point of view. The fact that the variable can assume only three values means that the variable has a purely ordinal character. In addition, in the analysis of the reports, the collection of information about the drivers that lead the company to sustainability is the more difficult activity and this makes the definition of the categories and of the variable generally less robust. For these reasons, it has been necessary to treat this variable in a more conservative way, as a categorical variable and not as an ordinal one. This decision has led to the need to structure the analysis in a slightly different way and to the choice of an appropriate statistical test.

The variables relative to collaborations, innovations and performances, in accordance with the method of calculation, not present particular problems and are configured as continuous variables. Despite this, it

has not been possible to make certain assumptions about their normal distribution and therefore, it has been necessary to adopt non-parametric tests that in this circumstance provide higher strength.

The following is a summary of relations and nature of the variables that have been put in relation. Different configurations have led to the choice of different tests and analysis methodologies.

Research questions	*Relation*	*Typology of first variable*	*Typology of second variable*	*Test typology*
Q1.1	Past performance / Innovations	*Ordinal*	*Continuous*	*Spearman's rank correlation*
Q1.2	Strategic approach / Innovations	*Categorical*	*Continuous*	*Kruskal-Wallis*
Q2	Innovations / Collaborations	*Continuous*	*Continuous*	*Spearman's rank correlation*
Q3.1	Past performance / Innovations	*Ordinal*	*Continuous*	*Spearman's rank correlation*
Q3.2	Strategic approach / Innovations	*Categorical*	*Continuous*	*Kruskal-Wallis*
Q4	Innovations / Collaborations	*Continuous*	*Continuous*	*Spearman's rank correlation*

Table 11 - Summary of statistical methodologies

For the study of identified relations, it has been possible to use two typologies of test, precisely the test of Spearman's rank correlation and the test of Kruskal-Wallis.

The test of Spearman's rank correlation is able to provide a nonparametric measure of statistical dependence between two variables that have to be almost ordinal variables. It is the equivalent of the classical Pearson's non-parametric correlation test that, on the contrary, is a method which falls within the category of parametric statistics. The method requires that both variables are measured on a scale at least ordinal. This method can be more powerful than the so called test "r" of Pearson for interval or ratio scales, when the conditions of validity of the parametric test are not fully respected. Therefore, as for the other non-parametric tests, its usage is recommended together with the application of the parametric test in order to further demonstrate and verify its conclusions.

In particular, this methodology is used when you have only few available data and therefore it is not possible to demonstrate that the conditions of validity of the parametric test are met in full. The correlation coefficient of Spearman's rank is used to test the null hypothesis of independence between two variables, in the sense that the N values of the variable Y have the same probability of associating with each of the N values of X.

The alternative hypothesis relative to the existence of an association may provide a positive or negative result. In the first the relation is defined as direct: the pairs of values are simultaneously high or low for both X and Y. In the second case, also called indirect association, at high values of X correspond to low values of Y or vice versa (Manuale di statistica per la ricerca e la professione statistica univariata e bivariata parametrica e non-parametrica per le discipline ambientali e biologiche, Soliani et al, edizione Aprile, 2005). This method has been used to perform the analysis relative to research questions: Q1.1, Q2, Q3.1 and Q4.

Instead, the test of Kruskal-Wallis has been used to perform the analysis for the research questions Q1.1 and Q3.2. In this situation, in fact, it has been necessary to analyse the existence of a relationship between a categorical and a continuous variable, which cannot be analysed through the test of Spearman's rank correlation. The test of Kruskal-Wallis is the non-parametric test equivalent to the parametric test of ANOVA and it is used to verify the equality of the medians among different groups. This methodology is analogous to the Wilcoxon test, however, is functional to the analysis in presence of exactly two groups or categories. The test of Kruskal-Wallis allows comparing the values of a given continuous variable for three or more groups: the values of the variable are converted into ranks and compared to the average rank of each group. It is an analysis between groups and in our case the variable "strategic approach" is characterized by three different categories, reactive, active and proactive strategic approach.

9 Results and discussion

9.1 Drivers of sustainability innovations

Q1: Which are the drivers of sustainable innovations?

The first research question investigate the role of firm's past performances and company sustainability strategic position as drivers for the development of sustainability innovations. This first research question is studied on the overall sample composed by twenty companies belonging to the electric and electronic sector and twenty companies belonging to the automotive sector. Naturally, in order to understand the relevance of the two different drivers it has been necessary to study the relations with such two drivers in a separate way.

9.1.1 The role of past performance on sustainability innovation development

Q1.1: Are past performance drivers of sustainable innovations?

Variables considered in this correlation test:

- **Past performance** - ***Environmental, Social and Sustainability performance*** during the years 2009, 2010, 2011.
- **Sustainability Innovation** – ***Innovativeness Index*** relative to different typologies of innovations developed in 2012.

Starting from the relation between the firm's past performance and the sustainability innovation development, it has been possible to analyse this relation taking into account the variable that measures the firm's sustainability performances. Such variable indicates the past corporate performances in terms of sustainability calculating on the years 2009, 2010 and 2011. The main objective is the study of relation between the past performances of the firms and their decisions within the sustainability ambit and the sustainability innovations. Indeed, it is possible that firms with a negative performance gap than the standard of the sample are more sensitive to the development of sustainability innovations. This happens because companies with worst sustainability performances result more exposed on the one hand to the pressure generated by institutional actors as NGO and governments and on the other hand to a higher risk relative to possible penalties and continuity lack of the business (Berrone et al., 2013). Consequently, the goal is investigate if effectively companies with worst past sustainability performances are oriented in a particular way to develop specific typologies of sustainability innovation. Given the nature of the variables, in this case the analysis has been performed through the test of Spearman's rank, the table below shows the results. The table includes the correlation coefficients both for the index of aggregate performance, which includes the three dimensions of the triple bottom line and for the values of specific performances relative to environmental and social dimensions.

Typology of Innovation	Relation between Past performance and Sustainability innovations		
	Sustainability	Environmental	Social
Incremental	0,342**	0,20	0,05
Radical	0,12	0,16	0,11
Process	0,26	0,12	0,00
Product	0,27*	0,365**	0,11
Product+Process&Business	0,15	0,07	0,19
Internal	0,24	0,05	0,00
External	0,316**	0,25	-0,11
Extended	0,09	0,12	0,17
Total	0,294*	0,19	0,07

*=p-value<0,1 **=p-value<0,05 ***=p-value<0,01

Table 12 - Results relative to the test of Spearman's rank correlation between past performances and sustainability innovations

The correlation data should be interpreted as follows: a high positive correlation value indicates the presence of a positive relation between the best firm's past performance and the type of sustainability innovation indicated.

Discussion

In general, seems that there is a positive relation among the high past performances in terms of sustainability and the development of subsequent sustainability innovations, therefore companies with high sustainability performances tend to be more oriented to the development of sustainability innovations. Considering the variables that aggregate all the typologies of sustainability innovations, it is possible to note a low positive correlation that indicates as there is a relation, albeit weak, between the positive past sustainability performances and the innovativeness degree of a company, which indicates its commitment in terms of sustainability. In the detail of the specific typologies of innovation, the correlation coefficients show as for companies characterized by high sustainability performances is relevant the development of incremental and external sustainability innovations. Such aspects are in contrast with what is affirmed in the academic literature by Berrone et al. (2013), who have hypothesized as companies characterized by worst sustainability performances tend to develop sustainability innovations able to generate a short term positive impact on sustainability performance in order to face the stakeholder pressures due to the registered negative sustainability performances. In this case it is possible to note as the past sustainability performances don't constitute a driver for sustainability innovation development for a company with negative past performance in terms of sustainability. Therefore, if it is not possible to assume the stakeholder pressures derived from the negative sustainability past performance, defined in an Institutional theory ambit, as a driver for the development of specific typologies of innovation. Indeed, the collected data show as the companies with higher sustainability performance are also the companies with the higher commitment in the sustainability issues, showing in this way the possible presence of a

strategic driver that led the companies to be strongly committed in the sustainability ambit registering as a consequence higher sustainability performances.

Observing the single environmental and social components, the only relevant correlation coefficient is relative to the development of product innovation in the environmental sphere. The not relevance of the other correlation coefficients shows as the commitment in the two single environmental and social spheres is not driven by the presence of negative sustainability past performances.

9.1.2 The impact of sustainability strategic position driver

Q1.2: Is the company sustainability strategic position driver of sustainable innovations?

Variables considered in this correlation test:

- **Strategic Approach** – **Reactive[1]**; **Active[2]**; **Proactive[3]** defined on base specific factors identified within the sustainability strategy section and CEO Message in the sustainability reports.
- **Sustainability Innovation** – ***Innovativeness Index*** relative to different typologies of innovations developed in 2012.

This research question aims to identify the firm's strategic approach to sustainability as a driver for the development of sustainability innovations and to determine if the proactive approach of a company led to the development of specific typology of innovations. The table below shows the results derived by the test of Kruskal-Wallis applied between the categorical variable strategic approach to sustainability and the continuous variable which measures the company's commitment in the development of a given typology of sustainability innovation. The table summarizes the results of the analysis and the chi-square values indicate the strength of the relation while the asterisks indicate the level of statistical significance.

Typology of Innovation	*TOTAL SAMPLE*		
	Sustainability	**Environmental**	**Social**
Incremental	6,54**	4,941*	3,07
Radical	5,216*	3,22	2,20
Process	6,623**	6,208*	2,47
Product	7,353**	7,959**	2,42
Product+Process&Business	1,30	0,76	2,57
Internal	5,218*	6,65**	1,94
External	1,49	0,72	1,29
Extended	6,559**	3,60	2,89
Total	8,12**	5,719*	4,40

*=p-value<0,1 **=p-value<0,05 ***=p-value<0,01

Table 13 - Results relative to test of Kruskal-Wallis between strategic approach to sustainability and sustainability innovations

Discussion

In general, the test of Kruskal-Wallis has highlighted a difference statistically relevant in the development of specific typologies of sustainability innovation in function of the firm's proactivity level. Given the relevance of such relations, it is possible to conclude that a different level of proactivity seems to affect the development of certain typologies of innovation.

On the base of academic literature developed in the environmental ambit, several authors describe how typically the proactive companies more oriented to sustainability take responsibility of their products during the entire life cycle, extending in this way their own horizon beyond the firm's internal processes outside the enterprise boundaries unlike the less proactive companies (Hellström 2007; Tseng et al., 2013; Hansen, Grosse-Dunker, Reichwald 2009; Klassen & Vachon 2006; Hart 1995; Hart 1997; Vachon & Klassen 2008). It is possible to note as such statements should be translated in this research work into significant achievements relative to the impact area of initiatives and to the object of innovation associating the more proactive companies to the development of external or extended initiatives that have as object a product.

Taking into account the general sustainability ambit, the more proactive companies result oriented to the development of incremental innovations that aim to modify processes or products and that are able to generate positive impacts beyond the company's boundaries till to the level of final customer. Considering that the academic literature in the environmental ambit sustains as the more proactive companies are oriented to the development of product innovations able to generate positive impact beyond firm's boundaries instead the less proactive companies tend to implement internal process innovations, it is possible to affirm that the results of the executed test confirm the considerations about the more proactive firms but are in contrast with those relative to the less proactive companies. Indeed, the results indicate as the companies characterized by an high proactivity to sustainability tend to develop both internal process innovations, which according to the academic literature on sustainability innovation allows to generate short term positive results (Tseng et al., 2013), and also product extended innovations able to generate positive impact till to the final costumers generating positive effects in the long term (Vachon & Klassen 2008).

Taking into account the only environmental sphere, it is possible to confirm the considerations included in different research works about the environmental innovations (Hansen, Grosse-Dunker, Reichwald 2009; Klassen & Vachon 2006; Hart 1995; Hart 1997; Vachon & Klassen 2008). Indeed, the test results confirm the orientation of the more proactive companies to the development of product innovations. On the contrary, it has s not been registered any relevance in the development of extended innovations.

The positive relation emerged between the firm's strategic approach to sustainability and the development of innovations in the general sustainability ambit and within the environmental sphere, it is

not emerged in the social side of sustainability. Therefore the linkage between the development of social innovations and a proactive sustainability approach is very weak. One of the reasons for such results may stem from the fact that the academic literature, in terms of social sustainability, often links a more proactive firm's approach to philanthropic initiatives (Carroll, 1979), which have not been considered in this analysis because they are investments with a social purpose but not with an economic goal. Therefore, the philanthropic initiatives cannot be classified as sustainability social innovations that see the simultaneous achievement of both goals. Undoubtedly, this influences the not relevant result of the analysis about this aspect.

9.2 The relation between stakeholder collaborations and sustainability innovations

Q2: Which stakeholder collaborations impact on sustainable innovations?

The second research question investigates the relation between the typologies of sustainability innovation implemented by sample companies and the typologies of collaborations established in order to support the innovation development. The aim is to identify the relevance of specific stakeholder collaboration in the development of a specific typology of innovation.

The considered variables in this relation are:

- **Sustainability Innovations** – ***Innovativeness Index*** relative to different typologies of innovations developed in 2012.
- **Stakeholder collaborations** - Number of collaborations established by a sample company with a specific stakeholder in 2012.

Using data and information collected from the corporate sustainability reports, it has been possible to calculate the correlations between the variables relative to the sustainability innovations and those relative to the collaborations with various considered stakeholders. Beyond the general information on the role of collaboration for the development of sustainability innovation, it has been possible to investigate in detail the relation between different actors and different typologies of initiatives bringing out some interesting peculiarities.

Below there is the table with the correlation values calculated using the test of Spearman's rank correlation. The results are referred to the relation between different typologies of sustainability innovations and a selected set of external stakeholders (Albino et al. 2012; Yarahmadi 2012; Ayuso et al. 2006; Holmes & Smart 2009), which play an important role in the development of sustainability initiatives.

Typology of Innovation Sustainability	*Correlation between Sustainability innovations and Stakeholder collaborations*									
	Cus	**Supp**	**Gov**	**NGO**	**OC**	**KL**	**IndA**	**Comm**	**MultiS**	**Coll**
Incremental	0,084	0,504***	0,435***	0,216	0,58***	0,416***	0,311*	-0,333	0,425***	0,588***
Radical	0,264	0,671***	0,516***	0,506***	0,406***	0,258	0,109	0,102	0,431***	0,638***
Process	0,102	0,553***	0,418***	0,21	0,422***	0,393**	0,274*	-0,347	0,336**	0,508***
Product	0,159	0,347**	0,3**	0,315**	0,524***	0,074	0,071	0,116	0,416***	0,504***
Product+Process&Business	0,209	0,561***	0,462***	0,413***	0,239	0,51***	0,115	0,103	0,342**	0,554***
Internal	-0,033	0,39**	0,42***	0,079	0,354**	0,356**	0,333**	-0,362	0,322**	0,401**
External	0,326**	0,699***	0,284*	0,465***	0,41***	0,334**	0,026	-0,275	0,369**	0,549***
Extended	0,13	0,357**	0,427***	0,382**	0,534***	0,151	0,154	0,319	0,488***	0,613***
TOT	0,178	0,602***	0,51***	0,301*	0,563***	0,417***	0,243	-0,174	0,449***	0,652***
ENV-Incremental	0,091	0,343**	0,284*	-0,04	0,473***	0,349**	0,169	-	0,332**	0,452***
ENV-Radical	0,45***	0,522***	0,385**	0,02	0,296*	0,391**	0,214	-	0,403**	0,575***
ENV-Process	0,06	0,348**	0,271*	-0,149	0,462***	0,289**	0,08	-	0,296*	0,419***
ENV-Product	0,33**	0,404**	0,292**	0,092	0,307**	0,337**	0,288*	-	0,422***	0,492***
ENV-Product+Process	0,212	0,323**	0,284**	0,144	0,234	0,397**	-0,031	-	0,219	0,36**
ENV-Internal	-0,06	0,152	0,218	-0,173	0,418***	0,12	0,015	-	0,221	0,248
ENV-External	0,403**	0,676***	0,36**	0,076	0,347**	0,461***	0,314**	-	0,423***	0,715***
ENV-Extended	0,31*	0,274*	0,326**	0,129	0,264	0,37**	0,095	-	0,335**	0,365**
ENV-TOT	0,245	0,445***	0,386**	-0,056	0,457***	0,448***	0,224	-	0,415***	0,563***
SOC-Incremental	0	0,409***	0,244	0,342**	0,173	0,135	-0,005	-0,159	0,261	0,306*
SOC-Radical	0,079	0,166	0,421***	0,573***	0,365**	0,047	-0,259	0,367	0,364**	0,476***
SOC-Process	0,053	0,389**	0,192	0,323**	0,107	0,149	-0,04	-0,333	0,205	0,253
SOC-Product	-0,114	0,299*	0,11	0,308*	0,245	-0,179	-0,148	0,299	0,223	0,218
Business	-0,044	-0,025	0,58***	0,335**	0,352**	0,1	-0,036	0,229	0,283	0,486***
SOC-Internal	0	0,351**	0,134	0,272*	0,012	0,157	0,002	-0,435	0,122	0,149
SOC-External	0,137	0,357**	0,176	0,454***	0,085	0,008	-0,209	-0,06	0,292*	0,253
SOC-Extended	0,025	0,198	0,37**	0,459***	0,485***	-0,014	-0,078	0,319	0,459***	0,507***
SOC-TOT	0,053	0,385**	0,375**	0,498***	0,239	0,15	-0,068	0,014	0,369**	0,431***

*=p-value<0,1; **=p-value<0,05 ; ***=p-value<0,01

Table 14 - Results relative to the test of Spearman's rank correlation between stakeholder collaborations and sustainability innovations

Discussion

At a general level, it is interesting to underline as for almost the totality of the different typologies of innovations, identified through the research framework, it has been verified a high relevant correlation value demonstrating that the engagement of external stakeholders in the development of sustainability initiatives is a relevant factor. This concept is consistent with the findings coming from the analysis of the academic literature in which several authors emphasize the enabling role of collaboration and partnership with external actors in the field of sustainability (Albino et al., 2012; Klassen & Vachon 2009; Vachon & Klassen 2006; Yarahmadi 2012; Ayuso et al. 2006; Nieto & Santamaria 2007; De Marchi 2012; Pagell & Wu 2009; Holmes & Smart 2009). The figure below shows the correlation values relative to the relation between the typologies of innovation, without distinctions between the environmental and social components, and collaborations with external stakeholders, that does not look to individual actors in a separate way.

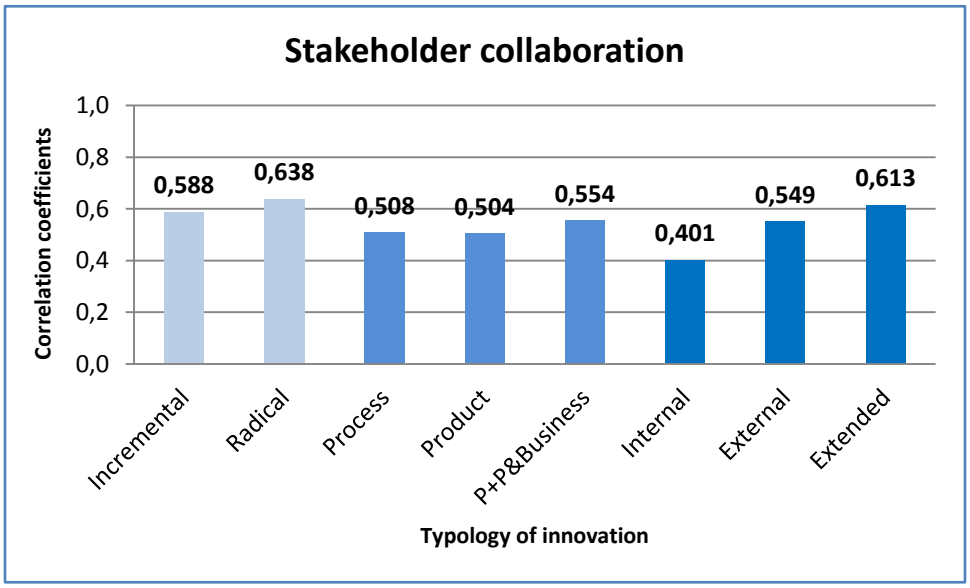

Figure 7 - Correlation values relative to the relation between typology of innovation and stakeholder collaboration

According to the academic literature, the results show a higher correlation value for the relation between stakeholder collaboration and radical innovations than the incremental ones (Klassen & Vachon 2008; Vachon & Klassen 2006). However, as shown by the graph, also the correlation value relative to the development of incremental innovations with the support of stakeholder collaborations results to be high, indicating in this way the relevance of the establishment of collaboration for the implementation of incremental initiatives. This result is in accordance with various authors who argue that the collaboration with external stakeholders is important for a wide range of sustainable innovations, including those less complex (Albino et al. 2012; Yarahmadi 2012; Klassen & Vachon 2008; Vachon & Klassen 2006; Hartman 1999; De Marchi 2012).Consequently, also in the case of innovations that lead to small changes, and thus that should be

manageable in easy way by a single company, it is considered important the contribution of external stakeholders in terms of knowledge, resources and skills.

Regarding the dimension relative to the impact area of innovation, it has been possible to identify correlation values that link the stakeholder collaboration in a stronger way to initiatives able to generate a sustainability impact along the traditional supply chain (external innovation) or even on the final customer during the time of usage (extended innovation). This result is in line with the statements of several authors of the academic literature on the subject. Indeed, it is commonly recognized in the environmental field that the engagement of stakeholders and the exploitation of knowledge and resources at their disposal is particularly enabler for innovations that deviate from the simple concept of Pollution control over external processes moving towards the concepts of Pollution prevention and Product stewardship (Hart 1995; Albino et al., 2012; Klassen & Vachon 2008; Vachon & Klassen 2006; Yarahmadi 2012; Ayuso et al. 2006; Nieto & Santamaria 2007; De Marchi 2012; Pagell & Wu 2009; Holmes & Smart 2009). Usually these programs are linked to innovations relative to products or combination of products and processes. From this perspective, it is possible to assume that being such innovations oriented outside the company, the involvement of external stakeholders is actually the enabler for the innovation development.

Taking into consideration the last dimension of analysis that is relative to the object of sustainability innovation, it is possible to highlight high correlation values for the totality of the considered objects. According to the academic literature, the role of external stakeholders should be more relevant in the development of product innovations and for more complex initiatives relative to the definition of new businesses or to the development of innovation relative to combination of products and processes rather than the development of process innovations (Klassen & Vachon 2008; Vachon & Klassen 2006). From the graph, it is possible to identify a situation similar to that described by the academic literature. Indeed, if actually the stakeholder collaboration results particularly relevant for the development of extend innovations, at the same time it is significant, even in a lower way, for developing sustainability innovations addressed to the firm's processes. The role of collaboration in the developing of innovations with different objects will be analysed in detail considering the single components of sustainability.

In this first overview the collaboration has been considered as an aggregated variable into which are included all the collaborations established by a company partnerships without making any distinction on the typology of involved actor. Therefore, the information is extremely aggregated and it is able to provide only a general framework. In order to understand the role that each stakeholder can assume in the development of a different typology of sustainability innovation, it has been necessary to analyse the results relative to the correlation values distinguishing among the nature of innovation, environmental and social innovations, and considering the different dimensions of the framework.

Preceding in this way it has been possible to bring out the particular relations that some external stakeholders have with specific typologies of sustainability innovation. The discussion treats in a distinct way environmental and social innovations considering the different dimensions of analysis.

Degree of innovation-Environmental sustainability

The figure below shows the correlation values between the incremental and radical environmental innovations and the established collaboration with different stakeholders. Not all the values in the figure are relevant (the level of statistical significance is indicated in the general table), but the following discussion will be relative to only values characterized by a sufficiently high statistical significance as shown in the general table.

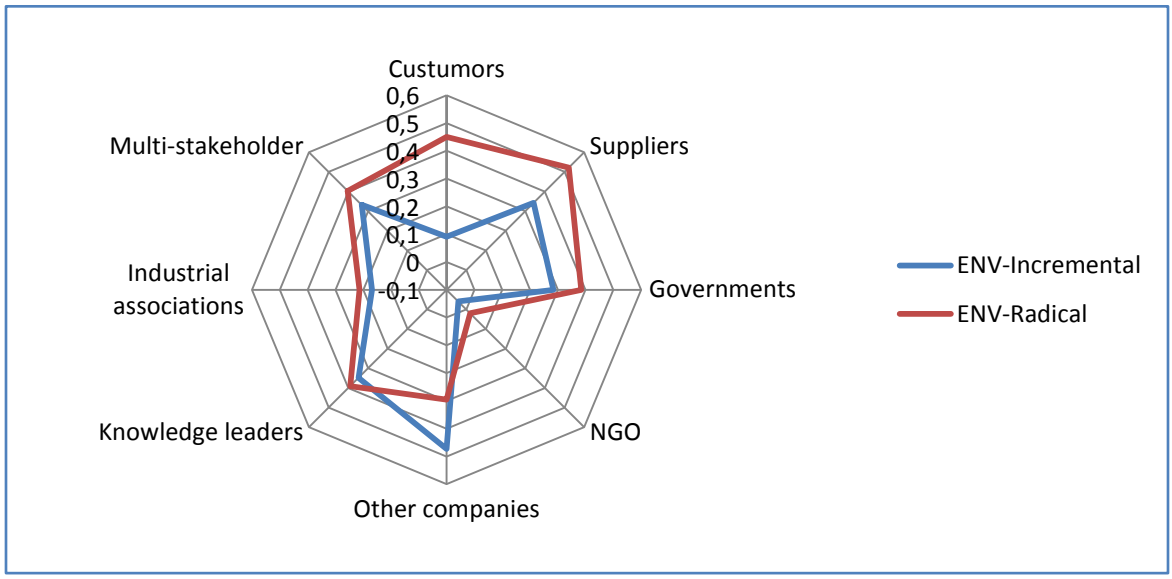

Figure 8 – Correlation relative to the relation between stakeholder collaboration and environmental innovation (focus on degree of innovation)

Regarding the incremental component the main actors involved are suppliers, governments, knowledge leaders and other companies, which includes competitors or external companies that have not a supplier or customer relationship with the companies of the test sample but that are involved in the innovation development context. The incremental innovation in the environmental ambit, developed establishing collaborations with external stakeholders, mainly consist into initiatives aimed to generate incremental changes of product. Some examples of such initiatives are the replacement of materials considered hazardous or harmful and the use of recycled materials for the realization of the products. Naturally, the examples change on base of the industrial sector in which the company operates. For example, AMD has involved some of its suppliers within an initiative that led to the re-design of some components of CPU and APU with the aim to eliminate the lead. Instead, in the automotive sector, in addition to the material substitution, the main examples relative to this typology of initiatives aim to improve the energy efficiency of vehicles through the adoption of efficient engines. In the analysis of collected data, it has been interesting to note the relevance of the so called multi stakeholder collaborations for developing environmental innovations of incremental typology. Indeed, happens that for the development of the same innovation, a company collaborates with more than one typology of stakeholders. For example, Intel has improved some products through the elimination of halogen flame retardants in collaboration with

suppliers, customers, and industrial associations. Another example is provided by Volkswagen, which within European project oriented to the development of high energy efficiency engine for light commercial vehicles has seen the involvement of knowledge leaders, competitors, suppliers and government entities. In general this result is in accordance with the statements of some authors (Albino et al. 2012; Yarahmadi 2012; & Klassen 2008; Vachon & Klassen 2006; Hartman 1999; De Marchi 2012), who within the academic literature have highlighted the relevance of stakeholder collaboration for the development of different typologies of sustainability innovation, also for those less complex.

From the analysis of correlation values, it is possible to observe that the more relevant stakeholder for the development of incremental innovation in the environmental ambit is the actor called “other company”. This category of stakeholder as already said includes competitors and external companies with which the company does not maintain customer and supplier relationships. Analysing data collected from companies' sustainability reports, it is possible to underline as the collaboration with external companies is mainly established for obtaining fundamental competencies required to improve the environmental performance of product, while with competitors for sharing the competencies required to develop new generation of technological standards adoptable by the entire industrial sector. The using of collaboration for obtaining new competencies from external companies (Resource based view) is visible into the BMW’s initiative. The German car manufacturer has established a joint venture with Boeing, airplane manufacturers, with the aim to exploit its competencies related to carbon fibre composite materials required to improve the environmental impact of own products during their entire life cycle. Instead, an example of collaboration among competitors is represented by the agreement between Ford and GMC. This collaboration has seen the two companies to share the own competencies in the development of a new 9-speed and 10-speed automatic transmission, which is able to improve the performance and efficiency in terms of fuel consumption.

Regarding the radical component of environmental innovations, the collaboration is considered as an enabler with a high number of stakeholders. Considering the primary stakeholders, in addition to suppliers, already determinants for incremental innovation, in particular for initiatives relative to products, it is possible to add the customers among the relevant actors for the development of radical environmental innovations.
In this circumstance, however, the programs are not relative to the incremental change of existing products but to the actual development of green products, which are specifically designed and developed for their impact on the environment. For example, HP, in collaboration with its suppliers, has developed an initiative called Project Moonshot. This project aims to develop a new generation of high-density servers with a low energy consumption. This result is in accordance with what is proposed by Albino et al. (2012) and Yarahmadi (2012), who emphasize the strategic role of suppliers, which are able to provide added value for business processes and for the production of goods and products. From the analysis of correlation values, it is possible to underline the relevant role played by the so called secondary

stakeholders in the development of radical innovations. Indeed, actors as governments and knowledge leaders show higher relevance in the development of radical initiatives than the case of incremental ones. In particular, the role of governments is recognized in the academic literature, where different authors see governments as a driver for innovation and sustainability (Yarahmadi 2012; De Marchi 2012). The result relative to the development of radical innovations through the collaborations of external stakeholder is in accordance with the statements of Shevchenko and Pagell (2013). These authors point out on one hand the need to develop radical innovations in order to move the company towards a truly sustainable future and on the other hand the importance to dialogue and collaborate in increasingly structured way with non-conventional actors such as NGO and Knowledge leaders. In this sense, the result of the research work contributes to the literature in the field of sustainability on the base of the Stakeholder theory emphasizing and characterizing the enabling role of secondary stakeholders.

Degree of innovation-Social sustainability

The figure below shows the correlation values between the incremental and radical environmental innovations and the established collaboration with different stakeholders. Not all the values in the figure are relevant (the level of statistical significance is indicated in the general table), but the following discussion will be relative to only values characterized by a sufficiently high statistical significance as shown in the general table.

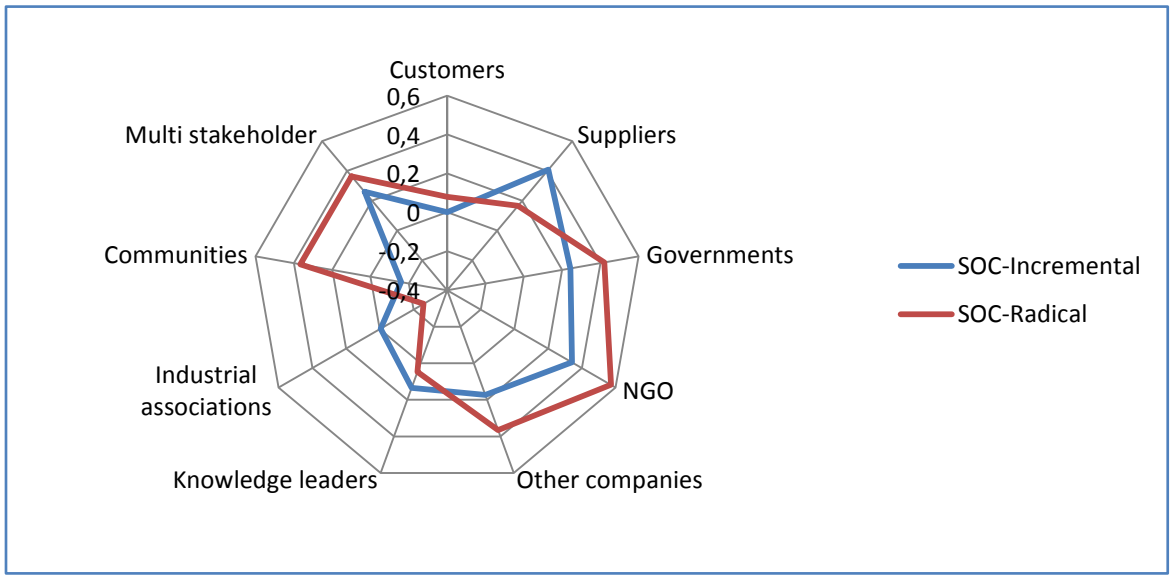

Figure 9 - Correlation relative to the relation between stakeholder collaboration and social innovation (focus on degree of innovation)

Taking into consideration the incremental innovations developed within the social field, it has been immediate to nota as in this specific case the number of typologies of involved stakeholders is lower than the environmental case. Indeed, in this ambit the typologies of stakeholders characterized by a high correlation value are only two against the five typologies of stakeholders considered relevant for the

development of incremental innovations within the environmental ambit. The two relevant actors are suppliers and NGO.

In the social field, the collaborations with suppliers mainly aim to improve security standards, corporate governance and labour practices through initiatives able to generate an external impact on the traditional supply chain of a company. From the analysis of corporate sustainability reports, it has been possible to note that these initiatives, in the totality of cases aim to preserve the health and well-being of the involved individuals, i.e. mainly the employees of suppliers and sample companies. Therefore, it is possible to state that, considering the social component, the incremental initiatives developed in collaboration with own suppliers mainly aim to the adoption of practices and systems that preserve the health and safety of individuals to which are addressed (Dawson and Daniel, 2010). Instead, the relevance of NGO's is mainly relative to the implementation of the initiatives addressed to the resolution of the problem concerned the so called "conflict minerals". The problem relative to the commercialization of conflict minerals is common for both the industrial sectors included in the research work. Indeed, there are many companies, belonging to both the industrial sectors included in the research sample, which are sensitive regarding this issue and that engage and involve its stakeholders in an attempt to solve this social issue of primary importance. In particular, the actors more involved in the implementation of "conflict minerals" activities are suppliers and NGOs. Such behavior is visible in some examples, as the initiative developed by Toyota, which involving own suppliers and NGO's has introduced new standards required to identify the real provenience of materials used in the own production processes with the aim to avoid the usage of so called "conflict minerals", whose selling is used to finance the wars that interested the extraction areas of these minerals. Another example is represented by Samsung, which has directly involved its own suppliers in the development of a system to control the origin of minerals used in the production or assembly process. The result relative to the relevance of NGO's in the development of incremental innovations in the social field is confirmed by numerous authors within the academic literature. Such authors recognize the fundamental role played by NGOs in the social ambit (Berrone et al. 2013; Pagell & Wu 2009; Shevchenko & Pagell 2013; Hartman 1999; Yarahmadi 2012; Holmes & Smart 2009).

Regarding the radical social initiatives, the actors with which it is turns to be relevant establishing collaboration for developing such typology of innovation are governments, NGOs and other companies. From the results it has been possible to highlight as the totality of relevant actors for radical innovation development is represented by secondary stakeholders. Such result is in accordance with the academic literature, which suggests as the collaboration with secondary stakeholders is an enabler for the development of radical innovations (Yarahmadi 2012; De Marchi 2012). The involvement of secondary stakeholders can derive by the fact that for the development of more complex innovations firms require specific resources and competences owned by actors as governments, NGOs and other companies (Shevchenko & Pagell 2013; Hartman 1999).

Indeed, the involvement of so called “other company” for developing a radical innovation, considering the social component, shows a high correlation coefficient and a high number of implemented initiatives. The main typologies of initiative developed in collaboration with external companies regard the development of new business or the participation to initiative or projects linked to the company’s core business. Being social initiatives of radical typology, they are oriented for example to the development of the future mobility systems and to the improvement of traditional systems.

Considering the development of new company businesses, the main social radical initiatives implemented by the companies of the automotive sector may be grouped in three categories: diffusion of car sharing services, development of applications able to optimize the researching process of parking areas and the definition of new urban transport systems. Examples related to the introduction of car sharing services are provided by Volkswagen and GMC, which have developed some collaborations with “other companies” with the aim to spread the usage of means of transport shared among customers and employees of involved companies. In this specific case, the involved companies don’t share the competencies required to develop the innovation but they make available their network of customers and employees. Contrarily, in the initiatives direct to develop application able to simplify the localization of free parking areas, the involved external companies share their specific competencies related to that ambit, as in the case of the collaboration that BMW has established with Urban Mobility. Instead, taking into account the development of new urban transport systems, the main example is provided by the project denominated Intermodal Route Planner, which through the collaboration with the transport companies of Munich, aims to define a system integrated to a navigation software able to plan travels or simple movements, exploiting the already available transport means.

Another stakeholder that plays an important role in the social ambit for the development of radical innovations is the NGO. This actor is often involved in initiatives that bring to company’s business innovations. The collaboration of NGOs is an enabler for radical innovations because brings skills and knowledge that integrate with the company’s technology assets making the projects actually successful. Such considerations have been supported in the academic literature by Hartman (1999) and Yarahmadi (2012), who have argued that over time the NGO’s have changed their traditional aggressive attitude towards the companies for a more active approach open to collaboration in order to share expertise to improve the sustainability performances. For example, a similar initiative has been developed by Philips with the collaboration of the Ministry of Health of China and with the NGO called “Imaging of the World”. The company, using its technology, has worked to improve the conditions of women in rural areas by introducing Chinese diagnostic systems for breast cancer.

An important aspect, also highlighted in the academic literature, is represented by the relevant role assumed by the multi stakeholder collaborations in the development of radical social innovations. Indeed, various authors have underlined the existing relation between the degree of complexity of social

initiatives and the need to involve different typologies of stakeholder at the same time in order to share and aggregate different skills and competence (Pagell & Wu 2009; Shevchenko & Pagell 2013; Dawson and Daniel,2010). The result provided by the correlation test shows as the establishment of multi stakeholder collaboration can become an enabler for the development of radical innovations in the social ambit (Hochgerner, 2009).

Object of innovation-Environmental sustainability

The figure below shows the correlation values between the process, product and the combination of products and processes environmental innovations and the established collaboration with different stakeholders. Not all the values in the figure are relevant (the level of statistical significance is indicated in the general table), but the following discussion will be relative to only values characterized by a sufficiently high statistical significance as shown in the general table.

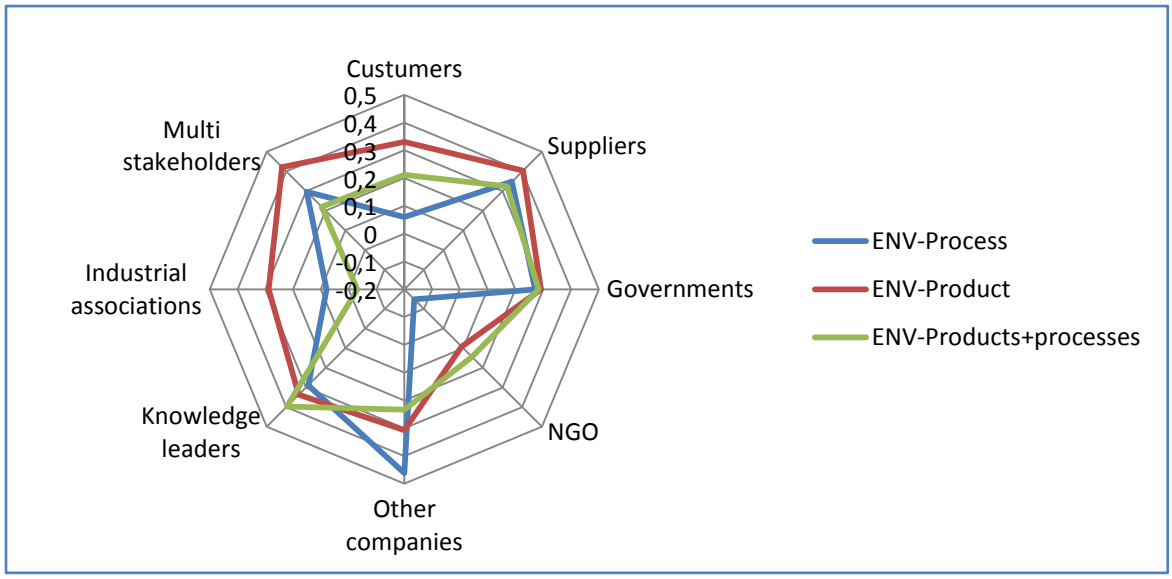

Figure 10 - Correlation relative to the relation between stakeholder collaboration and environmental innovation (focus on object of innovation)

Considering the object of innovation, that for the environmental component is divided into process, product and product and process combination, the establishment of collaboration turns out to be enabler only if it is developed with specific actors.

Regarding the innovation oriented to modify and improve a company's process in terms of environmental impact, the definition of collaboration turns out to be enabler for the development of this type of innovation if established with four specific actors: suppliers, "other companies", knowledge leaders and governments. The initiatives developed with the involvement of suppliers are mainly characterized by a limited degree of innovativeness. Observing the initiatives developed with the contribution of suppliers, it is possible to affirm that concerned innovations consist mainly in the development and implementation of

equipment and systems that are able to reduce the environmental impact of a firm and for this reason they require the collaboration of suppliers in order to exploit their competencies to improve firm's processes that are not considered as core business for the company. The relevance of suppliers in the development of process innovations is recognized in the academic literature on the base of the fact that the firm's suppliers have a privileged view on production processes of a company (Albino et al. 2012; Yarahmadi 2012).

The actors more relevant for the development of process innovations in the environmental field are the so called "other companies". In this case, it has been possible to note as mainly for the development of process innovations with the collaboration of "other companies", the initiative aim to involve companies characterized by different core businesses. The collaboration with these actors is mainly used to provide those fundamental competencies required for developing the initiative, competencies that otherwise would be missing (Yarahmadi, 2012). An example related to this behaviour is the collaboration established between Volkswagen and a printer manufacturer for developing equipment able to minimize the energy consumption. Another similar example is the collaboration among TATA and two different cement manufacturing corporations, ACC Cement Works and Ambuja Cements, with which the automobile manufacturer has developed a system able to co-process the waste of production processes. Other actors relevant for the development of process innovations are knowledge leaders and governments. The former in the academic literature is seen as an actor able to bring in a project technical knowledge accumulated through the research that the company does not possess individually (Yarahmadi, 2012). Instead, the latter, as underlined by Yarahmadi (2012), can bring improvements in the firm's sustainability performances and for its reputation. In addition, it has been possible to note also the weak relevance relative to the establishment of multi stakeholder collaborations. According to the academic literature, such result could be explained considering that the process innovations are mainly addressed to generate internal and incremental improvements that require initiatives characterized by a low level of complexity that lead to involve a limited number of stakeholders.

Regarding the development of environmental innovations that have as object the product, the establishment of collaboration is relevant with the totality of stakeholders except the NGOs. In particular, the suppliers are the actor more relevant to modify or develop a product with environmental characteristics. This is due to the fact that suppliers have a privileged view on firm's production processes and consequently they are able to give the largest contribution for the realization of firm's products (Albino et al., 2012; Yarahmadi, 2012). This happens for changing materials or components but also for the development of eco products or green products. For example, HP has worked with suppliers to develop a particular type of recycled resin used for the internal components of printers and external enclosures. In addition, it is important to underline the high relevance relative to the establishment of multi stakeholder collaborations, which, as just said are mainly addressed to face complex initiatives.

The initiatives that have as object the combination of products and processes are characterized by high relevant correlations values in the case of collaborations that involve the knowledge leaders, governments and suppliers. The main available example regards the participation of Volkswagen to the development of the ValueRess Project. This project has been developed in collaboration with "other companies" and knowledge leaders, in the case represented by different universities, with the aim to generate new analytical methodologies related to the life cycle analysis (LCA) of products and materials. The knowledge leaders, as said before in the analysis of degree of innovation, are mainly involved in the development of innovations in order to bring specific competences accumulated with years of research. Instead, the governments are usually engaged by multinational companies to implement and develop take back and recycling programs with the aim to produce a positive impact beyond the traditional boundaries of a firm (Pagell and Wu, 2009).

Object of innovation-Social sustainability

The figure below shows the correlation values between the process, product and business environmental innovations and the established collaboration with different stakeholders. Not all the values in the figure are relevant (the level of statistical significance is indicated in the general table), but the following discussion will be relative to only values characterized by a sufficiently high statistical significance as shown in the general table.

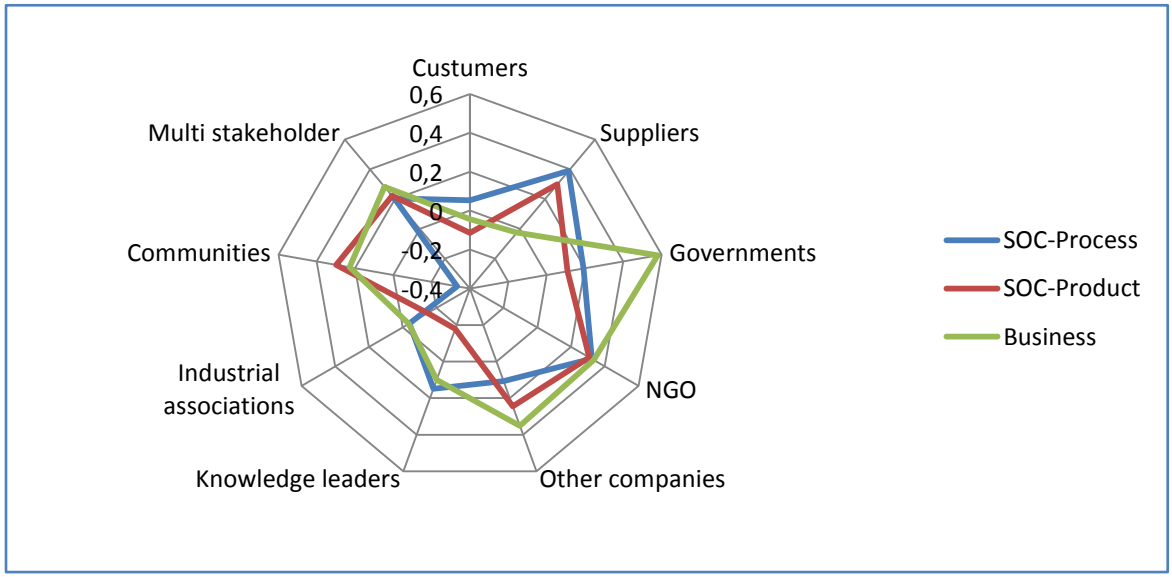

Figure 11 Correlation relative to the relation between stakeholder collaboration and social innovation (focus on object of innovation)

Starting from the consideration of process innovations related to the social component, through the analysis of correlation coefficients, it is possible to note that the actors resulted to be an enabler for developing such typology of initiative are suppliers and NGOs.

Among the initiatives developed with the involvement of suppliers, it is not possible to identify a typology of innovation able to prevail on the other ones. But observing the overall data collected from the sustainability reports, it is possible to note as a huge amount of collaborations established with suppliers are linked to the development of social initiatives that have as object a firm's process. From a theoretical point of view, the outcomes find a meaning recognizing that the suppliers are included in the traditional supply chain and participate in a direct manner to the organization and execution of some firm's processes (Yarahmadi, 2012). In this context, once again, it necessary to underline the role assumed by the programs focused on the problem of "conflict minerals", which are classified as social process innovations and mainly involve suppliers and NGOs. Consequently, the discussion about the involvement of NGOs is similar to that proposed for the social incremental innovations.

Regarding the development of product innovations in the social ambit, the results show only two relevant actors among the considered stakeholders and both with weak statistical significance. Such actors are suppliers and NGOs. Taking into consideration the suppliers, some authors, that have focused their attention on the collaboration with actors included in the traditional supply chain, have been able to find general feedbacks about the relevance of suppliers in the development of this typology of innovation (Vachon & Klassen 2008; Vachon & Klassen 2006). Instead, in the academic literature the NGOs are not usually considered relevant for the development of product innovations but for the development of initiatives addressed to define new businesses for a company (Hartman, 1999; Yarahmadi, 2012).

Such considerations find a validation in the result relative to the business innovations developed in the social ambit. Indeed, as affirmed by Hartman (1999), the collaboration with the NGOs is relevant for the development of business innovations, because brings skills and knowledge that integrate with the company's technology assets making the projects actually successful. In the development of such typology of innovation is also relevant the participation of governments and other companies. As previously said, the collaboration established with other companies mainly allows to obtain those skills and competences not owned by a company but required for the development of a new business. Instead, observing the initiatives collected from the sustainability reports has been possible to note as the governments assume a coordinating role among the different actors involved in the initiative. For the developing of business innovations in the social field, it is interesting to note as the relevant actors for the research work are secondary stakeholders.

Impact area of innovation-Environmental sustainability

The figure below shows the correlation values between the internal, external and extended environmental innovations and the established collaboration with different stakeholders. Not all the values in the figure are relevant (the level of statistical significance is indicated in the general table), but the following discussion will be relative to only values characterized by a sufficiently high statistical significance as shown in the general table.

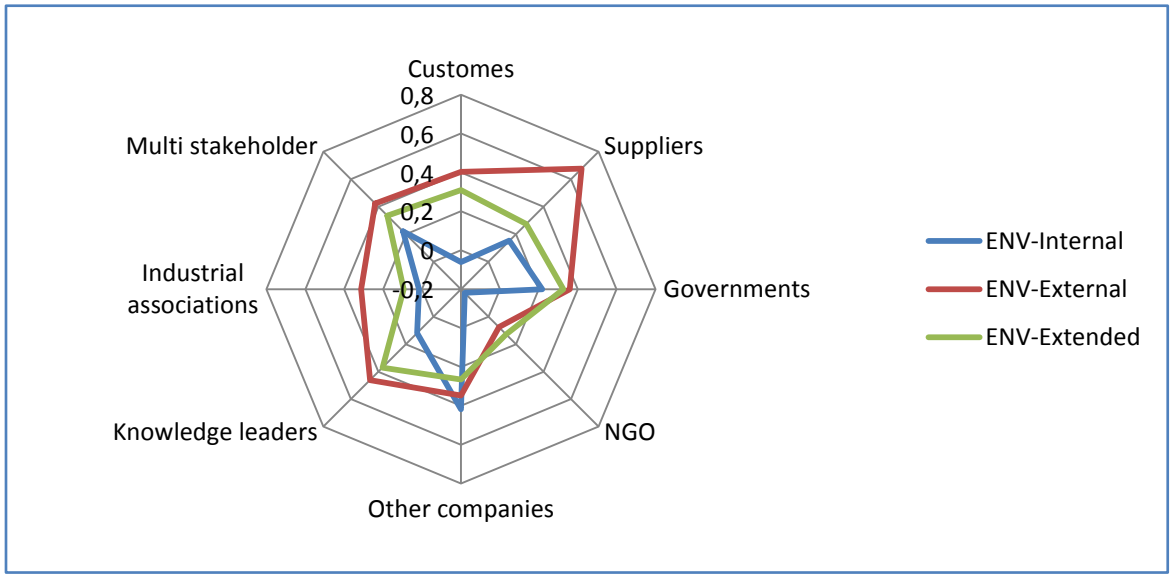

Figure 12 - Correlation relative to the relation between stakeholder collaboration and environmental innovation (focus on impact area of innovation)

Starting from the analysis of innovations that generate an internal impact to a company, it is possible to note that the unique actors with which the definition of collaborations turns to be relevant are the "other companies". The internal innovations developed in the environmental ambit are typically initiatives able to generate incremental changes on the firm's process (Zhu and Sarkis, 2004). Observing the sustainability initiatives collected from the corporate reports, it has been possible to note that the most number of initiatives developed with the collaborations of "other companies" regard interventions and changes aimed to improve the energy efficiency and exploit the renewable resources. This result brings to justify the involvement of "other companies" in the development of this typology of innovation in order to provide competences and skills not owned by the considered company but fundamental for the implementation of the innovation (Vachon and Klassen, 2006).

Instead, regarding the development of external innovations in the environmental ambit, the stakeholders mainly involved are numerous. Indeed, only the NGOs are not relevant for the development of this typology of innovation. The actors that have registered the maximum relevant correlation value for the development of this typology of innovation are the suppliers. From the collected data, it is interesting to

note as the collaborations with suppliers for this typology of innovations mainly aimed to the development of initiatives denominated Product reformulation, which aim to the introduction of an incremental change that makes the product more sustainable in environmental terms. Therefore, the suppliers through the development of such innovations, allow to the companies of the sample to obtain those technical competencies, mainly related to production materials, that otherwise the company would not have available to generate the innovation. The most significant examples are the collaboration that Nissan has defined with its supplier of steel for developing a new typology of material, called Advanced High Tensile Strength Steel (AHSS), which allows to improve the environmental performance of own product and the development of a new resin in cooperation between Mazda and Japan Polypropylene Corporation. This last collaboration has allowed to develop a material able to maintain the same rigidity level of traditional material reducing the weight of the vehicle and consequently its fuel consumption during usage. Similar examples are also identified among the electric and electronic companies, where Alcatel, collaborating with its suppliers, has identified and introduced alternatives to PVC for the production of some products. Instead, Lenovo has introduced the use of recycled plastic "post-industrial content (PIC)" and "post-customer content (PCC)" in the production of its products. This initiative was developed in collaboration with suppliers of these materials. These findings about the involvement of suppliers support what emerges from the analysis of the academic literature. Indeed, the suppliers are privileged stakeholders who are familiar with the processes and dynamics of the company. Therefore, they are identified as bearers of skills and knowledge that are considered the enablers in the development of innovations addressed to modify processes, relative to logistics and products (Albino et al. 2012; Yarahmadi 2012; Vachon & Klassen 2008; Vachon & Klassen 2006).

Among the others relevant actors for the development of internal innovations, it is interesting to underline the role played by the knowledge leaders. This typology of stakeholder, as recognized by the academic literature, allows to obtain knowledge and competences derived by numerous years of research that a company can only own through huge investments in research and development (Hartman, 1999; Yarahmadi, 2012).

The presence of many relevant actors for the development of this typology of innovations has brought to the need to develop multi stakeholder collaborations. The relevance of multi stakeholder collaborations can bring to think that the level of complexity of the external innovations is high and requires the collaboration of more than one typology of stakeholders in order to achieve e significant innovative improvement.

Regarding the innovations able to generate an impact outside the traditional supply chain, until to reach the final customer during the usage of the product, the analysis is similar to that executed about the environmental innovations relative to the development of products and processes combinations. From the graph it is possible to note that the actors more relevant in the development of extended innovations in

the environmental field are governments and knowledge leader. According to the academic literature, the main involved actors are secondary stakeholders able to provide knowledge and competence in the development of this typology of innovation through the collaboration (Wassmer et al., 2012). As said even the knowledge leaders are enablers for the development of this typology of innovation. The fact that actors such as universities and research institutes play an important role in the development of complex and holistic innovations in terms of sustainability is in accordance with what is highlighted by some authors in the literature (Albino et al. 2012; Yarahmadi 2012; Faems et al. 2005; De Marchi 2012). The research work of these authors highlights how these actors are holders of knowledge, skills and technical specifications that the company is not very often able to obtain and replicate. Consequently, the companies through the collaboration with these actors are able to access to specific and not imitable resources, in agreement with that proposed by the RBV (Albino et al. 2012; Ayuso et al. 2006; Yarahmadi 2012). In addition, from the result it is interesting to underline also the role of multi stakeholder collaborations in the development of extended innovations. As indicated by several authors in the academic literature, the statistical significance of multi stakeholder collaborations indicates the high complexity level relative to the development of innovations able to generate a positive sustainability impact beyond the traditional boundaries of a firm.

Impact area of innovation-Social sustainability

The figure below shows the correlation values between the internal, external and extended environmental innovations and the established collaboration with different stakeholders. Not all the values in the figure are relevant (the level of statistical significance is indicated in the general table), but the following discussion will be relative to only values characterized by a sufficiently high statistical significance as shown in the general table.

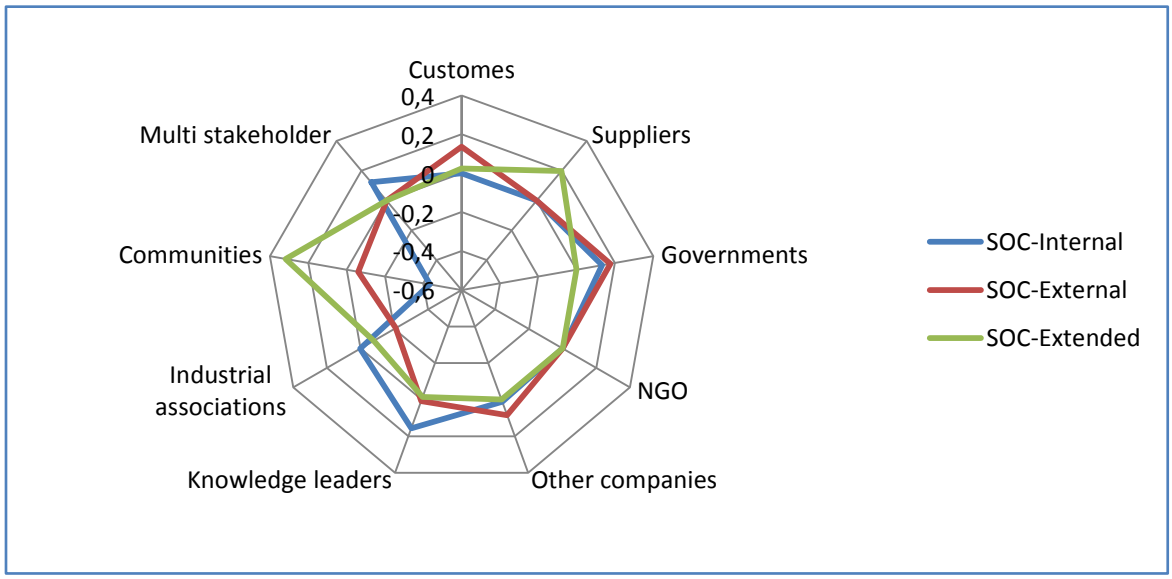

Figure 13 - Correlation relative to the relation between stakeholder collaboration and social innovation (focus on impact area of innovation)

Regarding the internal innovations developed on the social side of sustainability, from the results the actors considered more relevant for the development of such typology of innovation are the suppliers and in lower way the NGOs. The social innovations that have an impact within the company are typically initiatives addressed to employees and relative to various topics, from the development of safety programs in the workplace to initiatives for their professional growth. From the collected data it has been possible to note as the suppliers are mainly involved in order to improve the health and safety workplace conditions of company's employees through the substitution of harmful materials or the introduction of health and safety certification about the components and material provided to the company. Instead, the NGOs mainly collaborate with the companies in order to develop and update the code of conduct and human rights policies also collaborating in the development of training courses on these topics with the aim to improve the well-being conditions of employees.

Taking into consideration the social innovations able to generate an impact along the traditional supply chain of a company, it has been possible to highlight the relevant role as enabler for this typology of innovation played once again by suppliers and NGOs. In this case the involvement of suppliers is linked to the fact that the initiatives relative to the development of code of conduct and diversity programs are addressed to the employees of suppliers with the aim to conform the traditional supply chain to the firm's directives.

The last considered typology of innovations identifies those initiatives addressed to generate an impact in terms of sustainability beyond the traditional supply chain till to customers and communities. The actors recognized as enablers for the development of this typology of innovation are mainly secondary stakeholders. In detail the actors with the higher and relevant correlation values are governments, NGOs and other companies. This result is in accordance with what has been affirmed by Shevchenko and Pagell (2013). These authors have highlighted the importance of dialogue and collaboration with the non-conventional actors, as NGO and Knowledge leaders, in a more structured way. In this sense, these results contributes to the literature in the field of sustainability based on stakeholder theory emphasizing and characterizing the enabling role of secondary stakeholders as seen in the analysis of radical innovations.

As said, one of the most important actors in the development of extended innovations in the social field is the NGO. Indeed, this actor is particularly active in collaborations aimed to develop business innovations because they are bearers of complementary skills and knowledge typically relative to technology. Therefore, this result is in agreement with the statements of academic literature (Pagell & Wu 2009; Shevchenko & Pagell 2013; Hartman 1999; Yarahmadi 2012; Holmes & Smart 2009).The higher level of correlation is related to the involvement of other companies for the development of extended social innovations. Analysing the typologies of implemented initiatives it is possible to note as these actors are mainly involved for developing of new businesses directly or indirectly linked to the company's core

business and for participating to initiatives or projects linked to the core business of considered company. The last actor relevant for the development of this typology of innovation is government. The government entities usually in this typology of innovation assume a role of coordinator among the community to which the initiative is addressed and the company that act to develop the innovation. Such role has been assumed for example in the introduction of new social technologies within a community both in the automotive and electric sector.

These initiatives may be classified with a high level of complexity, in fact it is possible to note as this typology of innovation is often developed in collaboration with various stakeholder through the so called multi-stakeholder collaboration. The simultaneous involvement of different stakeholders and "other companies" for developing innovations characterized by an extended impact, i.e. that regards customers and communities, it is explainable taking into account the necessity to introduce extraneous competencies to the company's sector in order to develop complex innovations able to provide a competitive advantage on the market.

9.3 The impact of technological regimes on drivers

Q3: Does the technological regime of the industry impact on the relationship between drivers and sustainable innovations?

The third research question investigates the role of drivers for the development of sustainability innovations within a technological regime perspective. The objective is to verify if the role assumed by the past sustainability performances and by the strategic attitude to sustainability as drivers for the sustainability changes in function of the technological regimes to which a company belongs. This analysis has been executed calculating the correlation values among the considered drivers and the level of innovativeness of a company within the two industrial sectors in a separate way. Therefore, it has been followed the same process executed for the investigation of the first research question but in this case the overall sample has been divided on base of the technological regime to which the companies belong.

Before to proceed with the analysis of results, it is necessary to report the main characteristics of the two technological regimes to which belong the two industrial sectors included in the overall sample. The two considered industrial sectors are the electric and electronic sector and the automotive sector. Each sector is composed by twenty companies, which are selected, as already said, on the base of the same criteria naturally within the two different industrial sectors.

The belonging of an industrial sector to a specific technological regime has been established on the base of the classification framework defined by Marsili (2001) within a research work in which the author has analysed through the specific criteria, just described in the previous paragraph dedicated to the technological regimes, the main industrial sectors recognized in the academic literature identifying for each one a technological regime.

The electric and electronic sector has been included within the science-based regime. This regime is characterised by a high level of technological opportunity, high technological entry barriers especially originating in the high industry-specificity of the knowledge base, and high cumulativeness of innovation. Firms are homogeneous in their rates and directions of innovation, which are focused on closely related technologies. Innovative activities are principally devoted to product innovation and benefit from the direct contribution of scientific advances in academic research.

Instead, the automotive regime has been included in the complex system regime. Such regime is characterised by medium-high levels of techno- logical opportunity, entry barriers in knowledge and scale, and persistence of innovation. The distinctive feature of this regime is in the high degree of differentiation of technological competencies developed by firms, especially in upstream production technologies, and of external sources of knowledge, including an important, although indirect, contribution of academic research.

TECHNOLOGICAL REGIMES*	Electrical-electronics industries	Motor vehicles industries
	Science-based regime	*Complex system regime*
Technological opportunities	**HIGH**	**MEDIUM/HIGH**
Technological entry barriers	**HIGH** *Knowledge specificity; Cumulativeness of innovation*	**HIGH** *Knowledge complexity; Scale economies; Persistent of innovation*
Inter-firm diversity in the rate and directions of innovation	**HOMOGENEOUS**	**HOMOGENEOUS**
Diversification of the knowledge base	**INDUSTRY SPECIFICITY**	**VERY HIGH**
External sources of knowledge	**LOW**	**HIGH**
Links with academic research	**DIRECT CONTRIBUTION**	**INDIRECT IMPORTANT CONTRIBUTION**
Nature of innovation	**PRODUCT INNOVATION**	**DIFFERENTIATION**

Figure 14 - Summary of main technological regime features

From a comparison of the two sectors, the framework introduced by Marsili allows to highlight the main differences between the two analysed industries. The different knowledge base of the two technological regimes brings to additional differences about the external sources of knowledge, links with academic research and nature of innovation.

Following the analysis of Marsili, it is possible to identify two different innovation behaviours between the two sectors:

TECHNOLOGICAL REGIMES	Electrical-electronics industries	Motor vehicles industries
	Science-based regime	*Complex system regime*
Diversification of the knowledge base	INDUSTRY SPECIFICITY	VERY HIGH
External sources of knowledge	Low involvement of external stakeholders with low diversification in terms of typology of engaged actor.	High involvement of different typologies of external stakeholders due to the high knowledge complexity that requires different competences.
Links with academic research	Direct and frequent involvement of knowledge leaders.	Indirect involvement of knowledge leaders characterized by high benefits..
Nature of innovation	Mainly product innovations	Both product and process innovations with a propensity to generate more complex innovation as combination of product and process innovations or business innovations.

Figure 15 - Summary of technological regime differences

Taking into account the differences between the two industrial sectors highlighted on the base of the Marsili's classification of technological regime, it is possible to analyse the role assumed by the two considered drivers within the two technological regimes verifying if the differences can be attributed to the features underlined by Marsili.

9.3.1 The role of past performance within a technological regime perspective

Q3.1: Does the technological regime of the industry impact on the relationship between past performance and sustainable innovations?

Variables considered in this correlation test:

- **Past performance** - ***Environmental, Social and Sustainability performance*** during the years 2009, 2010, 2011.
- **Sustainability Innovation** – ***Innovativeness Index*** relative to different typologies of innovations developed in 2012.

The variables considered in this research question are the same variables used in the investigation of the Q1.1 question. The only difference is relative to the considered sample. Indeed, in this case the relation is analysed within the two industrial sectors in a separate way. Therefore, the objective is the study of relation between the past performances of the firms and their decisions within the sustainability ambit and the sustainability innovations assessing in a separate way the two industrial sectors. The theoretical hypothesis investigated has been introduced in the academic literature through a research work of Berrone et al. (2013). The authors have supposed that firms with a negative performance gap than the

standard of the sample are more sensitive to the development of sustainability innovations. This happens because companies with worst sustainability performances result more exposed on the one hand to the pressure generated by institutional actors as NGO and governments and on the other hand to a higher risk relative to possible penalties and continuity lack of the business (Berrone et al., 2013). Consequently, the goal is investigate if effectively companies with worst past sustainability performances are oriented in a particular way to develop specific typologies of sustainability innovation. In addition, in this specific research question the goal is to analyse the role assumed by past performances in the development of sustainability innovations through the comparison between the two industrial sectors. Given the nature of the variables, in this case the analysis has been performed through the test of Spearman's rank, the table below shows the results. The table includes the correlation coefficients both for the index of aggregate performance, which includes the three dimensions of the triple bottom line and for the values of specific performances relative to environmental and social dimensions.

Past performance	*AUTOMOTIVE*			*ELECTRIC and ELECTRONIC*		
Typology of Innovation	**Sustainability**	**ENV**	**SOC**	**Sustainability**	**ENV**	**SOC**
Incremental	0,802***	0,636***	0,599***	-0,108	-0,360	0,152
Radical	0,475**	0,478**	0,23	-0,303	-0,165	0,378
Process	0,721***	0,655***	0,542**	-0,232	(-0,481)**	0,102
Product	0,426*	0,542**	0,05	-0,050	-0,087	0,372
Product+Process&Business	0,39*	0,09	0,30	-0,273	0,004	0,253
Internal	0,663***	0,542**	0,602***	-0,308	(-0,618)***	0,014
External	0,577***	0,452**	0,449**	0,170	-0,041	-0,012
Extended	0,33	0,372*	0,20	(-0,438)*	-0,137	0,409*
Total	0,751***	0,605***	0,568***	-0,214	-0,299	0,239

*=p-value<0,1; **=p-value<0,05; ***=p-value<0,01

Table 15 - Results relative to the test of Spearman's rank correlation between past performances and sustainability innovations within the technological regimes

The correlation data should be interpreted as follows: a high positive correlation value indicates the presence of a positive relation between the best firm's past performance and the type of sustainability innovation indicated.

Discussion

In general, it is possible to note a strong positive relation among the firm's past sustainability performances and the development of sustainability innovations in the automotive sample. Therefore, the automotive companies characterized by high past sustainability performance are those companies more committed in the development of sustainability innovations. Such results are in contrast with the statements of Berrone et al. (2013), who have affirmed that companies with a negative performance gap

than the standard of the sample are more sensitive to the development of sustainability innovations. On the base of such results, it is possible to state that within the automotive sector the firms more oriented to the development of sustainability innovations are those with the best past performances in terms of sustainability. On the contrary, observing the correlation values relative to the electric and electronic sector, it is possible to note the presence of negative relations with some specific typologies of sustainability innovations. In particular, it is interesting to analyse the results relative to the environmental ambit, where environmental innovations of process able to generate an internal impact for a company present a negative correlation with the past environmental performance. Therefore, the graph for the environmental side in the electric and electronic sector shows as companies with negative performances in terms of environmental impact tend to develop short term process innovations able to generate a positive internal impact for the company in order to improve its environmental performance. Such results seem to partially confirm the statement of Berrone et al. (2013), who, through a research work in the environmental ambit, have supposed as companies with a negative performance gap than the standard of the market in which operate in order to respond to external pressures coming from governments or NGOs tend to develop specific typologies of environmental innovations with the aim to generate a short term improvement in the environmental performances.

Comparing the two sectors, it is possible to highlight as the past sustainability performances seem to assume two different roles within the two sectors. Indeed, in the electric and electronic sector the past performances partially assume a role of driver for the development of sustainability innovations in the environmental ambit, leading the companies with negative performances to develop innovations with a short term impact in order to generate an improvement of environmental performances answering in this way to possible external pressures. Instead, in the automotive sector the past sustainability performances seem to not influence the development of sustainability innovations. Indeed, the positive relation indicates as the best performers in terms of sustainability are in addition the companies with the higher level of innovativeness in this ambit. This behaviour brings to think that could be another driver that leads the automotive companies to develop sustainability innovations.

9.3.2 The role of strategic attitude within a technological regime perspective

Q3.2: Does the technological regime of the industry impact on the relationship between the company sustainability strategic position and sustainable innovations?

Variables considered in this correlation test:

- **Strategic Approach** – **Reactive[1]**; **Active[2]**; **Proactive[3]** defined on base specific factors identified within the sustainability strategy section and CEO Message in the sustainability reports.
- **Sustainability Innovation** – ***Innovativeness Index*** relative to different typologies of innovations developed in 2012.

The variables considered for the investigation of this research question are the same variables used in the research question Q1.2. Indeed, the aim is to identify the firm's strategic approach to sustainability as a driver for the development of sustainability innovations and to determine if the proactive approach of a company led to the development of specific typology of innovations, naturally in this case it is necessary to consider in a separate way the two industrial sectors that compose the overall sample. The table below shows the results derived by the test of Kruskal-Wallis applied between the categorical variable strategic approach to sustainability and the continuous variable which measures the company's commitment in the development of a given typology of sustainability innovation. The table summarizes the results of the analysis and the chi-square values indicate the strength of the relation while the asterisks indicate the level of statistical significance.

Typology of Innovation	*AUTOMOTIVE*			*ELECTRIC and ELECTRONIC*		
	Sustainability	**Environmental**	**Social**	**Sustainability**	**Environmental**	**Social**
Incremental	12,614***	9,166**	8,977**	0,56	1,06	0,06
Radical	8,548**	8,334**	4,60	1,58	2,13	0,01
Process	9,06**	10,634***	6,542**	1,79	2,80	0,04
Product	6,368**	6,589**	2,05	2,58	2,66	2,80
Product+Process&Business	3,80	0,67	4,754*	0,71	0,28	2,08
Internal	8,307**	13,921***	4,30	1,99	3,94	0,13
External	3,50	1,52	2,84	0,31	0,49	0,05
Extended	8,365**	5,761*	5,862*	0,59	1,08	0,20
Total	14,13***	10,943***	11,265***	0,62	1,60	0,03

*=p-value<0,1; **=p-value<0,05; ***=p-value<0,01

Table 16 - Results relative to test of Kruskal-Wallis between strategic approach to sustainability and sustainability innovations within the technological regimes

Discussion

Analysing the two industrial sectors in a separate way, it is possible to note as the company sustainability strategic position have a strong different relation on the sustainability innovation development within the two sectors.

Indeed, observing the automotive sector the relation seems strong and relevant. In the general sustainability ambit, the strategic approach of a company to sustainability is relevant for lead the development of short term sustainability innovation, identified as incremental process innovations able to generate internal improvements but also for developing more complex innovations that require a long term planning as in the case of radical innovations able to generate positive impact beyond the firm's boundaries. The same situation is observable for the environmental field, where the strategic attitude is relevant for the development of almost the totality of sustainability innovation typology. Instead, regarding the social component it is possible to highlight as a proactive approach to sustainability influence in a positive way the development of business innovations able to generate an extended impact till to customers and communities.

On the contrary, in the electric and electronic sector the sustainability strategic position of a firm seems to not have any influence on the development of sustainability innovations. Indeed, the results show in the totality of cases the non-relevance of this relation.

9.3.3 Overall discussion

Summarizing, the drivers considered in this research work for the development of sustainability innovations assume different roles and relevance within the two industrial sectors. Indeed, in the electric and electronic sector the past performances lead the companies of that sample to develop some specific sustainability innovations in particular for the environmental field in order to respond to the external pressures in accordance with the statements of Berrone et al. (2013). Instead, in the same sector the strategic attitude to sustainability does not assume the role of driver for the sustainability development, this means that the firm's commitment in the sustainability development does not depend by the company sustainability strategic position. On the contrary, the strategic attitude to sustainability is strongly relevant for the development of sustainability innovations in the automotive sector. Instead, for the automotive sector the corporate sustainability past performances seem to not represent a driver for the sustainability development because the firms with the best performances in sustainability also are the firms more engaged in the development of innovations in this ambit. According to the technological regime approach, a possible explanation to these results can be attributable to the knowledge bases and learning processes relative to the two industrial sectors analysed within a technological regime perspective (Nelson and Winter, 1982; Winter, 1984.). Several authors sustain as the nature of technology and the characteristics of a learning process are able to define and influence the pattern and the development trajectories of firm's innovation process (Gort and Klepper, 1982; Levin et al., 1985; Cohen and Levin, 1989). As discussed before, the automotive sector from a technological regime view point is characterized by a high complex knowledge and technology, which to be developed requires different competencies and also various collaborations with external actors. On the contrary, the electric and electronic sector is characterised by science based knowledge with high industry specificity. On these bases, it is possible to attribute the strong influence that the strategic attitude to sustainability has on the innovation development in this ambit taking into consideration the necessity to plan in the long period due to the complex knowledge and persistence of innovation in the automotive sector. On the contrary, in a sector, as the electric and electronic one, characterized by high knowledge specificity and cumulativeness of innovation the strategic attitude does not assume the role of driver for the sustainability. In this sector has a more influence the pressure linked to the negative past performance that lead the company to innovate, in particular in the environmental ambit, showing as such sector is more linked to a reactive attitude that to a proactive as in the case of automotive sector.

Naturally, these aspects have need to be analysed more deeply through additional considerations not linked only to the technological regime framework of Marsili, for example examining the in a more specific

way the industrial dynamics that characterize each sector or analysing the perception that in general the stakeholders and in particular the consumers have respect to a specific sectors in terms of sustainability.

9.4 The impact of technological regime on the relation between stakeholder collaborations and sustainability innovations

Q4: Does the technological regime of the industry impact on the relationship between stakeholder collaborations impact on sustainable innovations?

The forth question investigate the relation between the stakeholder collaborations and the sustainability innovations within a technological regime perspective. The objective is to analyse the impact of stakeholder collaborations on sustainability innovation development through the features defined by Marsili in the technological regime approach, in particular way the discussion will be focused on the differences between the two sectors.

In order to identify the relevance of specific stakeholder collaboration in the development of a specific typology of innovation, within the two separate industrial sectors, it has been necessary to follow the same procedure used in the research question Q2.

The considered variables in this relation are:

- **Sustainability Innovations** – ***Innovativeness Index*** relative to different typologies of innovations developed in 2012.
- **Stakeholder collaborations** - Number of collaborations established by a sample company with a specific stakeholder in 2012.

Using data and information collected from the corporate sustainability reports, it has been possible to calculate the correlations between the variables relative to the sustainability innovations and those relative to the collaborations with various considered stakeholders. Beyond the general information on the role of collaboration for the development of sustainability innovation, it has been possible to investigate in detail the relation between different actors and different typologies of initiatives bringing out some interesting peculiarities relative to the single industrial sector.

Below there is the table with the correlation values calculated using the test of Spearman's rank correlation. The results are referred to the relation between different typologies of sustainability innovations and a selected set of external stakeholders (Albino et al. 2012; Yarahmadi 2012; Ayuso et al. 2006; Holmes & Smart 2009), which play an important role in the development of sustainability initiatives.

Comparison based on typology of innovation	*Sustainability*		*Environmental*		*Social*	
	Electrical & Electronic	Automotive	Electrical & Electronic	Automotive	Electrical & Electronic	Automotive
Incremental	0,731***	0,763***	0,658***	0,396*	0,611***	0,647***
Radical	0,481**	0,432*	0,518**	-	0,590***	0,506**
Process	0,553**	0,753***	0,590***	0,536**	0,514**	0,649***
Product	0,414*	0,392*	0,545**	0,455**	0,590***	-
Product+Process&Business	0,628***	0,547**	0,709***	0,386*	0,798***	0,801***
Internal	0,420*	0,815***	0,412*	0,473**	-	0,663***
External	0,634***	0,764***	0,635***	0,438**	0,471**	0,644***
Extended	0,479**	0,588***	0,558**	-	0,461**	0,613***

Table 17 - Results relative to the test of Spearman's rank correlation between stakeholder collaborations and sustainability innovations within the technological regimes

Discussion

Observing the results, it is possible to note as the stakeholder collaborations in general have a strong influence on the sustainability innovation development in both the industrial sectors considered in this research work. Therefore, these results are in accordance with numerous authors that sustain as the stakeholder collaborations have a positive impact on the innovation development (Flynn et al., 2010; Kale and Singh, 2007; Mowery et al., 1996; Teece and Pisano, 1994). Taking into account the overall sustainability sphere, aggregating the environmental and social components, it is possible to highlight the strong relevance of the stakeholder collaborations for the development of each typology of sustainability innovation in both the considered sectors. Instead, some differences between the two sectors are visible in the analysis of single environmental and social components. Indeed, in the environmental field, the impact of stakeholder collaborations is more relevant in the development of sustainability innovations in the electric and electronic sector than the automotive one. In the electric sector the collaboration with external stakeholders is relevant for the development of the totality of sustainability innovation typologies. Instead in the automotive sector the collaborations are not relevant for the development of radical and extended sustainability innovations, in contrast with the academic literature that highlight the fundamental role of collaborations for the complex innovations as those radical and extended (Blomqvist et al., 2004; Caloghirou et al., 2004). Regarding the social component of sustainability, the collaborations result more relevant in both the sectors. In the electric sector the establishment of collaboration is not significant for the internal innovations in accordance to what is affirmed in the academic literature, which underlines the main usage of stakeholder collaborations also in the social field for developing innovations able to impact on the traditional supply chain or beyond till to customer and community (Selsky, 2005). On the contrary, from the results in the automotive sector the establishment of stakeholder collaborations is not significant for the development of product innovation in the social field. This result can be explained

taking into account the typology of product generated by this sector. In the social field, it is very interesting to highlight the role assumed by the stakeholder collaboration in the development of business innovations. Indeed, according to the numerous authors this result show as for the development of innovations that requires different competences and that usually aim to generate an impact on individuals or more in general communities, as the business innovations, the companies tend to establish collaborations with stakeholders able to provide extraneous knowledge and to create a direct and close contact to the society (Brown et al., 2000; Domask, 2003; Murphy and Bendell, 1999; Warner and Sullivan, 2004).

Analysing in detail the typologies of actors involved in the sustainability innovation development, it is possible to underline some differences between the two considered sectors. The table below shows the correlation values relative to each of considered stakeholders with the aim to evaluate the relevant of the single actors in the development of sustainability innovation inside the two different industrial sectors.

Typology of stakeholder	*Sector*	*Cust*	*Sup*	*Gov*	*NGO*	*OC*	*KL*	*Ind ass*	*Comm*	*M-Stake*
Sustainability	Automotive	-	0,686***	0,633***	-	0,575***	0,619***	0,39*	-	0,561***
	Electrical & Electronic	-	0,477**	-	-	0,692***	-	-	-	-
ENV	Automotive	-	0,369*	-	-	0,499**	0,408*	-	-	0,417*
	ELEC Electrical & Electronic	-	0,382*	0,38*	-	0,599***	-	-	-	-
SOC	Automotive	-	0,471**	0,715***	-	0,574***	0,487**	0,374*	-	0,452**
	Electrical & Electronic	-	-	-	0,517**	0,756***	-	-	-	-

Table 18 - Results relative to the test of Spearman's rank correlation between stakeholder collaborations and sustainability innovations within the technological regimes

In general observing the correlation values of the single actors inside the two sectors, it is possible to note as the involvement of different typologies of external stakeholders for the development of sustainability innovations is more relevant in the automotive sector than the electric one.

Indeed, taking into account the overall sustainability sphere, which aggregate social and environmental components, it is possible to see that whilst for the electric sector is relevant only the involvement of

suppliers and other companies, in the case of the automotive sector result significant the engagement of five different typologies of stakeholders.

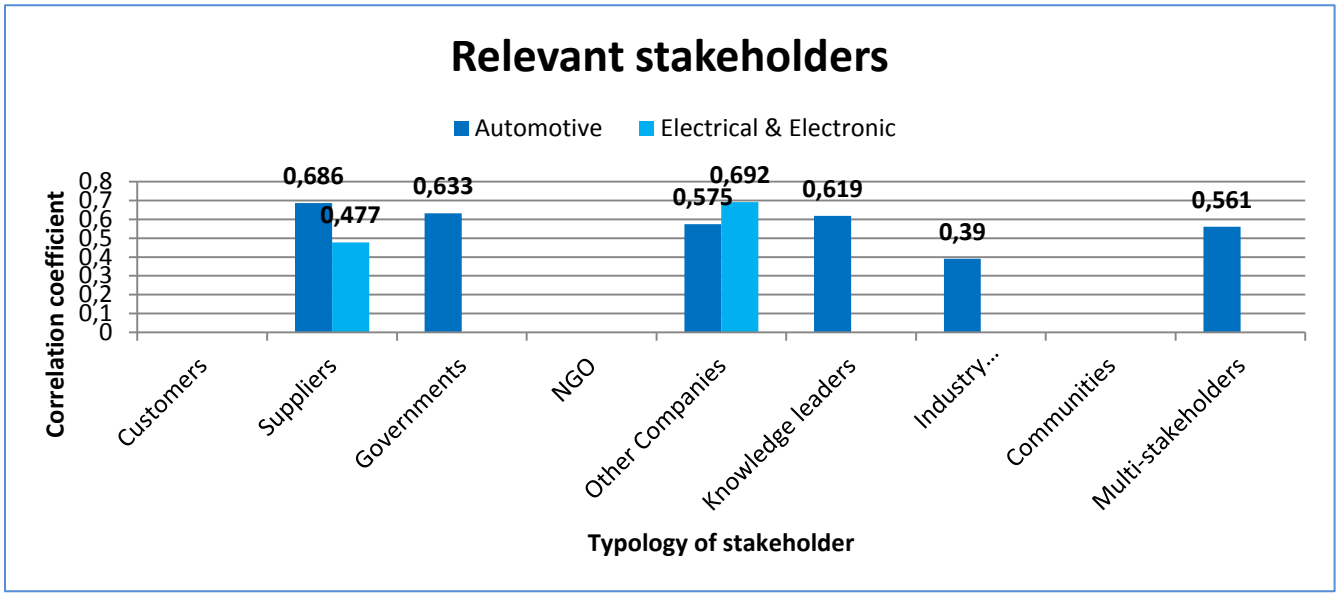

Figure 16 - Correlation values relative to the relation between sustainability innovation and stakeholder collaboration within technological regimes

The five relevant actors identified in the automotive sector are suppliers, governments, other companies, knowledge leaders and industry associations. This difference between the two sectors can be explained through the features defined by Marsili (2001) in its technological regime classification. Indeed, the author, as already said, has associated the automotive sector to the complex system regime. This regime is characterized by complex knowledge bases and persistent innovation, which require, due to the very high diversification of the knowledge bases, a high involvement of different typologies of external stakeholders (Malerba, 2005). In addition the author highlights the fundamental role assumed by the knowledge leaders, focusing in particular on the academic researchers, which are able to provide high benefits to the automotive companies within the innovation process. On the contrary, Marsili has associated the electric sector to the science-based regime because this sector is characterised by high knowledge specificity and cumulative innovations. These features drive the company of the sector to a low level of stakeholder involvement with a low diversification in terms of typology of engaged actor. Instead, regarding the links with the academic research, the author indicates as in this technological regime the involvements of knowledge leaders are frequent and direct (Marsili and Verspagen, 2002). According to what has been affirmed in the academic literature by several actors about the features relative to the technological regimes, it is possible to attribute the greater aptitude to the involvement of a larger range of stakeholders to the characteristics of the knowledge bases relative to the belonging technological regime. Therefore on the base of the results, the automotive sector involves the higher number of different typologies of stakeholders than the electric sector because its knowledge bases and the learning process,

defined through the technological regime approach, are more complex than a sector characterized by high industry specificity.

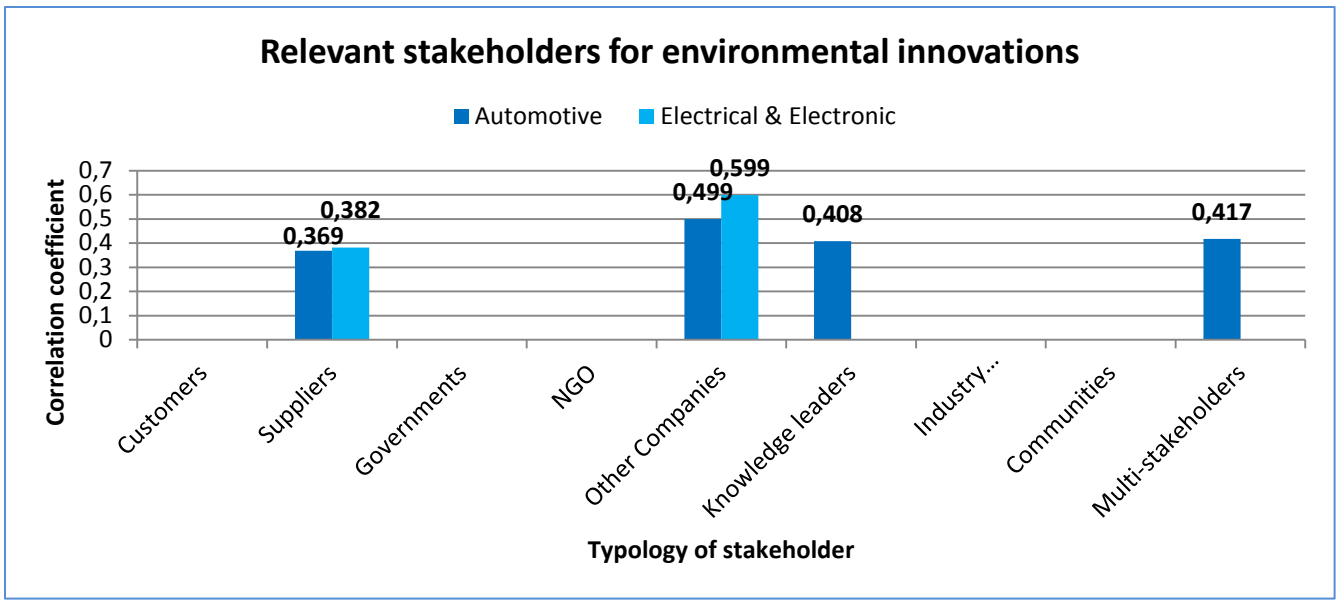

Figure 17 - Correlation values relative to the relation between environmental innovation and stakeholder collaboration within technological regimes

Such differences linked to the features of knowledge bases are also visible in the environmental field even if in lower way. Regarding the environmental sphere, the only difference among the two sectors is represented by the relevance of the knowledge leaders. In accordance with the statement of Marsili (2001), the involvement of knowledge leaders results significant within a more complex system. Indeed, from the result this actor represent for the company a source of important benefit more in the automotive sector than in the electric one in which the knowledge is more specific and less complex (Marsili, 2001,2002; Malerba and Orsenigo, 1996).

Taking into consideration the social side, it is possible to note as the most typologies of involved actors are included in the category of secondary stakeholder in accordance with the academic literature that link the social innovation to the involvement of this type of stakeholders (Gray, 1989; Trist, 1983;Waddell, 2005). The only primary stakeholders involved are the suppliers but its relevance is mainly linked to the involvement of this actor in the initiatives addressed to the resolution of the problem about “conflict minerals”.

According to academic literature about the technological regimes, also in the social sphere it is possible to highlight the wider range of stakeholder typologies involved in the more complex automotive sector than the more specific electric sector.

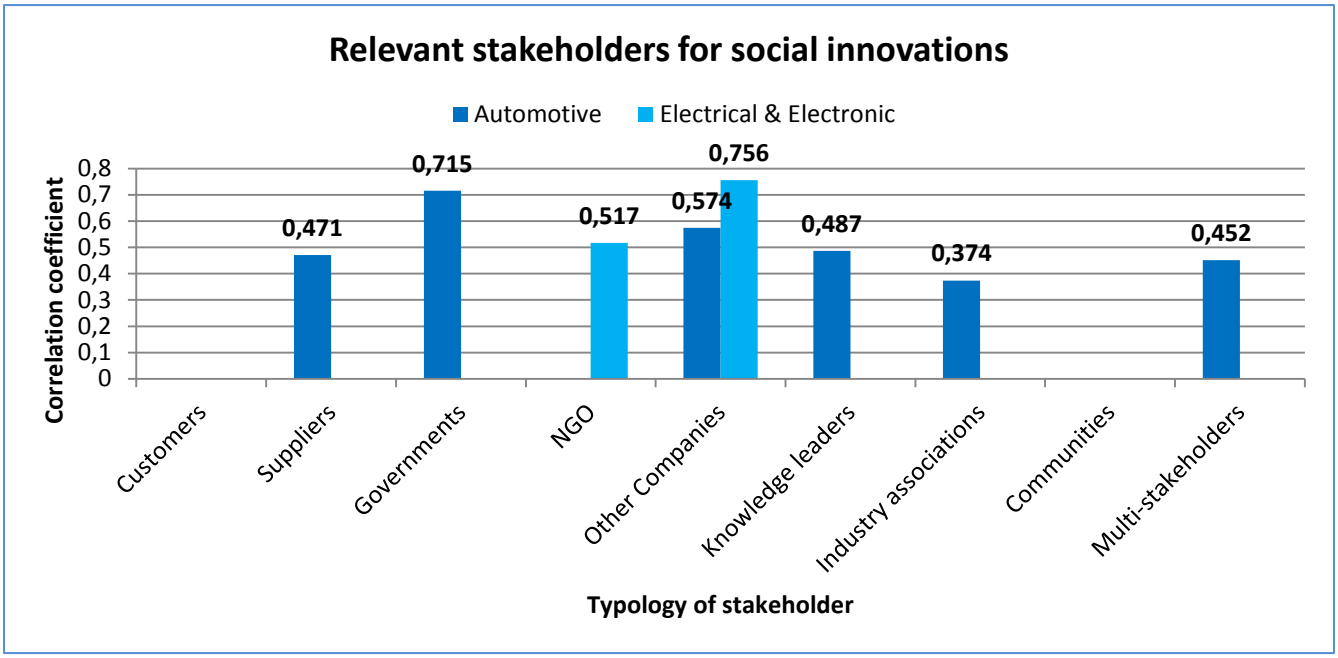

Figure 18 - Correlation values relative to the relation between social innovation and stakeholder collaboration within technological regimes

From the result the stakeholders relevant for the development of sustainability innovations in the automotive sample are suppliers, governments, other companies, knowledge leaders and industry associations, instead the only two relevant actors in the electric sector are NGOs and other companies. Also in this case, as underlined by Marsili (2001), the companies operated in the industry with the more complex knowledge establish collaboration with a higher number of different typologies of stakeholders.

Another important aspect is the establishment of multi stakeholder collaborations, which are characterized by the simultaneous involvement of more than one typology of actor in the development of an innovation. The relevance of the establishment of multi stakeholder collaborations has been linked by numerous authors in the academic literature to the need to acquire different competences and skills from different stakeholders (Dyer and Singh, 1998; Flynn et al., 2010; Mesquita et al., 2008). From the results, it has been possible to note as the establishment of multi stakeholder collaborations is significant for the development of sustainability innovation exclusively in the automotive sector. Taking into account the technological regime approach and the academic literature relative to the sustainability innovations, it is possible to link this result to the more knowledge complexity that characterizes the automotive sector than the electric one. As just said, the complexity of the knowledge bases influences the innovation development and lead companies to follow a specific innovation pattern (Nelson and Winter, 1977, 1982;

Malerba, 2005). Therefore, on this base it is possible to attribute the difference relevance assumed by the multi stakeholder collaboration in the two sectors to the need of different skills and competences for the development of sustainability innovation within a sector based on a high complex knowledge base.

10 Conclusions

10.1 Context and research objectives

Over the last decades, sustainability has received a growing concern from firms and scholars. Pressures following from public opinion, regulators, governments, NGOs and financial enterprises have contributed to an unprecedented rise of public attention drawn to the concept of sustainability. The development of the sustainability awareness has led academic researchers and executives to consider the sustainability variable as a significant competitive priority including it into the overall process of strategy formation (Kleindorfer et al. 2005). The increasing awareness, relative to the fundamental role that the sustainability has assumed in a corporate decision process, has lead scholars and companies to associate this concept to the innovation issue (Schaltegger et al., 2013). Indeed, several authors argue that the commitment of companies in the development of sustainability innovations often represents a key to business success and progress. For this reason companies are faced with the need to understand that today sustainability is equivalent to innovation (Asongu 2007; Nidumolu et al. 2009). In this context, sustainability has not to be understood as an immutable state or vision, but rather as a continuous process, which recalls the need to combine the three fundamental and inseparable dimensions of development: environmental, economic and social (Banerjee, 2007; Luke, 2005; Redclift, 2005). In other words, the sustainability innovations have to be able to generate not only economic outcomes but also positive environmental and social effects. The relation between sustainability and innovations has brought to the introduction of firm's stakeholders as a relevant source of innovative ideas to generate new solutions. The engagement of stakeholders for the development of sustainability innovations can not only be associated to their contribution in terms of innovativeness but also to the fact that a firm in order to be considered actually sustainable has to reach the sustainability internally and through its supply chain partners till to generate positive impacts on customers and communities (Krause et al. 2009). Naturally, the relation between sustainability and the innovation development is influenced by numerous factors that can lead companies to follow different innovation paths (Kamien and Schwartz, 1982). Among these factors numerous authors have argued starting from the empirical observation that the innovation development varied significantly across industries (Malerba, 2005).

Within the context described above, this research work analyses the sustainability innovations focusing the attention on the factors that can led companies to the development of such initiatives and on the role assumed by the stakeholder collaborations in this development process. The study of these relations has been subsequently included in a sectorial industrial perspective in order to identify possible behavioural variations in the sustainability innovation development. The identification and classification of sustainability innovations has been executed through the framework introduced by Benaglia and Cola (2013), which allows analysing the sustainability innovation in a complete way considering simultaneously environmental and social components of sustainability. Therefore, the objective of the research work is to

enhance on the one hand which are the factors that lead a company to develop sustainability innovations and on the other hand the stakeholder collaboration issue, assessing these relations also within a technological regime perspective.

The first objective of this research work aims to investigate the determinant factors for the development of sustainability innovations. The academic literature has used the Institutional theory in order to analyse the factors that drive companies to take particular strategic decision even in the context of sustainability (Yarahmadi, 2012; Hartman 1999). In the sustainability ambit several authors have emphasized the role of different strategic approaches in the development of sustainability expanding the range of factors considered by the Institutional theory. Indeed, in accordance with the academic literature on this issue, the theoretical domain referred to the Institutional theory has been expanded beyond the traditional external factors connected to the external pressures. In the evaluation of strategic attitude to sustainability has been also included the internal drivers, which have gained increasing importance in the academic debate (González-Benito and González-Benito, 2010). In addition to the role of company strategic position as driver for innovation development in the sustainability ambit, the research work takes into account an innovative aspect not largely considered in the academic literature. This aspect is linked to the research work of Berrone et al. (2013), in which the authors analyse the role of past performance as possible driver to the sustainability development.

The second research question aims to analyse the role of stakeholder collaborations in the development of sustainability innovations. This analysis arises from the recognized assumption that the stakeholder collaborations represent a fundamental mean for a company to acquire new resources and capabilities (Albino et al. 2012). In this context, the collaboration with stakeholders allows to firms to obtain resources that are valuable, rare, inimitable, and non-substitutable, making them able to achieve competitive advantages (Barney, 1991; Conner and Prahalad, 1996; Nelson, 1991). Therefore, the stakeholder collaborations for a company can actually generate significant competitive advantages in form of trust reputation and innovation, in accordance with the consideration made within the resource based view (Rodrıguez et al., 2002; Albino et al. 2012; Ayuso et al. 2011; Yarahmadi, 2012).

The last two research questions investigate the two previous questions within the context of technological regime approach. The objective is to analyse the role assumed by the two considered drivers, i.e. past performance and strategic approach, and the impact of stakeholder collaborations in the development of sustainability innovations within two different technological regimes. These regimes have been characterized on base of technology and knowledge bases as indicated by various authors in the academic literature (Kamien and Schwartz, 1982; Malerba, 2005). Such authors suggest as the nature of knowledge bases, the technological context and the learning processes are important explanatory variables of the sectorial patterns of innovation (Nelson and Winter, 1977; Gort and Klepper; 1982; Levin et al., 1985; Cohen and Levin, 1989; Audretsch, 1995). This research work attempts to bring the technological regime

perspective within the sustainability ambit in order to explain some differences in terms of sustainability innovation development between the two considered sectors.

The research questions defined on the base of the outlined objectives are as follows:

Q1: Which are the drivers of sustainable innovations?

> **Q1.1:** Are past performance drivers of sustainable innovations?
> **Q1.2:** Is the company sustainability strategic position driver of sustainable innovations?

Q2: Which stakeholder collaborations impact on sustainable innovations?

Q3: Does the technological regime of the industry impact on the relationship between drivers and sustainable innovations?

> **Q3.1:** Does the technological regime of the industry impact on the relationship between past performance and sustainable innovations?
> **Q3.2:** Does the technological regime of the industry impact on the relationship between the company sustainability strategic position and sustainable innovations?

Q4: Does the technological regime of the industry impact on the relationship between stakeholder collaborations and sustainable innovations?

10.2 Drivers of sustainability innovations

Q1: Which are the drivers of sustainable innovations?

Q1.1: Are past performance drivers of sustainable innovations?

The relation, studied through the test of Spearman's rank, between the past sustainability performances, calculated on the years 2009, 2010, 2011, and the various typologies of sustainability innovations developed by the firms has not provided interesting insights. The results indicate a weak positive relation among the firm's past performance in terms of sustainability and the development of some typologies of sustainability innovations. Such correlation values show as the companies with the best past sustainability performance are also subsequently the companies of the sample more committed in the development of sustainability innovations. This result is not consistent with the statements proposed by Berrone et al. (2013), who sustain that a negative performance gap generates a greater propensity of companies to the development of sustainability innovations. This happens because such companies are more exposed to the judgement of the actors responsible to create normative pressure that lead the companies to innovate in a sustainable perspective. Naturally, these pressures will make the managers of these companies more sensitive to aspects of CSR in order to safeguard its assets by sanctions or risk of business continuity.

Hence, from the application of this investigation on the overall sample it is not possible to consider the past performance as an antecedent factor in the analysis of the sustainability initiatives developed by companies.

Q1.2: Is the company sustainability strategic position driver of sustainable innovations?

The strategic approach to sustainability is resulted a relevant factor in the firm's decisions relative to the development of sustainability innovations. The results show as companies characterized by a more proactive approach to sustainability tend to be more oriented to the development of sustainability innovations. These outcomes is relevant regards the overall sustainability ambit, which aggregates the environmental and social components, and the environmental one. Instead, in the social sphere of sustainability the role of strategic attitude to sustainability does not seem to be relevant in the development of social innovations.

Taking into account the overall sustainability ambit, the companies characterized by a strategic attitude more proactive to sustainability issue don't show a precise orientation towards the development of particular typologies of sustainability innovations. However, it is possible to identify a general trend that indicates as the more proactive companies are mainly oriented to the development of incremental sustainability innovations able to generate changes on internal processes. Simultaneously, it is also possible to highlight an orientation towards the development of radical innovations relative to firm's products that are able to generate a positive impact in terms of sustainability beyond the traditional supply chain until the final customer and the communities. This last tendency is consistent with the academic literature, which sustains that proactive companies more oriented to sustainability typically assume the responsibility of their products during the entire product life cycle, extending the firm's horizon beyond the internal firm's processes, outside the company's boundaries unlike companies less proactive (Hellström 2007; Tseng et al. 2013; Hansen, Grosse-Dunker, Reichwald 2009; Klassen & Vachon 2006; Hart 1995; Hart 1997; Vachon & Klassen 2008).

In the environmental ambit, the companies more proactive to sustainability, as in the case of the overall sustainability, show an orientation to the development of internal innovations able to generate incremental changes on firm's processes. Furthermore, these companies show an attitude to the development of product innovations that usually are addressed to generate positive effects outside the company mainly towards customers and communities. This last aspect is in accordance with the statements of academic literature that, as already said, underlines the inclination of proactive companies to the development of initiatives able to impact outside the company.

In the social ambit, the relation between the strategic approach to sustainability and the different typologies of sustainability innovations is not significant and it is not able to provide any indication on a possible orientation of the analysed companies of the sample. This can be attributed to the fact that more

proactive companies in the social field are still seen as companies mainly engaged in philanthropic investments (Carroll, 1979), demonstrating a low maturity of social issue in the corporate ambit.

10.3 The relation between stakeholder collaborations and sustainability innovations

Q2: Which stakeholder collaborations impact on sustainable innovations?

The academic literature has recently showed an enhancing interest for the role of stakeholder collaboration in the sustainability and sustainability innovation ambits (Albino et al., 2012; Klassen and Vachon, 2009; Vachon and Klassen, 2006; Yarahmadi, 2012; Ayuso et al., 2006; Nieto and Santamaria, 2007; De Marchi, 2012; Pagell and Wu, 2009; Holmes and Smart, 2009). Indeed, the complexity of sustainability issues requires that firms, embracing sustainability into their strategies and activities, collaborate with a wide range of external parties and include a broad range of stakeholders that can be a source of environmental knowledge and competencies outside the firm's main domain (Arts, 2002; De Bruijn and Tukker, 2002; Hartman and Stafford, 1997; Seuring and Müller, 2008; Srivastava, 2007). Therefore, the issue of collaborations for sustainability is a hot topic for companies (Lacy et al., 2010). This research work, based mainly on the theoretical framework provided by the Stakeholder theory and the Resource based view, has attempted to expand the literature on this issue analysing the role of different actors for different typologies of sustainability innovation.

The analysis of the available data has allowed deducing some interesting conclusions linked to the considerations that various authors have developed in the academic research ambit.

- As underlined by various authors, it has been possible to recognise the existence of a strong relation between the collaboration established with external stakeholders and the development of sustainability innovations (Albino et al. 2012; Klassen & Vachon 2008; Vachon & Klassen 2006; Yarahmadi 2012; Ayuso et al. 2006; Nieto & Santamaria 2007; De Marchi 2012; Pagell & Wu 2009; Holmes & Smart 2009). In the academic literature, it has been hypothesized as different stakeholders, described as bearers of specific resources and competences, are linked to different typologies of innovations (Yarahmadi 2012; Albino et al. 2012; De Marchi 2012; Ayuso et al. 2006; Holmes & Smart 2009). From the results, it has not been possible to associate particular typologies of stakeholders to the development of specific typologies of innovations, except for some cases that will be analysed at a later stage. In particular way, some authors have supposed as the collaboration with external stakeholders is mainly linked to the development of radical and complex innovations (Klassen & Vachon 2008; Vachon & Klassen 2006). This consideration cannot be confirmed by the results of the research because the correlation values show as also for the development of incremental initiatives the establishment of stakeholder collaborations assumes a relevant and fundamental role. This conclusion can be explained considering the technology that is

at the base of the products developed by the two industrial sectors included in the sample. Indeed, the two sectors are based on mature technologies that require the development of incremental changes on products and processes linked to a so called conventional technology.

- As said, at the base of this research work there is the Stakeholder theory, which proposes a fundamental distinction among the primary and secondary stakeholders (Ayuso et al. 2006). This classification has been introduced in the research works of various authors, who has hypothesized as for a company it is necessary to dialogue and collaborate in increasingly structured way with non-conventional actors such as NGO and Knowledge leaders (Yarahmadi 2012; De Marchi 2012; Pagell & Wu 2009; Shevchenko & Pagell 2013; Holmes & Smart 2009; Albino et al. 2012; Faems et al. 2005; Berrone et al. 2013).Starting from this consideration, the results partially confirm the statements of the academic literature even if it has not been possible to identify a strong difference between the two typologies of stakeholders. Indeed, the secondary stakeholders mainly show an orientation to develop radical innovations able to generate an extended impact beyond the firm's boundaries.
- Analysing more in detail the secondary stakeholders, it is possible to make some considerations on the single actors. In this context, the actors more relevant are governments, NGOs, other companies and knowledge leaders. Starting from the NGOs, it is possible to highlight their different role within the sustainability components. Indeed, this typology of stakeholder result not relevant in the environmental field but on the contrary in the social field its correlation values show a strong contribution in the development of sustainability innovations. This result is confirmed in the academic literature, where various authors have highlighted the growing importance of NGOs in the social commitment of private corporations (Weisbrod, 1997; Young, 1999). Indeed, these authors underline the development of a different relationship between firms and NGOs than the past. Today, NGOs and firms tend to share their goals in order to generate a positive relation for both the considered parties (Iyer, 2003; Alsop, 2004; Zammit, 2004; Millar et al., 2004). On the contrary of the NGOs, the knowledge leaders are relevant in the environmental field but not in the social one. Also for these actors it is possible to highlight their role in the development of radical and complex innovations able to generate positive impact beyond the traditional supply chain of a company. Both NGOs and knowledge leaders are recognised in the academic literature as actors able to provide knowledge and competences about social and environmental issues not available in the corporate ambit (Albino et al. 2012; Yarahmadi 2012; Faems et al. 2005; De Marchi 2012). Therefore, as shown by the results, the companies through the collaboration with these actors are able to access to specific and not imitable resources, in agreement with that proposed by the RBV (Albino et al. 2012; Ayuso et al. 2006; Yarahmadi 2012).
  Another important secondary stakeholder is represented by the other companies. These actors, as the two previously analysed, are seen in the academic literature as a source of unique and inimitable resources and capabilities. Therefore, within the RBV the establishment of profitable

relationships with these entities represents an engine for innovation and a potential source of competitive advantage (Dyer and Singh, 1998; Lavie, 2006). In particular, for the other companies the results, in accordance with the statements of various authors, show an inclination in the social field to the development of radical innovations relative to the implementation of new business able to generate positive impacts on customers and communities (Ammenberg and Hjelm, 2003; Amundsen, 2000; Andersen & Lund, 2007; Glasbergen and Groenenberg, 2001; McEvily and Marcus, 2005). From the results also the governments represent a relevant stakeholder. In accordance with the academic literature also this actor show to provide an important contribution to the development of radical and complex innovation in the social field (Milliman and Grosskopf, 2004). In a lower way the analyses show the relevance of industrial associations. The correlation values relative to this typology of secondary stakeholder are in contrast with the statements of academic literature. Indeed, this actor does not show an orientation towards the collaborations addressed to the development of radical and complex innovations but on the contrary the collaboration with the industrial associations aims to the development of internal process innovations able to generate incremental improvements.

- Regarding the primary stakeholders, it is possible to note the fundamental role assumed by suppliers in the development of sustainability innovations while customers don't show any relevance in this ambit. In particular, the suppliers show a wide involvement in the development of environmental innovation. In this ambit, the collaboration with this actor is relevant for the development of any typologies of innovations. Instead, in the social field the suppliers are mainly relevant for the development of internal incremental innovations linked to processes. This important role assumed by suppliers has been recognized by different authors, who sustain as the privileged position occupied by this actor about processes and products of the company makes them owners of complementary skills and resources that allow them to be involved in a wide range of sustainable innovations (Albino et al., 2012; Yarahmadi, 2012; Ayuso et al., 2006; Nieto and Santamaria, 2007; Vachon and Klassen, 2008; Vachon and Klassen, 2006). In particular, as shown by the academic literature and confirmed by the results, the suppliers are a key player in the development or modification of products and processes in terms of environmental sustainability. Instead as just underlined, the collaboration with customers is generally not significant. According to research works in the field of supply chain management), it is generally easier to work with its suppliers rather than engage customers in partnerships that lead to the development of sustainable innovations (Vachon and Klassen, 2008; Vachon and Klassen, 2006).
- Lastly, it is interesting to highlight the strong relation between the establishment of multi stakeholder collaborations and the development of sustainability innovations. The definition of this typology of collaboration results relevant for any typology of sustainability innovations. In accordance with the academic literature the establishment of multi stakeholder collaborations are considered positive and significant in both the environmental and social components for the

development of radical and complex sustainability innovations (Klassen and Vachon, 2008; Vachon and Klassen, 2006). In particular, this role is evident in the social field where the establishment of collaboration with more than one typologies of stakeholder results relevant only for the development of radical initiatives able to generate an extended impact beyond the traditional supply chain (Elbers, 2004; Utting, 2002).

10.4 The impact of technological regimes on drivers

Q3: Does the technological regime of the industry impact on the relationship between drivers and sustainable innovations?

Q3.1: Does the technological regime of the industry impact on the relationship between past performance and sustainable innovations?

This research question places the relationship between past performances and sustainability innovations within a technological regime perspective. The objective consists in the analysis of the role assumed by past performances in the development of sustainability innovations within the two different technological regimes included in the overall sample trying to associate eventual differences to the features of technological regimes. The results, obtained through the test of Spearman's rank, show as the past performances seem to assume a different role within the two technological regimes. In the automotive sector, which is associated to a complex system regime, the past performances result strongly positive oriented to the development of sustainability innovations. Therefore, in this technological regime companies characterized by better past performances in terms of sustainability result to be the firms more committed in the development of sustainability innovations. On the contrary, in the electric and electronic sector, which is included in a science based regime, the past sustainability performances result weakly negative correlated for specific typologies of sustainability innovations in the environmental ambit. According to the statement of Berrone et al. (2013), a negative performance gap generates a greater propensity of companies to the development of environmental innovations. In particular, these authors sustain as companies with worst sustainability performances result more exposed on the one hand to the pressure generated by institutional actors as NGO and governments and on the other hand to a higher risk relative to possible penalties and continuity lack of the business (Berrone et al., 2013). The results in the environmental field seem to confirm these statements because indicate as negative past environmental performances lead companies to develop environmental internal innovations able to generate an internal impact. Summarizing, the past performances generate two different impacts in the development of sustainability innovations on the base of the considered technological regimes. In a complex system regime, characterized by complex knowledge bases and persistence innovation, from the result the past performances cannot be considered as a driver for the development of sustainability innovation. Therefore, it is possible to affirm that inside this regime the statement of Berrone et al. (2013) cannot be confirmed. On the contrary, in the science-based regime associated to the electric and electronic sector,

the proposition of Berrone et al. (2013) is partially proved because the past performances lead companies to develop environmental innovations in particular able to generate short term positive impacts inside the company. Such difference between the two technological regimes can be partially explained considering the deep difference highlighted by the technological regime approach in terms of nature of technology, complexity of knowledge bases and features of the learning process.

Q3.2: Does the technological regime of the industry impact on the relationship between the company sustainability strategic position and sustainable innovations?

This research question investigates the relation between the firm's strategic approach to sustainability and the development of sustainability innovations within a technological regime perspective. The objective is to verify the role of company sustainability strategic position as driver for the development of sustainability innovations within the two considered technological regimes. This analysis has allowed verifying an opposite situation within the complex system regime and the science-based regime. In the first case, the relation between the strategic approach to sustainability and the development of sustainability innovations results very positive in the overall sustainability ambit but also in a lower way in the single environmental and social fields. According to the academic literature, the results indicate as companies characterized by a more proactive approach to sustainability tend to be more oriented to the development of sustainability innovations (Hellström 2007; Tseng et al. 2013). On the contrary, in the science-based regime the strategic approach to sustainability doesn't represent a driver for the development of sustainability innovations. Indeed, the results don't show any relevant values of correlations. Summarizing, the strategic approach of a company to sustainability results a driver for the development of sustainability innovations in the complex system regime but not within the science-based regime.

Overall conclusion

The two considered drivers for the development of sustainability innovations assume opposite roles within the two technological regimes. Indeed, the complex system regime seems to be more influenced in the decisions about the development of sustainability innovations by the strategic approach to sustainability. On the contrary, in the science-based regime the most influence on the development of sustainability innovations is generated by the past sustainability performance in particular in the environmental ambit. This difference can be partially explained through the features of the two technological regimes in terms of technology, knowledge and learning process. As indicated by Marsili (2001) the complex system regime is characterized by high complex knowledge bases that require the presence of different competences and skills. Instead, the science based regime is characterized by high industry specificity. Such considerations can bring to think that more complex knowledge bases and a more complex technology lead the companies to link their decisions to the strategic approach rather than to the pressure linked to the past performances. Naturally, this investigation starting from the Marsili's

classification of technological regimes require a more specific and deep study relative not only to the features of knowledge and technologies but also to consider for example the market dynamics and the external pressures linked to a specific industrial sector.

10.5 The impact of technological regime on the relation between stakeholder collaborations and sustainability innovations

Q4: Does the technological regime of the industry impact on the relationship between stakeholder collaborations impact on sustainable innovations?

The last research question investigates the relation between the stakeholder collaborations and the sustainability innovations within the two considered technological regimes. The investigation has been executed with the same methodology of the second research question but in this case the analysis is performed on the single technological regime. This investigation has bring to identify some different innovation behaviours within the two technological regimes not in the typologies of sustainability innovations developed but mostly in the typology of stakeholder involved in the establishment of collaborations. Observing the results, it is possible to note as the stakeholder collaborations in general have a strong influence on the sustainability innovation development in both the industrial sectors considered in this research work. Therefore, these results are in accordance with numerous authors that sustain as the stakeholder collaborations have a positive impact on the innovation development (Flynn et al., 2010; Kale and Singh, 2007; Mowery et al., 1996; Teece and Pisano, 1994). The more interesting contributions coming from the analysis of the correlation values relative to the single actors included in the two technological regimes.

- In accordance with the technological regime classification of Marsili (2013), it is possible to verify a greater involvement of different typologies of external stakeholders in the complex system regime than the science-based regime. The relevance of the involvement of five different typologies of stakeholders in the complex regimes versus the only two significant typologies engaged in the science-based regime confirms the statements of Marsili. The author has associated this greater and diversified involvement to the need to obtain different competences and skills within a technological regime characterized by complex knowledge bases and technology.
- On the contrary, Marsili (2001, 2002) describes the science-based regime as a regime characterized by a very high industry specificity that requires a low involvement of external stakeholders in particular in terms on typology of stakeholder. In accordance with this statement the results show as the only two relevant typologies of stakeholder are represented by suppliers and other companies. In particular, the involvement of suppliers can be attributable to the industry specificity. Indeed, in the academic literature the privileged position occupied by this actor about processes and products of the company makes them owners of complementary skills and resources strongly linked to the industry specificity (Albino et al., 2012; Yarahmadi, 2012;

Ayuso et al., 2006; Nieto and Santamaria, 2007; Vachon and Klassen, 2008; Vachon and Klassen, 2006).

- In the academic literature, various authors have highlighted the fundamental role assumed by the knowledge leaders, which are mainly able to provide high benefits in the complex system regime (Malerba, 2005; Marsili, 2001, 2002). This aspect is confirmed by the results, which show as the involvement of knowledge leaders in the development of sustainability innovations is significant in the overall sustainability and in both the environmental and social components. On the contrary in the science-based regime where the contribution of knowledge leaders is considered frequent but not fundamental as in the complex system regime the correlation values are not relevant.
- Another aspect that highlights the influence of the technological regimes in the relation between the stakeholder collaborations and the sustainability innovations is relative to the development of multi stakeholder collaborations. The use of this typology of collaborations result relevant in the development of sustainability innovations in the complex system regime, instead it is not relevant in the science-based regime. This difference can be attributable to the level of complexity of the knowledge bases that characterize the technological regimes. According to various authors the involvement of stakeholders in the development of sustainability innovations is strongly linked to the competences and knowledge required for the definitions of such innovations (Blomqvist et al., 2004; Caloghirou et al., 2004; Chang, 2003; Macpherson et al., 2004). This result shows as within the complex system regime, characterized by a complex knowledge and by a need of different competences and skills, companies tend to establish multi stakeholder collaborations in order to manage this complexity also within the innovation process.

10.6 Contributions and implications

The present work contributes to the academic literature in the field of sustainability in several aspects and proposes some interesting ideas for the corporate management.

Starting from a deep literature analysis, it has been possible to identify the importance of the relation among sustainability, innovation and collaboration. The development of analysis on the firm's data has allowed reaching the objectives set and contributing on the academic literature on this issue. The framework proposed by Benaglia and Cola (2013) has allowed analysing the corporate sustainability innovations within both the environmental and social sphere. In this context, the sustainability innovation has been associated by Hart (1995) to the concept of capability. The author sustains as the sustainability innovation can be considered in a company as a capability and a resource able to generate opportunities and competitive advantages. This research work has allowed contributing to a greater understanding of the firm's efforts in terms of sustainability. With the aim to make the analysis of sustainability initiatives in the corporate ambit more complete, it has been necessary to address a particular attention to the collaboration with external stakeholders and to the innovation patterns developed inside specific technological regimes. Indeed, the importance of stakeholder collaboration is confirmed by various

authors, who sustains as the establishment of partnership relations with external actors is a fundamental and not easily replicable resource that companies can enhance with the aim to develop the sustainability innovations (Albino et al., 2012; Ayuso et al., 2006; Yarahmadi, 2012). Regarding the effect of the technological regimes on the innovation development, various authors have emphasized as the features of the knowledge bases, the technology and the learning process of a specific regime can affect sources, determinants and directions of the resulting innovation trajectories (Malerba, 2005; González-Benito, 2005; González-Benito and González-Benito, 2006,2010).

The present research work highlights the fundamental role of stakeholder collaboration in the development of different types of sustainability innovations. In this sense, this research work confirms the statements of several authors for which the competences and resources of various external stakeholders are enabling for the development of initiatives and programs in the sustainability ambit (Albino et al. 2012; Ayuso et al. 2006; Yarahmadi 2012). Therefore, it is clear as the stakeholder collaborations is now perceived as a key not negligible capability able to generate competitive advantages (Vachon & Klassen 2006; Albino et al.2012; Yarahmadi 2012; Ayuso et al. 2006; Hansen 2009; Vurro et al. 2010). In this sense, this research work allows not only the validation of the set of stakeholders proposed by some authors in the academic literature (Albino et al. 2012; Yarahmadi 2012; Ayuso et al. 2006; Holmes & Smart 2009) but also indicates which can be the roles of different actors in the development of specific typologies of programs and innovations. This aspect enriches the academic literature in the sustainability ambit proposing a further step in the study of relations between firms and stakeholders, not restricting the analysis to a general consideration.

Regarding the role that some authors have attributed to the past performances and strategic approach to sustainability for the development of sustainability innovations, it is possible to partially confirm the impacts that these determinants can have on the sustainability innovation process of a company (Ayuso et al., 2011; Ayuso et al., 2006; Yarahmadi, 2012; Berrone et al., 2013). Indeed, it has been recognized in the overall sample the effect of company sustainability strategic position in the orientation of sustainability innovation development. Instead the supposition made by Berrone et al. (2013) has not found a validation.

Furthermore, this research work has investigated the possible drivers to sustainability within the context of technological regimes. Such analysis has allowed observing in accordance with the academic literature relative to this ambit as the determinants of a specific innovation path vary on the base of the features relative to technological regimes (Malerba, 2005; Marsili, 2001, 2002; González-Benito and González-Benito, 2006, 2010).More findings have been identified applying the concept of technological regimes to the analysis of relation between the stakeholders collaborations and sustainability innovation development. In particular, it has been possible to identify, on the base of features relative to the

knowledge bases and to the learning process, a specific model of stakeholder engagement that varies within the different technological regimes.

Lastly, in the light of the findings and conclusions described above it is possible to recognize as for a corporate it is fundamental to become increasingly aware of the network in which the company operates in order to be able to exploit the latent potential associated to possible collaborations. Therefore, the present research work not only helps to understand the role of collaboration but indicates the need and the potential to identify stakeholders with competences and appropriate resources in order to support specific typologies of sustainability innovations. Based on the firm's strategic needs and on the typology of impact that a company wants to generate in terms of sustainability, the firms and executives can develop links and collaborations with different typologies of stakeholders.

10.7 Limitations and future developments

The research work has some limitations that it is necessary to make explicit.

- First of all, some limits are related to the quantitative analysis of the results. As described during the previous chapters the analysed sample is not very large and this may lead to results not particularly strong from a statistical point of view. In any case, the quantitative analysis is useful to verify the significance of relation identified from the analysis of the literature and the qualitative analysis of business cases. Given the small number of observations every company has a rather relevant impact on the overall results of the analysis. However, using non-parametric tests and statistical methods, it has been possible to conduct a robust analysis on not very large samples.
- Furthermore, it is necessary to make some considerations on the nature of the sample. The sample composition represents both a strong point and a limitation. The presence of two different technological regimes, the complex system regime including the automotive companies and the science-based regime composed by the electric and electronic firms, within the overall sample allows partially generalizing the results of the research work. However, the inclusion of firms belonging to two technological regimes can reduce the comparability of data. Similarly, the creation of a sample through the selection of best performer companies can shed light on characteristics and dynamics that are not necessarily common to the companies of the whole sector.
- Another limitation is related to the calculation of the sustainability performance of companies. In particular for the companies is even more difficult to define standard indicators able to evaluate the performances in the sustainability ambit. This difficulty is even more evident on the social dimension of sustainability where the development both in the corporate and academic ambit is in the initial phases.
- Regarding the technological regime approach, the main limitations are relative to the technological regime classification of Marsili. Indeed, it is necessary to analyse in a deeper way the

features defined by Marsili for the inclusion of industrial sectors in the different technological regimes. Such updating can take into consideration also new evaluation dimensions as the market demand and the external stakeholder perception of a specific sector.

Regarding the opportunities of future development for the research in this ambit, in my opinion the main opportunity to development is linked to the introduction of companies that are not included among the best performers of their sector. In this direction, it will be possible to address the attention towards different realities in terms of dimension, localization in order to study a different approach to collaboration with different typologies of stakeholders of firms very different. In addition, it will also be interesting to expand the sample in quantitative and qualitative terms, increasing the number of companies and the number of industrial sectors/technological regimes. The aspect relative to the introduction of technological regimes allows identifying many possible opportunities of development. Indeed, as shown by the academic literature, it will be possible to analyse in a more detail the features used by Marsili in order to associate the industrial sectors to the different technological regimes. Furthermore, other authors have expanded the sample of the factors considered in the characterization of the industrial sector taking into account in addition to features relative to knowledge bases and technologies also characteristics able to define the actors and the networks linked to the considered industrial sector.

Another interesting future development concerns the analysis of the role of the internal stakeholders for the development of sustainable innovations, for example the employees. Furthermore, this research has highlighted the need to consider the sustainability as an issue relative to the inside and outside of the company. From this point of view, the research of data has showed a lack of data and indicators relative to the outside of the company. Therefore, another possible future development could be relative to a detailed study of sustainability performances, their accountability and the need to extend the horizons beyond the boundaries of the individual firm.

Bibliography

Asongu, J. (2007). Innovation as an argument for Corporate Social Responsibility. Journal of Business and Public Policy, 1(3).

Ayuso, S., Rodríguez, M. Á., García-Castro, R., & Ariño, M. Á. (2011). Does stakeholder engagement promote sustainable innovation orientation? Industrial Management & Data Systems, 111(9), 1399–1417.

Banerjee S B. 2007. Corporate social responsibility: The good, the bad and the ugly. Edward Elgar: Cheltenham.

Bansal, P., 2002. The corporate challenges of sustainable development. Acad. Manag. Exec. 16 (2), 122e131.

Boons F, Berends M. Stretching the boundary: the possibilities of flexibility as an organizational capability in industrial ecology. Business Strategy and the Environment 2001;10:115e24.

Breschi, S., F. Malerba and L. Orsenigo (2000), 'Technological regimes and Schumpeterian patterns of innovation,' Economic Journal, 110, 388–410.

Carrillo-Hermosilla, J., del Río, P., Könnölä, T., 2010. Diversity of eco-innovations: reflections from selected case studies. Journal of Cleaner Production 18, 1073e1083.

Carter C.R. & Rogers D.S. (2008) "A Framework of Sustainable Supply Chain Management: Moving toward New Theory". International Journal of Physical Distribution & Logistics Management, Vol. 38, No. 5, pp. 360-387

Clarke SF, Roome NJ. Managing for environmentally sensitive technology: networks for collaboration and learning. Technology Analysis & Strategic Management 1995;7(2).

Clarkson M.B.E (1995). "A Stakeholder Framework for Analyzing and Evaluating Corporate Social Responsibility". Academy of Management Journal, Vol. 20, No. 1, pp. 92-117.

Cooper, RG (2001). Winning at New Products: Accelerating the Process from Idea to Launch, 4th ed. CambridgeMA: Perseus.

Corbett, C.J., Klassen, R.D., 2006. Extending the horizons: environmental excellence as key to improving operations. Manuf. Serv. Oper. Manag. 8 (1), 5e22.

Dahlgaard-Park, S.M., 2009. Decoding the code of excellence e for achieving sus- tainable excellence. Int. J. Qual. Serv. Sci. 1 (1), 5e28.

Day, RM(1998). Beyond Eco-Efficiency: Sustainability as a Driver for Innovation.Wash- ington:World Resources Institute Sustainable Enterprise Initiative.

Donaldson, T. and L. E. Preston: 1995, 'The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications', Academy of Management Review 20(1), 65–91.

Dosi G, Technological paradigms and technological trajectories, Res. Policy 11 (3) (1982) 147–162.

Dyllick, T., Hockerts, K., 2002. Beyond the business case for corporate sustainability. Bus. Strategy Environ. 11 (2), 30e141.

Elkington J. 1994. Towards a Sustainable Corporation: Win-Win-Win Business Strategies for Sustainable Development. California Management Review 36(2): 90-100.

European Commission. Sustainable production, challenges and objectives for EU research policy. Report of the Expert Group on Competitive and Sustainable Production & Related Service Industries in Europe in the Period to 2020, EUR19880, 2001

F. Malerba, Sectoral systems of innovation and production, Res. Policy 102 (2002) 845–859

Flynn, B., Schroeder, R., & Sakakibara, S. (1995). "The impact of quaility management practices on performance and competitive advantage". Decision Sciences, Vol. 26, No. 5, pp. 659 – 691

Foster C, Green K. Greening the innovation process. Business Strategy and the Environment 2000;9:287e303.

Garvare, R., Johansson, P., 2010. Management for sustainability e a stakeholder theory. Total Qual. Manag. Bus. Excell. 21 (7), 737e744.

Hall, J. and Vredenburg, H. (2003), "The challenges of innovating for sustainable development", MIT Sloan Management Review, Vol. 45 No. 1, pp. 61-8.

Hart, S.L., 1997. Beyond greening: strategies for a sustainable world. Harvard Busi- ness Review 75, 66e76.

Hart, S.L., Milstein, M.B., 1999. Global sustainability and the creative destruction of industries. Sloan Management Review 41, 23e33.

Heaton G, Environmental policies and innovation: an initial scoping study, OECD Report, 1997.

Jenkins R. 2005. Globalization, Corporate Social Responsibility and poverty. International Affairs 81(3): 525-540.

Jonker, J., Karapetrovic, S., 2004. Systems thinking for the integration of management systems. Bus. Process Manag. J. 10 (6), 608 e 615.

KemP R, Technology and environmental policy: innovation effects of past policies and suggestions for improvements, Proceedings Innovation and the Environment, OECD, Paris, 2000.

Klefsjo, B., Bergquist, B., Garvare, R., 2008. Quality management and business excellence, customers and stakeholders: do we agree on what we are talking about, and does it matter? TQM J. 20 (2), 120e129.

Kolk A, van Tulder R. 2006. Poverty alleviation as business strategy? Evaluating commitments of frontrunner Multinational Corporations. World Development 34(5): 789

Luke TW. 2005. Neither sustainable nor development: reconsidering sustainability in development. Sustainable Development 13 (4): 228-238.

Malerba F, L. Orsenigo, Schumpeterian patterns of innovation, Camb. J. Econ. 19 (1) (1995) 47–65.

Malerba F, L. Orsenigo, Technological regimes and sectoral patterns of innovative activities, Ind. Corp. Change 6 (1997) 83–117.

Malerba F, R. Nelson, L. Orsenigo, S. Winter, 'History-friendly' models of industry evolution: the computer industry, Ind. Corp. Change 8 (1999) 3–40.

Malerba, F. and L. Orsenigo (1993), 'Technological regimes and firm behavior,' Industrial and Corporate Change, 2, 45–74.

Malerba, F. and L. Orsenigo (1996), 'Schumpeterian patterns of innovation are technology- specific,' Research Policy, 25, 451–478.

Marsili O, Technological regimes and sources of entrepreneurship, Small Bus. Econ. 19 (3) (2002) 217–231

Marsili O, The anatomy and evolution of industries: technological change and industrial dynamics, Edward Elgar, Cheltenham, 2001.

Marsili, O. and B. Verspagen (2001), 'Technological regimes and innovation: looking for regularities in Dutch manufacturing,'mimeo, EindhovenUniversity of Technology.

Martens P, Rotmans J, De Groot D. Biodiversity: luxury or necessity? Global Environmental Change 2003;13:75e81.

Nelson R.R, S.G. Winter, An evolutionary theory of economic change, The Belknap Press of Harvard University Press, 1982.

Nelson, R. R. and S. G.Winter (1977), 'In search of a useful theory of innovation,'Research Policy, 6, 36–76.

Nelson, R. R. and S. G.Winter (1982),An Evolutionary Theory of Economic Change. Belknap Press ofHarvardUniversity Press: Cambridge,MA.

Pagell, M., & Wu, Z. (2009). Building a More Complete Theory of Sustainable Supply Chain Management Using Case Studies of 10 Exemplars. Journal of Supply Chain Management, Vol. 45, No. 2, pp. 37–56.

Pavitt K, Sectoral patterns of technical change: towards a taxonomy and a theory, Res. Policy 14 (4) (1984) 182–188.

Porter, M.E., Kramer, M.R., 2006. Strategy & society. The link between competitive advantage and corporate social responsibility. Harv. Bus. Rev. 84 (12), 78e92

Prahalad CK, Hamel G. The core competence of the organiza- tion. Harvard Business Review MayeJune 1990;79e91.

Prahalad, C.K., 2005. The Fortune at the Bottom of the Pyramid. In: Eradicating Poverty through Profits. Wharton School Publ., Upper Saddle River, NJ.

Prahalad, C.K., Hart, S.L., 2002. The fortune at the bottom of the pyramid. Strategy and Business (Reprint) 26, 1e14.

Redclift M. 2005. Sustainable Development (1987-2005): An Oxymoron Comes of Age. Sustainable Development 13(4): 212-227.

Rondinelli DA, London T. Partnering for sustainability. Manag- ing non-profit organization e corporate environmental alliances. Washington, DC: Nonprofit Sector Research Fund, The Aspen Institute; 2001.

Roome NJ. Metatextual organizations e innovation and adap- tation for global change (inaugural lecture), Centre for Sustain- able Development and Management, Erasmus University Rotterdam, The Netherlands; 2001.

Sachs JD. 2005. The end of poverty. Penguin Books: London. Schmidheiny S. 1992. Changing Course. A Global Business Perspective on Development and the Environment. MIT Press: Cambridge, Mass.

Schaltegger, S., Beckmann, M., Hansen, E.G., 2013. Transdisciplinarity in corporate sustainability: mapping the field. Bus. Strategy Environ. 22, 219e229.

Schnurr, J. and Holtz, S. (1998) The Cornerstone of Development: Integrating Environmental, Social and Economic Policies, International Development Research Centre, Lewis Publishers, Boca Raton, Ottawa.

Seelos, C., Mair, J., 2005. Social entrepreneurship: creating new business models to serve the poor. Business Horizons 48, 241e246.

Seelos, C., Mair, J., 2007. Profitable business models and market creation in the context of deep poverty: a strategic view. Academy of Management Perspec- tives 21, 49e63.

Shilling JD, Osha J. Paying for environmental stewardship. Using markets and common pool property to reduce rural poverty while enhancing conservation. WWF Macroeconomics Program Office; January 2003.

Starik M, Rands G. 1995. Weaving an integrated web: multilevel and multi-system perspectives of ecologically sustainable organizations. Academy of Management Review 20: 908-935.

Szulanski, G. (1996). "Exploring Internal Stickiness: Impediments to the Transfer of Best Practice Within the Firm". Strategic Management Journal, Vol. 17, No. 1, pp. 27 – 43

Throop GM, Starik M, Rands G. 1993. Sustainable strategy in a greening world: integrating the natural environment into strategic management. Advances in Strategic Management 9: 63- 92.

Totterdell, P, D Leach, K Birdi, C Clegg and T Wall (2002). An investigation of the con- tents and consequences of major organizational innovations. International Journal of InnovationManagement, 6(4), 343–368.

United Nations World Commission on Environment and De- velopment (UNWCED). Our common future. New York: Oxford University Press; 1987.

Van Dijk, M. (2000), Technological Regimes and Industrial Dynamics: the Evidence from Dutch Manufacturing, Industrial and Corporate Change, 9(2), 173-194.

Van Marrewijk, M., Were, M., 2003. Multiple levels of corporate sustainability. J. Bus. Ethics 44, 107e119.

Wagner,MandSSchaltegger (2003).Howdoes sustainability performance relate tobusiness competitiveness? GreenerManagement International, 44, 5–16.

WCED (ed). 1987. Our Common Future: The World Commission on Environment and Development. Oxford: Oxford University Press:. Oxford.

Winter M, Steger U. Managing outside pressure. Strategies for preventing corporate disasters. West Sussex, England: John Wiley & Sons; 1998;

Winter, S. G. (1984), Schumpeterian Competition in Alternative Technological Regimes, Journal of Economic Behavior and Organization, 5(3-4), 287-320.

Yunus, M., Moingeon, B., Lehmann-Ortega, L., 2010. Building social business models: lessons from the Grameen experience. Long Range Planning 43, 308e325.

Zhang,QandWJ Doll (2001).The fuzzy front end and success of newproduct development: A causal model. European Journal of InnovationManagement, 4(2), 95–112.

APPENDIX A: Sustainability performances

Performance values relative to the year 2010, 2011 and 2012.

- ***Automotive companies***

Performance values 2009				
N°	COMPANY NAME	Environmental performance	Social Performance	Sustainability performance
1	*VOLKSWAGEN*	4,00	4,00	3,67
2	*FIAT*	5,00	3,00	3,67
3	*BMW*	5,00	5,00	4,33
4	*NISSAN*	3,00	3,00	3,00
5	*PSA PEUGEOT CITROEN*	3,00	5,00	3,67
6	*TOYOTA*	3,00	3,00	3,33
7	*DAIMLER*	5,00	5,00	5,00
8	*FORD*	3,00	3,00	3,00
9	*SUZUKI*	1,00	3,00	2,33
10	*FHI*	2,00	2,00	2,33
11	*MAZDA*	4,00	3,00	3,33
12	*GMC*	3,00	1,00	1,67
13	*ISUZU*	2,00	1,00	2,00
14	*HONDA*	2,00	3,00	2,67
15	*MITSUBISHI*	1,00	3,00	2,33
16	*YAMAHA*	2,00	2,00	1,67
17	*RENAULT*	3,00	4,00	3,33
18	*KIA*	4,00	5,00	4,00
19	*TATA*	4,00	5,00	4,33
20	*ASTRA*	3,00	2,00	2,67

Table 19 – Performance values 2009 – Automotive companies

Performance values 2010				
N°	COMPANY NAME	Environmental performance	Social Performance	Sustainability performance
1	*VOLKSWAGEN*	5,00	4,00	3,67
2	*FIAT*	5,00	5,00	4,33
3	*BMW*	5,00	5,00	4,00
4	*NISSAN*	3,00	3,00	2,67
5	*PSA PEUGEOT CITROEN*	5,00	5,00	4,00
6	*TOYOTA*	2,00	2,00	3,00
7	*DAIMLER*	5,00	5,00	4,67

8	*FORD*	3,00	3,00	2,33
9	*SUZUKI*	1,00	3,00	1,67
10	*FHI*	2,00	2,00	2,00
11	*MAZDA*	5,00	3,00	3,67
12	*GMC*	3,00	1,00	1,67
13	*ISUZU*	1,00	1,00	2,33
14	*HONDA*	2,00	2,00	2,33
15	*MITSUBISHI*	1,00	3,00	3,00
16	*YAMAHA*	1,00	2,00	1,67
17	*RENAULT*	3,00	4,00	3,33
18	*KIA*	3,00	5,00	3,67
19	*TATA*	4,00	4,00	3,67
20	*ASTRA*	2,00	3,00	3,33

Table 20 – performance values 2010 – Automotive companies

Performance values 2011				
N°	COMPANY NAME	Environmental performance	Social Performance	Sustainability performance
1	*VOLKSWAGEN*	4,00	5,00	4,00
2	*FIAT*	5,00	5,00	3,67
3	*BMW*	4,00	5,00	4,00
4	*NISSAN*	4,00	3,00	3,33
5	*PSA PEUGEOT CITROEN*	5,00	5,00	4,33
6	*TOYOTA*	2,00	2,00	3,00
7	*DAIMLER*	5,00	5,00	4,33
8	*FORD*	3,00	3,00	2,33
9	*SUZUKI*	1,00	3,00	2,00
10	*FHI*	2,00	2,00	2,00
11	*MAZDA*	5,00	3,00	3,67
12	*GMC*	3,00	1,00	1,67
13	*ISUZU*	1,00	1,00	1,67
14	*HONDA*	2,00	2,00	2,33
15	*MITSUBISHI*	1,00	3,00	3,00
16	*YAMAHA*	1,00	2,00	2,00
17	*RENAULT*	3,00	4,00	3,33
18	*KIA*	3,00	5,00	3,67
19	*TATA*	4,00	4,00	3,67
20	*ASTRA*	2,00	3,00	3,33

Table 21 – Performance values 2011 – Automotive companies

➢ *Electric and electronic companies*

Performance values 2009				
N°	COMPANY NAME	Environmental performance	Social Performance	Sustainability performance
1	*VOLKSWAGEN*	1,00	2,50	2,83
2	*FIAT*	3,00	3,50	3,17
3	*BMW*	3,50	3,50	2,67
4	*NISSAN*	3,50	3,00	3,83
5	*PSA PEUGEOT CITROEN*	3,00	1,50	2,50
6	*TOYOTA*	4,00	4,00	3,67
7	*DAIMLER*	3,25	1,00	2,42
8	*FORD*	2,50	2,00	2,17
9	*SUZUKI*	3,75	3,50	3,42
10	*FHI*	2,75	2,00	3,25
11	*MAZDA*	4,00	2,00	2,67
12	*GMC*	2,75	3,50	2,75
13	*ISUZU*	2,75	3,00	2,92
14	*HONDA*	3,75	3,00	2,92
15	*MITSUBISHI*	2,50	2,50	3,00
16	*YAMAHA*	3,75	4,00	3,58
17	*RENAULT*	2,50	3,50	2,33
18	*KIA*	2,50	2,50	2,67
19	*TATA*	2,50	2,50	2,33
20	*ASTRA*	3,00	1,00	2,33

Table 22 – Performance values 2009 – Electric and electronic companies

Performance values 2010				
N°	COMPANY NAME	Environmental performance	Social Performance	Sustainability performance
1	*VOLKSWAGEN*	1,00	2,50	2,83
2	*FIAT*	3,00	2,50	3,17
3	*BMW*	3,50	3,00	2,83
4	*NISSAN*	3,25	2,50	2,92
5	*PSA PEUGEOT CITROEN*	3,00	1,50	2,50
6	*TOYOTA*	4,00	4,00	3,67
7	*DAIMLER*	3,25	2,50	2,92
8	*FORD*	3,25	2,00	2,75
9	*SUZUKI*	3,75	3,50	3,42
10	*FHI*	3,00	2,00	3,33
11	*MAZDA*	4,00	2,00	3,00

12	***GMC***	2,50	3,50	2,67
13	***ISUZU***	2,75	3,00	2,25
14	***HONDA***	3,75	2,50	2,75
15	***MITSUBISHI***	2,25	2,50	2,92
16	***YAMAHA***	3,75	4,00	3,58
17	***RENAULT***	2,50	4,00	2,83
18	***KIA***	2,25	2,50	2,25
19	***TATA***	2,50	2,50	2,33
20	***ASTRA***	2,75	1,00	2,25

Table 23 – Performance values 2010 – Electric and electronic companies

Performance values 2011				
N°	**COMPANY NAME**	**Environmental performance**	**Social Performance**	**Sustainability performance**
1	***VOLKSWAGEN***	1,00	2,50	2,83
2	***FIAT***	3,00	3,00	3,17
3	***BMW***	3,50	3,25	2,75
4	***NISSAN***	3,38	2,75	3,38
5	***PSA PEUGEOT CITROEN***	3,00	1,50	2,50
6	***TOYOTA***	4,00	4,00	3,67
7	***DAIMLER***	3,25	1,75	2,67
8	***FORD***	2,88	2,00	2,46
9	***SUZUKI***	3,75	3,50	3,42
10	***FHI***	2,88	2,00	3,29
11	***MAZDA***	4,00	2,00	2,83
12	***GMC***	2,63	3,50	2,71
13	***ISUZU***	2,75	3,00	2,58
14	***HONDA***	3,75	2,75	2,83
15	***MITSUBISHI***	2,38	2,50	2,96
16	***YAMAHA***	3,75	4,00	3,58
17	***RENAULT***	2,50	3,75	2,58
18	***KIA***	2,38	2,50	2,46
19	***TATA***	2,50	2,50	2,33
20	***ASTRA***	2,88	1,00	2,29

Table 24 – Performance values 2011 – Electric and electronic companies

Appendix B: Strategic approach to sustainability

- Values obtained through the application of Content Analysis in order to define the strategic approach.
  - ✓ 1=Reactive approach to sustainability
  - ✓ 2=Active approach to sustainability
  - ✓ 3=Proactive approach to sustainability

N	*Automotive companies*	*Strategic approach*	*N*	*Electric companies*	*Strategic approach*
1	***ASTRA***	1	21	***3M***	1
2	***BMW***	3	22	***ABB***	2
3	***DAIMLER***	3	23	***ALCATEL***	2
4	***FHI***	1	24	***AMD***	3
5	***FIAT***	3	25	***BOSCH***	3
6	***FORD***	3	26	***DELL***	1
7	***GMC***	2	27	***ERICSSON***	2
8	***HONDA***	2	28	***HITACHI***	1
9	***ISUZU***	1	29	***HP***	3
10	***KIA***	2	30	***INTEL***	1
11	***MAZDA***	2	31	***LENOVO***	2
12	***MITSUBISHI***	1	32	***PANASONIC***	3
13	***NISSAN***	2	33	***PHILIPS***	1
14	***PSA PEUGEOT CITROEN***	2	34	***RICOH***	3
15	***RENAULT***	2	35	***SAMSUNG***	1
16	***SUZUKI***	2	36	***SCHNEIDER***	3
17	***TATA***	2	37	***SHARP***	1
18	***TOYOTA***	3	38	***ST MICROELECTRONICS***	2
19	***VOLKSWAGEN***	3	39	***TOSHIBA***	1
20	***YAMAHA***	1	40	***WHIRLPOOL***	3

Table 25 – Values relative to the strategic approach to sustainability