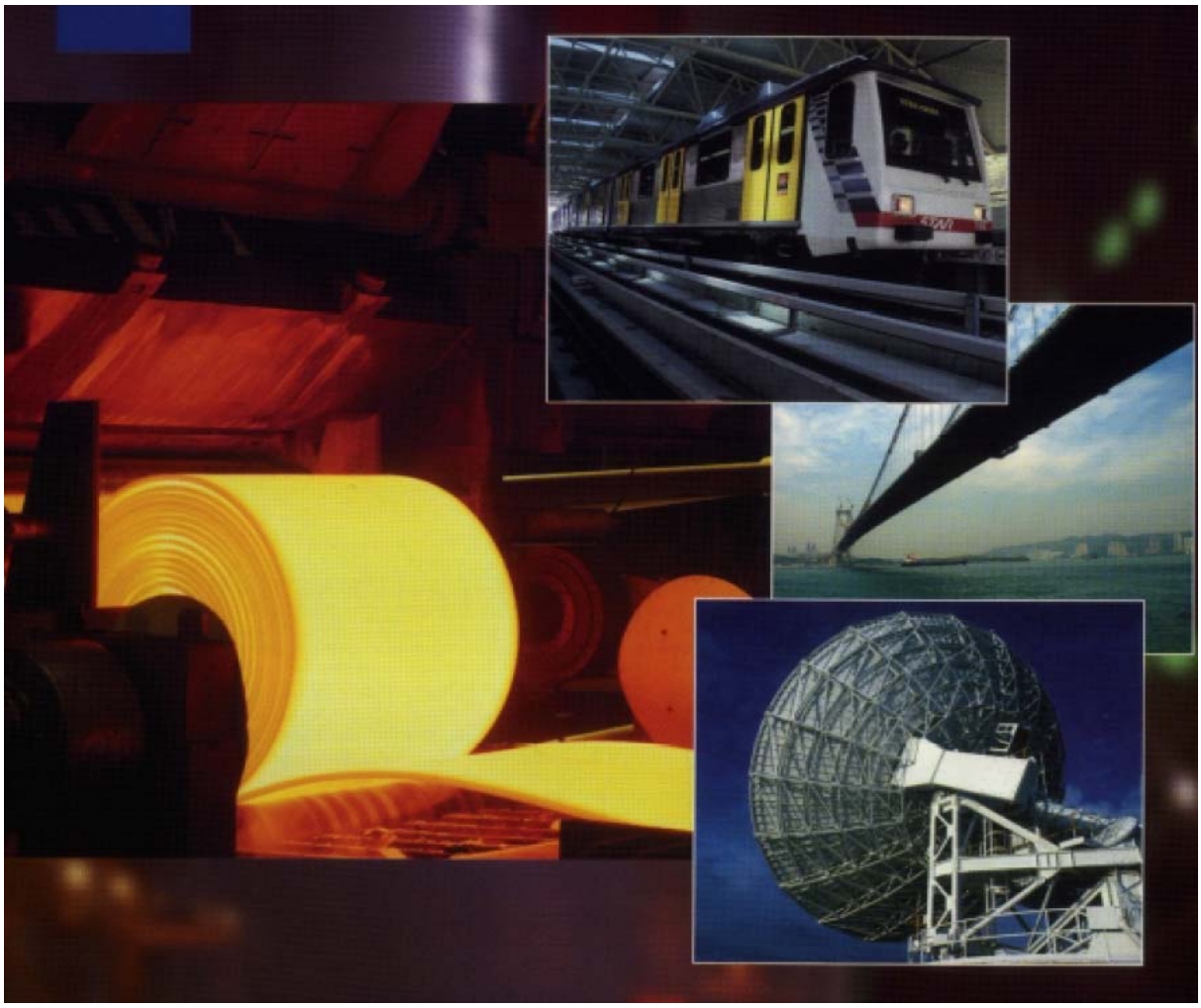
Pressure, economic competition, environmental regulation and innovation in the steel sector

With benchmark of two special steel mills



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Submitted on June 2006

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TITLE:

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ABSTRACT:

An analysis of key-underlying factors driving innovation and strategies related to improve sustained competitiveness and performance in steel industry on both economic and environment dimensions.

As component of system of innovation both internal and external aspects of competitive advantage are reviewed. It also presents the innovation linkages with both external environment and internal resources with discussion the drivers of innovation on industry as well as on firm level through two case studies. An benchmark is made on two case firms along with the discussion of their paths and strategies. In addition, there is a discussion of environment issues in steel industry with empirical analysis about potential strategies.

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PREFACE

This is the report written for the 10th semester at the Department of Planning and Development, at Aalborg University submitted on June 2006.

The focus of this paper is on exploring innovation process on sustained competitive advantage and strategies for performances improvement in the steel sector
on both economic and environmental dimensions. Most discussions further narrow down to a fast growing value added stainless steel sectors. As theoretical foundations to provide basis for wider generalization, both internal and external aspects of completive advantage are reviewed and system method is used to find the factors that determinate the innovation. A method of evaluating performance is employed to act as a tool for benchmark at firm level. Multiple cases are applied at firm level study. Sandvik material technology (SMT) is chosen as the main case study. To make benchmark, one of its competitors Tubacex is introduced as parallel case. In addition, there is a discussion of sustainable issues in steel industry with empirical analysis about potential strategies. This report provides an opportunity to reveal key-underlying factors of driving innovation and strategies related to improve sustainable competitiveness and performance in steel industry. Finally a future research agenda is presented.

Special thanks to my supervisor, Niels Dengsøe for his great help and encouragement during the writing of this report. Also thanks to Karin Östman and Bo Berglund from Sandvik material technology for giving the access to important data and information about the company.

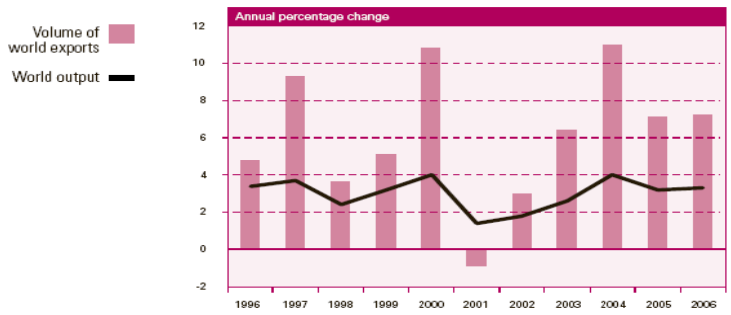
Chapter 1: Introduction and methodological framework

1.1 The research topic

1.1.1 The purpose of this research

According to UN report[1], Gross world product increased by about 3.25% in 2005 and the world economy is expected to maintain to grow at a rate of 3.5 per cent during 2006. Global economic has continued to grow despite a little sign of slow down compared with year 2004. Growth is strong in the United States, also the growth in developing economies in Asia and Eastern Europe are expected to continue. In Europe economic progress continue to be slow but having signs of increase growth. Despite the general economic growth, not all the firms perform the same in industries.

Figure 1.1: World economic growth



Source: UN 2006

There are two worlds in industry. According to Arthur[2], increasing returns are the tendency for those companies having competitive advantages to go ahead to go further ahead because this is a system of positive feedback operating within markets, business and industries. Still there is instability and it only back those making continue adjustment with market first and outstanding technology. There is also another world, Product or companies that move forward a market will finally run into limitation because the probable balance of price and market shares is reached in the selection process. Those industries under pressure for survival are a world of continues improvement, improving quality, and reducing cost. This is especial for standardized product in sizeable processing industry such as steel mills, which product primarily the similar product for on another .

Beside above competition pressures, there are governmental pressures for industries, including meeting environment standards, pressure for natural resources and energy

[1] UN, World Economic Situation and Prospects 2006, http://www.un.org/esa/analysis/wess/wesp2006files/es_2006_english.pdf
[2] Brian Arthur, Increasing Returns and the New World of Business , Harvard Business Review, July-Aug.,1996
[3] Brian Arthur, Increasing Returns and the New World of Business , Harvard Business Review, July-Aug.,1996

conservation. It is generally accepted that the world cannot go on using the resources of the planet at the present rate. The globe has scarce resources and it has only limited capacity to deal with the pollution rooted from many ways such as production, distribution, consumption, disposal etc. The most well known view of this was in the Limits to growth, published in 1972 by 'the club of Rome'.

The resource based economic growth is faced with a double challenge[4] in conditions of sustainability regarding the reproducible dimensions. There is an inherent risk of creation tangible capital in present material production; it may be threatened by a neglect of environmental sustainability. On the other hand, the production and efficient use of intangible resources, an important element of innovation, highly depends upon social capital. To face the challenges, firm needs strategy to sustain its growth and profit among their competitors.Barney argues about **sustained competitive advantage**[5], a firm having sustained competitive advantage when it is "implementing a value creating strategy not simultaneous being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefit of this strategy".More and more, people have realized that knowledge and competence are to a large degree the most significant resource of firms to keep their sustainable competitiveness in economy[6].Those findings drive people's search for balanced sustainable growth patterns.

1.1.2 Scope of study and problem formulation

This paper is focusing on sustainable growth of steel industry; an industry that has witnessed economic growth. It future narrows down to a fast growing value added stainless steel sector within steel industry. It is a sector that through the last 100 years has undergone a development that characterizes the industry as it is today. It is a big and technologically complex sector with backward and forward linkages in its supply chain in material, value and knowledge generation (see figure5.2). Different alternatives in its development strategies and its specific resources have formed the present structure.

Continued economic growth is accompanied with a remarkable increase in the use of stainless steel but combinations of challenges[7] are continuing giving pressures to this sector. First challenge faced the sector is the growing impact of globalization. Stainless sector is characterized by a strong competition in worldwide trade. Another important development is a change in the role of international capital, the effect of economies of scale are becoming essential to the success of stainless producers. Further change is the coming of new technologies such as Minimill, which significantly decrease entry barrier leading to more competitive players over the world. All those development leads to possibility of reduced margins and loss of market share for the existing firms that are not

[4] Lundvall 2002, National systems of production, innovation and competence building, Research policy yr:2002 vol:31 iss:2 pg:213
[5] Barney 1991 Firm resources and sustained competitive advantage Journal of management [0149-2063] Barney yr:1991 vol:17 iss:1 pg:99
[6] Alice Lam , DRUID Working Paper No. 98-22 'Tacit Knowledge, Organizational Learning and Innovation: A Societal Perspective' , October 1998
[7] D'Costa, Anthony P. 1999, The Global Restructuring of the Steel Industry: Innovations, Institutions and Industrial Change, ROUTLEDGE CHAPMAN HALL

prepared to adjust, the strategies with respect to changes are essential to the success of producers. The second challenge is to match steel supply to demand. The markets of stainless steels are growing increasingly, but the stainless steel industry is cyclical and the difference depending on the period and on the geographical region, besides there is always new demand in new industry segments and applications. To following the demand, a stainless producer has to undergo significant change in flexibility of product mix and methods of production etc. For those with ability to grow in a changing market, innovations in new products and process are essential. Further there are challenges from the changing of regulations and environmental concerns. For the EU steel industry, regulations with a potentially impact includes integrated pollution prevention and control permits, air quality standards and the Clean Air Act, and waste legislation on chemicals. [8] The key environment regulation for steel industry is the implementation commitments according to the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC). There is risk of European steel producers will loose cost advantage to non-EU competitors without any CO2 emissions restrictions.

To understand why the stainless sector has made above average performance in steel industry under challenges, one has to understand under what circumstances the different choices have been made and the key factors influences its evolutional change and its way to gains competitiveness on its populations.

The purpose of this study is to understand the impact of innovation on sustainable competitiveness for steel industry with the stainless steel sector in particular. The study also seeks explanations of how system of innovation contributes to improve sustainable competitiveness.

[8]Strategic Research Agenda of the Steel Technology Platform
http://www.eurofer.org/publications/pdf/2006-SRAFull.pdf

Problem formulation:

Main research question is to explore innovation process on sustained competitive advantage and strategies for performances improvement in the steel sector

The main research question is divided into four sub-questions:

- What are main factors contribute to innovation process to sustain competitiveness on different levels?
- How can system of innovation contribute to sustained competitive advantage leading to the change of performance in the sector?
- What are the roles of environmental regulations in motivating innovation contributed to sustainable development in the steel industry?
- What kind of strategies could contribute to performance improvements on sector?

1.1.3 Structure of report

For the purpose of this paper, both internal and external aspects of competitive advantage on both economic and environmental dimensions are reviewed as theoretical foundations to provide basis for wider generalization. System methods were employed to find the factors that determinate the innovation at sector and then use case study to find the underlying linkage between those factors and performances. At this stage of the research strategies which contribute to performance improvements on sector will be discussed. More broadly to find the linkage between variables of improved performance, this analysis provides a roadmap for further empirical studies.

Table 1.1: Research questions and theoretical and empirical answers

Main research question		
To explore innovation process on sustained competitive advantage and strategies for performances improvement in the steel sector		
Sub-research questions	**Theoretical answer**	**Empirical answer**
What are main factors contribute to innovation process to sustain competitiveness on different levels?	Having a theoretically reviews of both internal and external aspect of competitive advantage with the details discussion of sustaining competitive advantage especially knowledge and learning process Having presented a framework for drivers of innovation with quality linkage Sectional technological pattern is given for pattern match in empirical study	Having study actual drivers of innovation in both industry and at firm levels
	Chapter 2, 3, 4	Chapter 3, 4, 5, 6
Sub-research questions	**Theoretical answer**	**Empirical answer**
How can system of innovation contribute to sustained competitive advantage leading to the change of performance in the sector?	Having theoretically reviews of the role of system of innovation towards competitive advantage. Having presented casual linkages between drivers of innovation, innovation and performance Having reviewed performance evaluation method	Having evaluated the role of system linkages and their performances in case study
	Chapter 2	Chapter 5, 6
What are the roles of environmental regulations in motivating innovation contributed to sustainable development in the steel industry?	Having reviewed roles of environment regulation Presented environmental strategies with a linkages amongst environmental impact, regulation, innovation and economic implication	Having presented two examples with empirical data to explain the impacts of environmental regulation with cost-benefit analysis
	Chapter 4	Chapter 4
What kind of strategies could contribute to performance improvements on sector?	A roadmap leading to better performance is presented.	Comparative studies give the hints of improvement performance with different focus
	Chapter 2, 6	Chapter 5, 6

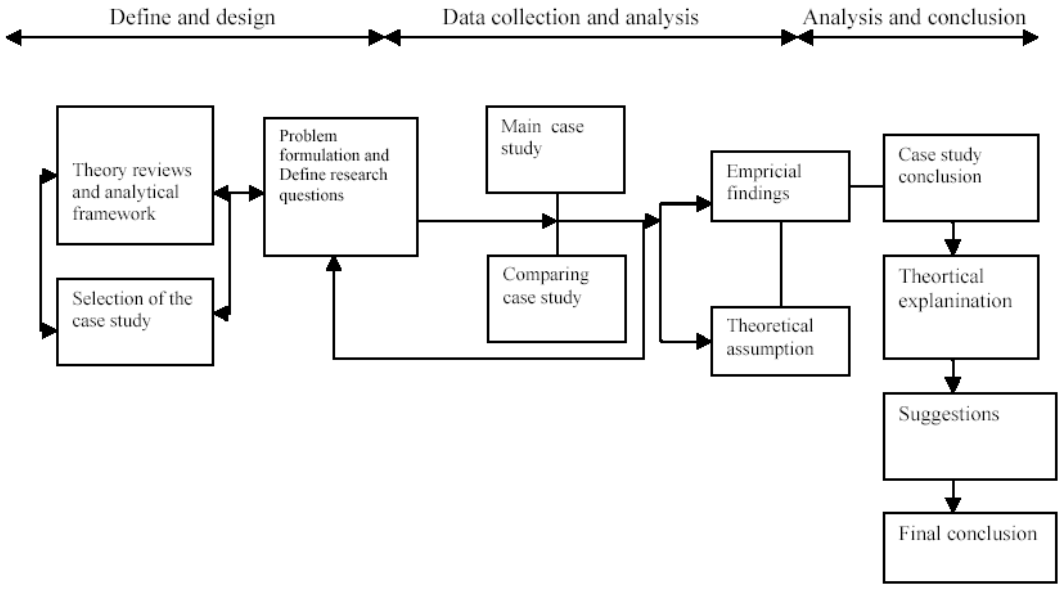
The table above gives a match of both theoretical and empirical answers to research questions.

1.2 Methodology

1.2.1 Research design

It is important to clarify the overall approach since the approach might have a great influence on the results of the study. Arbnor and Bjerke[9] suggest that it is the role of methodology to assure that the process of discovery follows a format that is considered to be scientific and which assures "the quality of developed knowledge". They have represented a simple clarification for the methodology for creating knowledge by illustrating main methodologies approach. Indeed, each person has its own view on the world and so do researchers. As a result, the research design is influenced by the scientific pattern that can be defined as 'a fundamental way of viewing and interpreting the world'. Those factor and views on the problem stated the argument of choice of the methodological approach. The choice of approach determines how the project is formed and how researchers will deal with challenges and other aspects of project writing. Different approaches have specific conceptions and ways to deal with reality through actions of the researcher.

Figure 1.2: Research design [10]



Source: based on Yin 2002

This study aims at determining how innovation can sustain the competitive advantage of at both sector and company level particular and what the drivers of the innovation are. Firms are perceived as an objective reality, which is operating among the network of different actors that influence its performance (Arbnor 1997). As innovation is a strategic

[9] Arbnor, I. and Bjerke, B. (1997), Methodology for Creating Business Knowledge, Sage, UK
[10] Yin, RK 2002 Case Study Research, Design and Methods, 3rd ed. Newbury Park, Sage Publications: 50

tool for firm to gain competitive advantages, the process of innovation cannot be put as a single process, but it involves the coordination of different processes and activities. To improve the firm's performance, better managing innovation becomes the key success factors of firms. Processes and activities are linked, better understanding and organized them is able to facilitate firms sustain their competitiveness. By having a holistic and objective view about the problem stated, system approach will be chosen as methodological base for this sector level analysis of innovation.

At firm level study, two cases are applied. Sandvik material technology (SMT), a leading firm with high market share is chosen as main unit of analysis in case study. To benchmark with one of its competitors, Tubacex is introduced as parallel case study. The purpose is to provide comparisons between the main factors influences innovation and its implication on performance at firm level .The comprehensive understanding of case comes from the description variables with significant in different aspects. It provides an opportunity to understand key underlying facts, their development paths, various linkages and room for improvement of performance. Here the theoretical dimension established is also employed to understand the case and explain the outcomes.

Unlike quantitative methods of research, in the case studies the most preferred research questions are 'how' or 'why' questions (Yin 2002). This is the preferred method for this report because of limitations of time and resources. Although the knowledge gained is about one specific firm, the goal of case studies is to reveal the versatility and true benefits of innovation. Finally the case study may offer new questions for further research.

1.2.2 Date collection methods

Due to the time limitation, most of the data quoted is secondary such as from papers, articles, journals, books, and statistics. There is a large amount of secondary data accessible in the University Library and on the Internet. In contrast, much of the information from the case studies is taken directly from the companies' own intranet and survey results.

1.2.3 Date analysis method

The case analysis is arranged around the theoretical concept and research questions. Before this case study, a theoretical framework was established and this will lead the case analysis. One way of theory testing analysis is pattern-matching logic. According to Yin (2002), it is a type of theory testing study to compare an empirically based pattern with an established set of predictions. For the explanatory case studies, Pattern matching provides a suitable way of analysis and comparing cases because established theoretical model stands for a clear theory testing approach. Here the two cases are used, by comparison their independent variables and outcome dependent variables with theoretical assumption, logical explanation will be specified.

Chapter 2: Theoretical framework

The purpose of this chapter is to find out the theoretic foundation for analysis of sector system as well as guides for the case study. It is a main interest of this paper to discover drivers of innovation process leading to the changing performances. Microeconomics based competitive advantage, resource based view and system of innovation will be discussed. A casual linkage among those drivers of innovation, innovation activities and performance will be established and this structures a framework of determinant of the innovation. Finally methods for empirical evaluation are reviewed and it will apply to case studies comparison.

2.1 Competitive advantage: different perspectives

Competitiveness is the characteristic of suitable to compete and Competitive problems[11]'deal with choice in interactive situations where the outcome of one decision maker's choice depends on the choice, either helpful or harmful, of one or more others.' It is always important to development advantage in competition in order to success.

Competitive Advantage is a firm's ability to create more economic value than the breakeven competitor in its product market. The Economic Value created by a firm during providing a good or service is the difference between the perceived benefits of its customers and the economic cost to the firm[12].

Different stream of literatures have contributed to thought of competitive advantage, however it has been strong influenced by schools of the organization economics about firm. There are a lot of definitions on strategy and their common concern is survival and deal with the changing environment. There are two levels of strategy[13]: Competitive strategy (business strategy) for a single business unit, which points toward how business manager try to win in a given industry and corporate strategy for a combination of business units usually happens in industries level, which specifies where competition take place.

2.1.1 Industrial organization's view on competitive advantage

Porter argues that competition decide the appropriateness of a firm's activities which can contribute to its performance, such as innovations or good implementation. **Competitive strategy** is 'the search for a favorable competitive position in an industry, aims to establish a profitable and sustainable position again the forces that determine industry competition.'[14]

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[11] "Operations research." Encyclopædia Britannica from Encyclopædia Britannica Online. <http://search.eb.com/eb/article-68196>

[12] Peteraf, Margaret and Barney, Jay, "Unraveling The Resource-Based Tangle", Managerial and Decision Economics, 2003, Vol. 24, 309-323.

[13] Douma, S. and Schreuder, H. (2002), Economic Approaches to Organisations, 3rd. Edition (Essex, Pearson Education Limited).

[14] Michael E .Porter (1985) Competitive advantage: creating and sustaining superior performance, Free Press: p1

Five force
In his analysis of the competitive environment, Porter developed the leading prototype in the field. It is rooted from the structure-conduct-performance model of industrial organization, which stresses that the firm can create defensive position against competitive force. Porter's works outline the framework for analysis of industry structure, put five competitive forces

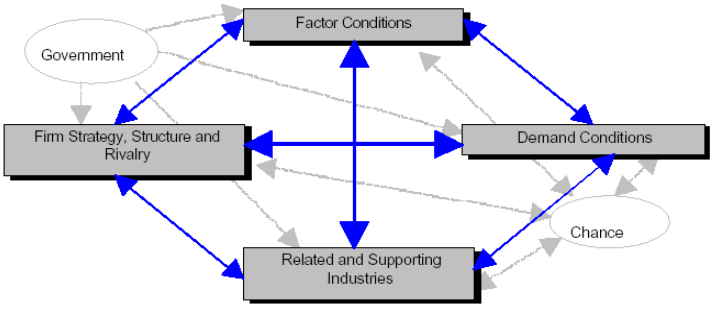
- Relations with supplier
- Relations with buyers
- New entrants
- Substitute product
- Rivalry amongst established firms

These force will take away long-term industry normal profitable. It explains the sustainability of profits against competition basis from the outside factors, its industry environment because they are able to influence the price, cost, and firm' investment (Porter 1985:5).
By connecting technology to 'five force', it is a major contribution to analysis of innovating in corporate strategy. However Porter's framework undervalues the power of technological change to alter industrial structure while it overestimates the influence of managers to choice of technological strategies. [15] First it views the strategy process as a linear causal one instead of interactive flow running from environment to position the internal organization .It fails to explain intra-industry performance heterogeneity and the reason some firms are capable of get into profitable position[16]. Second it overemphasizes external competition environment and underestimate cooperation in industry. Third Porter's strategy is about positioning a business in a specified industry structure, while "the reality of business during the 1990s is that industry structures are far from stable and are undergoing major transitions" [17]

Diamond model
Later a framework of the 'diamond' model was developed by Porter (1990)[18]. It captures five forces, a cluster based model composed of four principal determinants of the competitive advantage of industry including factor conditions, Domestic demand conditions, Firms' strategy, structure and rivalry among domestic. It was also recognized by Porter that government could have significant influence on competitive advantage via four principal determinants. Further the important of chance, a force out of our control, can direct four determinants as well.

[15] Tidd, J., Bessant, J. and Pavitt, K. (2005), Managing Innovation – integrating technological, market and organizational change, Wiley, 3rd edition.
[16] Rumelt, Richard, "How much does industry matter?", Strategic Management Journal, 1991,Vol. 12, 167-185.
[17] Prahalad, C. K. and Hamel, Gary, "Strategy as a Field of Study: Why Search for a New Paradigm?", Strategic Management Journal, 1994, Vol. 15, Special Issue, 5-16.
[18] Porter, M.E. (1990), The Competitive Advantage of the Nations. New York, NY: Free Press.

Figure 2.1: Porter's diamond' model of competitive advantage



Source: Porter 1990

Porter's diamond model of competitive advantage is a powerful tool for industry analysis but just like any other models has its limitation: when it was used to analyze the driving forces of conduct in the comparable determinants, the result would be that all firms would display similar behavior and performance. In reality the firms act differently because the firms' specific factors also play a major role to their achievement.

2.1.2 Resource based view and sustained competitive advantage

Overview

One of most important lines of research for supporting strategies management is the resource-based view .It is a fundamental contemporary approach to understand the sources that generate Sustained Competitive Advantage in a firm. It deals with the central question of the firm: why they are different and how they can attain and sustain competitive advantage by organizing their resources.

Currently much discussion on the resource based views center on the ideas of capabilities, and knowledge creating of firm. Edith Penrose had analyzed some of those issues and she is considered as the pioneering in the resource based view represented by her book 'the theory of growth of firm'. As descried in her book[19], the firm may be viewed as a collection of interchangeable resources. Furtherer and best possible pattern of firm expansion may exist, which requires a balanced use of internal and external resources in a particular order.

Two key figures, Wernerfelt and Teece in the field of study, cited Edith Penrose's work in their study and put resource-based view as a basis for analysis of competitive advantage with new approaches. Wemerfeit [20] published his article 'a resource based view of the firms 'in 1984 .It focus on the analysis of firms on the resource perspective and new strategic options for competition such as entry barriers. The firm can earn sustainable supra-normal returns if and only if they have superior resources which protected by some type of isolating mechanism.

[19] Penrose 1959. The theory of the growth of the firm, oxford university press
[20] Wernerfelt , a resource-based view of the firm ,strategic management journal, 1984

Teece [21] argues that the competitive advantage of firms stems from dynamic capabilities rooted from high performance routines operating inside the firm within its processes conditioned by its history .The dynamic capabilities as a new pattern of the modern business firm with multiple disciplines and its development will drive research topics with more details. Because the change nature of innovation, one of the closest theoretical line for attaining competitive advantage might be the dynamic capabilities approach within the interactive system context of organization and institutional which the role of position, path and processes of innovation can be explained.

Resources and sustainable competitive advantage

According to Barney[22], **sustained competitive advantage** obtained from the resources and capabilities a firm in control having distinctive characteristic of valuable, rare, imperfectly imitable, and not substitutable. These resources and capabilities can be analysis as collection of tangible and intangible assets, with a firm's management skills, its organizational processes and routines, and the information and knowledge in their control. Above the firm the resource can be broadly defined, including both tangible and intangible ones. Tangible resource includes Financial or physical resources. The intangible resource includes employees' knowledge, experiences and skills, Firm's reputation, brand name, firm's culture, and organizational procedures etc. Intangible assets/intellectual capital can be further be classified in three categories[23]: human capital, structural or organizational capital and relational capital or social capital.

A firm can gain a competitive advantage when it applies a value–creating strategy not simultaneously being implemented by any current or potential competitors[24]. The essential propositions of the resource based views is firms' heterogeneous in terms of strategic resources they own and control[25].

The growth of firms is based upon the utilization of these heterogeneous endowments of resources[26]. Barney argues (1991) if firms' resources are perfectly mobile, then firms seeking to enter this industry are able to easily acquire these resources and return, the competitive advantage of the existing firms may be in danger. Thus entry or mobility barriers become sources of Sustainable competitive advantage, only when firm resources are not homogeneously distributed across competing firm and not perfectly mobile.

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[21] Teece, DJ, Pisano, Gary (1994), The dynamic capabilities of firms: An introduction, Industrial and Corporate. Change, 3 (3), 537-556

[22] Jay barney, the resource based view of firm : then years after 1991 ,journal of management 27 (2001)

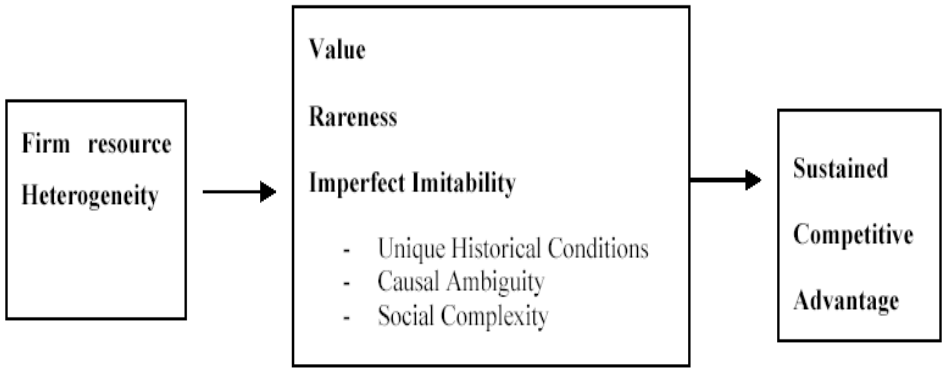
[23] Taug, J and Roberts, H.: Intellectual capital –an introduction, AMCHAM, Winter 2004
Relational capital or social capital is defined by Fukuyama in 1999 as the existence of a certain set of informal values or norms share among members of a group that permit cooperation among them.

[24] Barney, J.: Strategic factor markets: Expectations, luck, and business strategy, Management Science, 1986, Vol. 32, 1231-1241

[25] Penrose 1959. The theory of the growth of the firm, oxford university press

[26] Peteraf, M.A.: The cornerstones of competitive advantage: A resource-based view, Strategic Management Journal, 1993, Vol.14, 179-191

Figure 2.2: The Barney's framework of sustained competitive advantage



Source: Barnery 1991

Given assumption that firm resources may be heterogeneous and immobile, Barney identified empirical indicators of the potential of firm resources to generate sustainable competitive advantage

Rare resources
Barney defines the rareness of resources as a counting fact. According to Barney's analysis, the more a resource is unique the easier is for firms to generate a SCA.
Valuable resources
Resources are valuable when they are able firms to conceive of or implement strategies that improve its efficiency and effectiveness. Valuable resource can capture an opportunity in the firm's environment or neutralize some threats in that environment.
Imperfectly imitable resources
Although valuable and rare resources are two necessary attributes, they do not guarantee SCA. Firm resources can be defined imperfectly imitable or "costly-to-imitate" for one or combination of three features: unique historical conditions, causal ambiguity and Social complexity.[27]

Resource Non-substitutability and Knowledge
When Sustainable competitive advantage based on valuable, rare, imperfectly imitable resource, the ability of other firms to imitate these resources is significantly constrained. Then non-substitutability is important for firms, for the inability of competitor firms to effectively implement the same resources that are source of Sustainable competitive

[27] Foss, N.J. and Knudsen, The resource-based tangle: towards a sustainable explanation of competitive Advantage, Paper for DRUID's Learning Economy Conference, June 2000
Unique historical conditions: the ability of firm to acquire and exploit some resources depends on their place in time and space (location, know-how, experience, culture, traditions, etc)
Causal ambiguity: refer to the difficulty in duplicating successful firm's strategies. Imitating firms cannot know the actions they should take in order to duplicate the strategies of firms with a SCA.
Social complexity is constituted by social phenomena, which are beyond the ability of other firms to systematically manage and influence (i.e. the interpersonal relations among managers in a firm, a firm's culture, a firm's reputation among stakeholders, etc).

advantage in other firms. Those are element of competences, knowledge in the sense of knows how, group of skill, experience etc.

Thomas[28] defined knowledge as 'a fluid mix of framed experience, value, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information.' Knowledge[29] is a distinct as information in personalized context. It is information that is experienced, interpreted and processed by a person in a particular situation and in that way developed into insights and skills.

From the epistemological dimension human knowledge can be divided into the tacit and explicit forms. Tacit knowledge denotes knowledge with intuitive, unarticulated and it cannot be easily codified and transferred. Explicit knowledge stands for elements of human knowledge, which can be specified or communicated verbal, or in symbolic forms. While from ontological dimension, knowledge both tacit and explicit can exist in individual or collective form.[30]

To put those two dimensions in matrix give four combinations, as first suggested by Collins[31] to give rise of four categories of knowledge.

Table 2.1: categories of knowledge

	Individual	Collective
Tacit knowledge	Embodied knowledge	Embedded knowledge
Explicit knowledge	Embrained knowledge	Encoded knowledge

Source: Collins 1993

As illustrated by Thomas, Knowledge can in minds of knower and embedded in organization via document and its routine, process, practice or norms (Thomas 1998).

As intangible assets, Knowledge has non-substitutability characteristics and it is important source of sustainable competitive advantage. It has been argued by Nonake, 'in an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge.'[32]

Limitations of resource based view

Despite of the various outcomes, the study of resourced based view also suffers from a number of limitations. Less attention has been paid to the key word innovation in details,

[28] Thomas H. Davenport ,1998 ,Working knowledge ,Harvard business school press
[29] the European committee for standardization,2004
[30] Alice Lam ,1998**,** Tacit Knowledge, Organisational Learning and Innovation:
A Societal Perspective, DRUID Working Paper No. 98-22
[31] Collins,H.M.,1993 ,the structure of knowledge, social research 60/1:95-116
[32] Nonaka, Ikujiro ,1991,The knowledge-creating company , By: Nonaka, Ikujiro, Harvard Business Review, 0017-8012, November 1, 1991, Vol. 69, Issue 6

which should be a good linkage between resource based view with innovation and competitive advantage, however the development of 'Resources, dynamic capabilities and knowledge' study had led to hope that there will be more study devoted to those field, a good example is the Pavitt and Patel's works[33] "How Technological Competencies help define the Core (not the Boundaries) of the Firm".
Furthermore area is study-connected learning and innovation, for instance Nielsen, P. and Lundvall [34] published article, "Innovation, Learning Organizations and Industrial Relations". All these works are helpful for better understanding the relation between resourced based views and innovation.

2.1.3 Summary of competitive advantage discussion

Going back through discussion in section, it will give a better picture to understand competitive advantage from both internal and external perspectives. The key concept of this paper sustained competitive advantage is reviewed. From outside perspective, those factors are can be explained by five forces .it is a function of industry structure and determinates of relative position within an industry. To look inside, it is the firm specifies resources, which are the major determinants of performance different. **Sustained competitive advantage** obtained from the resources and capabilities a firm in control having distinctive characteristic of valuable, rare, imperfectly imitable, and not substitutable. Because of its heterogeneity and immobility, the intangible resource is of special importance and they are the source of sustained competitive advantage**.** The feedback route also existed; certain strategy followed by performance of firms' may alter the competitive environment and resources in certain degree. Strategy, ongoing sequence controlled by the firm resources and competitive Environment can be on the other hand viewed as external events in the environment of other firms. Further analysis of the dynamic behind the sustaining competitiveness clearly needs a more dynamic theory and better tools. Innovation study offers one of the alternatives to better understand this process.

2.2 Innovation theories

2.2.1 The concept of innovation

Famous for his theories on capitalistic development and business cycles, Joseph Schumpeter can be regarded as the founder of innovation study. In his observation the root of innovation is the process of 'creative destruction'[35].

"Innovation is a process of turning opportunity into new ideas of putting those into widely used practice" (Tidd 2005). This is a common definition of innovation characterized by notion of change. The first firm to make a technical change in a good or service or used new method or input, it is an innovator and its action is called innovation.

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[33] Pavitt, K. and Patel, (2002), "How Technological Competencies help Define the Core (not the Boundaries) of the Firm", in Dosi, G., Nelson, R., and Winter, S. (eds.) (2002), The Nature and Dynamics of Organizational Capabilities, OUP. (p. 313-333)
[34] Nielsen, P. and Lundvall, B.Å. (2003), "Innovation, Learning Organisations and Industrial Relations", DRUID Working Paper 2003 no. 7.
[35] Joe Tidd, John Bessant, Keith Pavitt (2005),Managing Innovation: Integrating Technological, Market and Organizational Change, 3rd Edition ,John Wiley & sons,p7

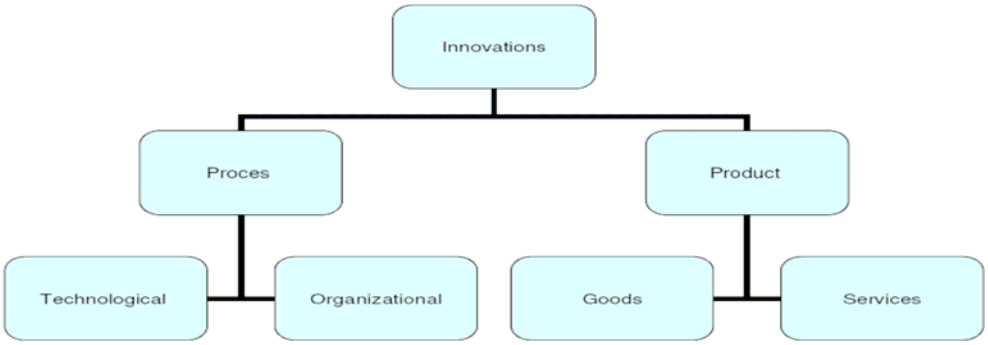
The innovation has been extensively studied and many scholars have contributed to its development. The concept can differ in its scope, the Schumpeter's version is a broad one as it refers to the idea of the 'new combination' while narrow might be restricted to the technical innovations as conceived by Nelson and Rosenberg[36]. Hence innovation study can be either on broad theoretical sense or narrow down to empirical ground.

2.2.2 Type of innovation

Regarding to innovation categories, Schumpeter classified them into five types: new products, new methods of production, new sources of supply, the exploitation of new markets, and new ways to organize business.[37]

In the DRUID Conference 2001, Edquist illustrated in his paper [38] that" different kinds of innovations can be expected to have different determinants. Product innovations may be goods or services. It is a matter of what is being produced. Process innovations may be technological or organizational. It concerns how goods and services are produced. Some product innovations are transformed into process innovations in a 'second incarnation' (or 'second appearance')." In this classification, innovation of Goods and technological process are of 'material' kind while Organizational process innovations and services are 'intangibles' kind.

Figure 2.3: Edquist's classification of innovation



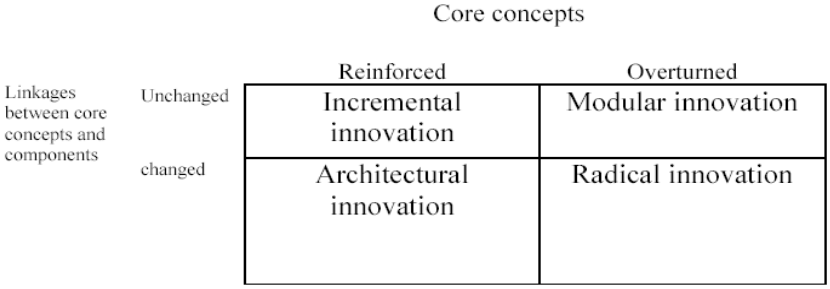
Source: Edquis 2001

The product and process innovation are most common types for empirical study. According to Edquist[39], as a direct effect, technological process innovation usually leads to productivity growth. Product innovations are a significant part of industrial Research

[36] RR Nelson, N Rosenberg,1993, National innovation systems: a comparative analysis, Oxford university press , http://scholar.google.com/url?sa=U&q=http://disciplinas.adm.ufrgs.br/adp722/TECH.PDF
[37] Swedberg, R. (1991), Joseph Schumpeter: His Life and Work, Cambridge: Polity Press
[38] Charles Edquist, The Systems of Innovation Approach and Innovation Policy: An account of the state of the art. Lead paper presented at the DRUID Conference, Aalborg, June 12-15, 2001
[39]Charles Edquist 1997, Systems of innovation: technologies, institutions and organizations : P22

& Development to the development of new or better product. Process of Research & Development intensive goods new product is positively correlated to high productivity and its growth. As source of productivity growth and competitiveness, new product development has led manager and research to pay more attention to organizational innovation as leverage.

Figure 2.4: Abernathy and Clark's classification of innovation



Source: Abernathy and Clark 1990

Abernathy and Clark [40] put forward the concept of architectural innovation 'the essence of an architectural innovation is the reconfiguration of an established system to link together existing components in a new way'. It emphases the core design concept of which each component remains the same. Further types of innovation were listed by applying concept as in the following diagram. Here the Modular innovation' innovation indicates 'that changes only the core design concepts of a technology, it is an innovation that changes a core design concept '[5].

With the respect of the degree of originality of innovations, Freeman & Perez (1988) classified it within the framework of incremental and radical innovation. Incremental innovations are taking place '...more or less continuously in any industry or service activity although at differing rates in different industries and different countries, depending upon a combination of demand pressures, socio-cultural factors, technological opportunities and trajectories', while radical innovations are 'the result of a deliberate research and development activity in an enterprise and/or university and in government laboratories'. Radical innovations 'may often involve a combined product, process and organizational innovation'.[41]

[40] Henderson, Rebecca M., Clark, Kim B. Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms , By:, Administrative Science Quarterly, Mar1990, Vol. 35, Issue 1
[41] Freeman, C & Perez, C. 1988. Structural crises of adjustment, business cycles and investment behaviour In Dosi et al. Technical change and economic theory. London, Pinter.

2.2.3 Systems of Innovation

Concept of system
A system can be understood as a set of components and their relations. Fleck (1992)[42] referred to **system** as "complexes of elements or components, which mutually condition and constrain one another, so that the whole complex works together, with some reasonably clearly defined overall function." **Technology system**[43] was defined as" a network of agents interacting in a specific economic/industry area under particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion and utilization of technology". It is a common type of system used in the industry analysis.

System theory is a source of ideas about how certain characteristic and behaviors of real system can be focuses[44]. It helps people to see the dynamic reality in a more comprehensive way and system studies have increased robustly over last few decades in many fields including business studies such as in the field of innovation. Arbnor (1997) illustrated that system theory includes systems models and relations applicable for more than one real case. Further, the analysis and recreation of real system are elements that can help the development of new system theories.

Innovation system
The '**innovation system'** concept was introduced by Lundvall [45] as a new approach for the study innovations in the economy, "the concept innovation system was introduced in the middle of 1980s to capture the relationship and interactions between R&D laboratories and technological institutes on one hand and the production system on the other hand…the interplay between firms and institution involved in knowledge production."

Later Charles Edquist[46] defined the System of innovation for institution analysis as 'the determinants of innovation process', which gathers *'all important economic social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovation'*. Highlighted the role of institutions in the functioning of innovation had been, Edquist made it clear that main components of system of innovation are organizations and institutions.

System boundary
As the scope is fundamental in the system approach because this makes identification between the inside and outside of the system, it is essential to define boundary of a system being studied and the system of innovation can be national, sectional, regional

[42] Fleck, J. (1993) "Configurations: Crystallizing Contingency", International Journal of Human Factors in Manufacturing, Vol. 3, No. 1, pp. 15-36.
[43] Carlsson , On the nature, function and composition of technological systems, Journal of evolutionary economics yr:1991 vol:1 iss:2 pg:93
[44] Ingeman Arbnor(1997), Methodology for Creating Business Knowledge, Sage Publication.Inc
[45] Lundvall, B.-Å. (2002), Innovation, social cohesion and growth; the Danish model, London, Elgar
[46] Charles Edquist ,Systems of innovations -perspectives and challenges , The Oxford Handbook of Innovation, 2005, p14

and cluster, however those can be existed at same time and supplement to each other. Those approaches are useful in interconnected study such as economic growth, competitiveness at different level.

Sectional innovation system represents an important part of innovation study.Malerba[47] gives a working definition," A sectoral system of innovation and production is a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products. A sectoral system has a knowledge base, technologies, inputs and an existing, emergent and potential demand." A number of articles have discussed relations between industry sector and the role innovation, for example Keith Pavitt's works [48],'Sectoral Patterns of Technical Change' using statistics methods analyzing the sectional patterns of technical change and innovation.

If viewed the nation as system boundary, it is called **national system of innovation** and it can be traced back to the Friedrich List's conception of "The National System of Political Economy'.[49] It was introduced by Freeman (1987) as 'the network of institution in the public and private sector whose activities and interactions initiate, import and diffuse new technologies'. Lundvall[50] clearly defined it in a broad sense as 'All parts and aspects of economic structure and the institutional setup affecting learning as well as searching and exploring - the production system, the marketing system and the system of finance present themselves as subsystems in which learning take place.'

Early in 1890, in his principle of economic, Alfred Marchall has ideas on localized industries and the industry district. Maskell [51] have discussed the relationship between industrial cluster and localized learning and innovation. Porter [52] sees **cluster** as driver of national growth and competitiveness and make a definition of clusters as

'geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate.'

Cluster, collection of domestic players, takes part in an important role in system of innovation. The significance behind is that industry clusters pool resource. Porter argues[53] that those local players strongly encourage the rapid expansion of skilled human resources, connected technologies, market specific knowledge and particular infrastructure and resulted in the significant amount of remarkable competitive success in

[47] Franco Malerba ,Sectoral systems of innovation and production, Research policy yr:2002 vol:31 iss:2 pg:247
[48] Pavitt, K. (1984). Sectoral patterns of technical cahnge: Towards and taxonomy and a theory. Research Policy, 13, 343-373
[49] C Freeman , The 'National System of Innovation' in historical perspective, Cambridge Journal of Economics, 1995
[50] Lundvall, Bengt-Åke (ed.) 1992, National systems of innovation: towards a theory of innovation and interactive learning, Pinter, London 1992: p12-13
[51] Maskell P. 2001. Towards a knowledge-based theory of the geographical cluster. Industrial and Corporate Change 10: 921-943.
[52] Porter, M.E. RESEARCH AND PRACTICE, Location, Competition, and Economic Development: Local Clusters in a Global Economy, ECONOMIC DEVELOPMENT QUARTERLY, Vol. 14 No. 1, February 2000 15-34 http://www.egs.mmu.ac.uk/users/smillington/eg3121/Porter%202000.pdf
[53] Porter, M.E. (1990), The Competitive Advantage of the Nations. New York, NY: Free Press

some business areas. This has been witnessed by worldwide in developing of industry clusters. Local government often provides favorable policies in hoping of promote the growth of regional economy.

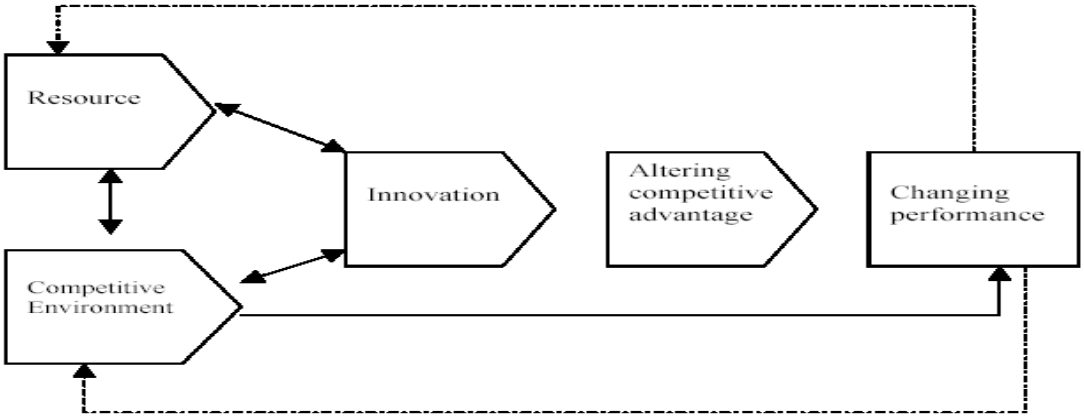
Below are some Common features of the system of innovation approaches[54]

- Innovation, learning and institution at center
- Encompasses product technologies and organization innovation
- Holistic , interdisciplinary with a historical perspective
- Differences between systems, non-optimality and Non-linearity
- Conceptually diffuse, Conceptual frameworks rather than formal theories

Those characteristic makes it possible to analyses the innovation at different levels with the combination of the framework from other theories.

2.2.4 Innovation and competitive advantage

Figure 2.5: Innovation, competitive advantage and performance



Based on Bridoux 2004

Competitive advantage is the result of innovation driven by internal and external forces. It is closely linked to innovation in two ways. By connecting technology to 'five force' externally, competitive advantage is linked to innovation. From internal perspective, firm's intangible resource characterized by Non-substitutability is a dynamic capability that provides original force in support of innovation to create new possibilities. The pattern of competitive advantage is increasingly coming to support those organizations, which can organize knowledge and technological skills and experience to make innovation in their product/service and the ways they generate and deliver those offerings.[56]

[54] Charles Equist 1997,system of innovation, Printer: p15
[55] Kay, J. (1993) Foundations of Corporate Success: How business strategies add value. Oxford University Press, Oxford.P416
[56] Kay, J. (1993) Foundations of Corporate Success: How business strategies add value. Oxford University Press, Oxford.P416

Innovation provides necessary conditions to maintain competitiveness. Competitiveness or increasing of performance is the result of innovation and they are closely related. The increase competitiveness echoes in performance or in other words, those are the result of innovative activity pushed by internal and external forces. [57]

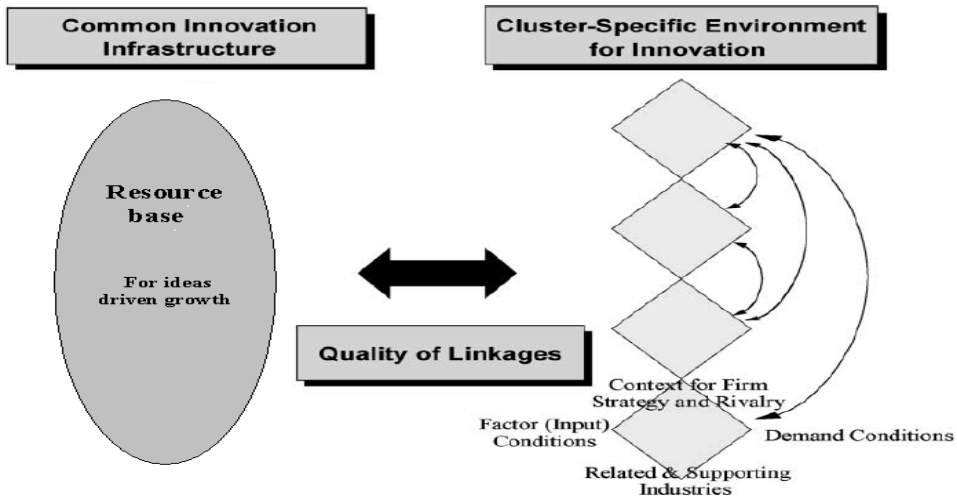
2.3 Determinates of innovations: a framework

To find out the forces behind the innovation is a complex matter, however the discussion throughout lead to the combination or complementation of both the internal and external perspectives and it can be the most important drivers behind innovation that in turn generates competitiveness. Many studies have be done in the line of industrial organization views for understand environment. On the other hand, from the resource-based view of firms, a firm's capacity to innovate also depends on what it knows, or the knowledge base. Internal source of knowledge creation covers learning by doing [59], Learning by using [60] that is through the use of products, machinery, and it is also learning by researching [61], which explains that innovation is an interactive process driven by both market forces or 'science and technology push', mainly by R&D, resulting in the creation and applying useful knowledge.

The feedback route also existed; certain strategy followed by performance of firms' may alter the competitive environment and resources in certain degree. According to Bridoux[62], given that those changes produce new information, which sequentially creates new learning opportunities and it may lead to the creation and development of new resources. Those can be further explained by the system of innovation. Hence to find the drivers of innovation, a framework with the combination of Industrial organization views, resource based view and system of innovation will give a better picture.

[57] William L.Baldwin, 1987 Market structure and technological change, Harwood Academic Publishers, page 63
[58] William L.Baldwin, 1987 Market structure and technological change, Harwood Academic Publishers, page 63
[59] Arrow, Kenneth. "The Economic Implications of Learning by Doing." Review of Economic Studies 29, no. 3 (June 1962)
[60] Rosenberg, N. 1982. Inside the Black Box: Technology and Economics. Cambridge,
U.K.: Cambridge University Press.
[61] Fischer, Manfred M. ,Innovation, knowledge creation and systems of innovation**,** Annals of Regional Science; 2001, Vol. 35 Issue 2, p199, 18p
[62] Flore Bridoux 2004, A resource-based approach to performance and competition : An overview of the connections between resources and competition
http://www.isys.ucl.ac.be/working_papers/documents/WP110Bridoux.pdf

Figure 2.6: Framework of factors drive the innovation at sector level



Source: based on Furman 2001

On the sector level, as collection of firms, main factors that driver innovation can be sector specific environment, common innovation infrastructure and quality linkage. (Furman 2002, Malerba 2002)

The framework[63] combines three blocks: the Porter's diamond model based on microeconomics competitive advantage, resource based view for idea driven growth and system of innovation, because those theories have common elements to stress drivers of innovation process.
Sector specific environment: factor of production, demands conditions, a local competitive production structure and related and supporting industry
Common innovation infrastructure: necessary conditions and resource for knowledge base and learning process such as human capital and financial resources commitments, innovation policy and stock of ideas available.
Quality linkage: Mechanisms as institutions setup facilitate potential for innovation. Those include process of generation of variety and of selection, interaction between actors in the sector.

2.4 Performance evaluation

The purpose of this discussion is to review method of evaluating performance prepared firm level analysis. Also steps to make assessment are specified, which provide tool for benchmarking the results of innovation.

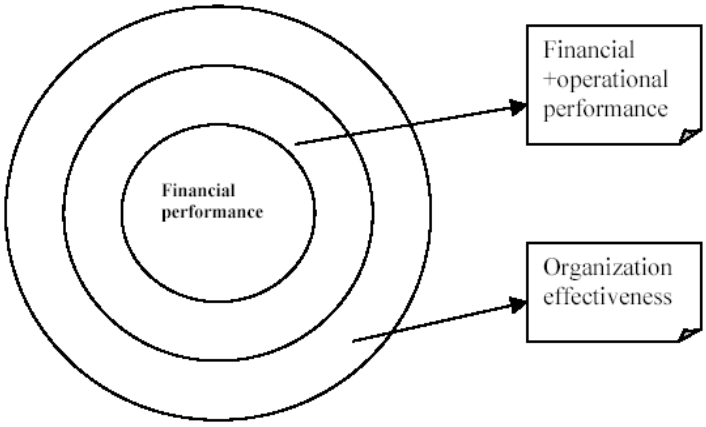
[63] Jefffrey Furman 2002,the determinatnt of national innovative capacity , Research policy [0048-7333] vol:31 iss:6 pg:899
Malerba yr:2002 Sectoral systems of innovation and production, Research policy [0048-7333] vol:31 iss:2 pg:247

2.4.1 The concept and approaches

Performance is a topic in most management studies, but in spite of a large body of literature, yet no basic agreement was reached on the definition. Performance in board sense is effectiveness of overall of organization. In the narrow sense, the working definition is usually put in relation to the scope of study; for instance, it can be the results of activities of an organization or investment over a given period[64].

Traditional performance studies are focused on narrow sense, based on the financial report. Since there is little linkage between non-financial metric and financial number, traditional accounting of performance method is inadequate to give the whole picture and for strategic decision[65]. Further these performance measures are too historical and backward looking given that they lack predictive ability to explain future performance and provide little information on root cause. In addition, they do not take intangible assets into consideration. [66] To better guide performance measurements ,it is necessary to have a deeper understanding the domain of performances.

Figure 2.7: The domain of performances



Source: Cameron, Whetten 1996

In the above figure, the three levels of performance sphere are illustrated. The basic is the a classical approach based on financial performance measures, then extended measurements combine operating performance, such as including customer satisfaction

[64] N Venkatraman, V Ramanujam, Measurement of Business Performance in Strategy Research: A Comparison of Approaches- The Academy of Management Review, 1986
[65] Robert S Kaplan, David P Norton ,The Balanced Scorecard: Translating Strategy into Action**,** Published in 1996 by Harvard Business School Press
[66] S Yeniyurt ,2003, A literature review and integrative performance measurement framework for multinational companies, Marketing Intelligence & Planning, 2003

and innovation . Further extensive field of performance reflects organization effectiveness, which can be found in strategic management and organization theory literatures.[3]

2.4.2 The development of measurements

Organization cannot be assessed directly. The performance variables, those driving the value of business[67], can help translate three-dimensional object into two-dimensional quantifiable messages. Despite this is a process with expected loss of information, a well-defined measurement can balance between accuracy and simplicity. Measurement of performance variable can help follow progress in achieving targets and it plays a crucial role in effective strategic implementation[68].

There is different performance measurement frameworks[69] designed for different organizations. The narrowest method lies on the use of outcomes based on financial indicators .which is assumed to be related to the fulfillment of economic goals of firm. For instance, a company's main operating goal is to earn a higher return on its invested capital.[70] The business performance is commonly evaluated by various profit relation to demonstrate the degree to meet its objective. Typically, these indicators are sales growth, profitability, earning per share etc. [71]

A broader conceptualization of performance would include indicators of no-financial operational performance as market share, new product introduction, product quality, marketing effectiveness, manufacturing value added and technological efficiency etc. Also there are linkages between financials performances related to environmental, strategic and organizational factors as in published studies.[72]

Reviewed by Andy [73] in terms of three generations of performance measurement systems, the development is taking dynamic of performances and transformation processes into consideration to better illustrate linkage between different performance measurements. Those new generations of measurement methods will be constructed on past developments and search for explicit linkages between the non-financial and intangible dimensions of business performance to the production of free cash flow.

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[67] Tom Copeland, 1995, valuation measuring and managing the value of companies (p104)
[68] RS Kaplan, DP Norton , Using the balanced scorecard as a strategic management system, HARVARD BUSINESS REVIEW, 1996
[69] Andy Neely, 2000,performance measurement system design
[70] Britannica Student Encyclopedia. Retrieved February 27, 2006, from Encyclopedia Britannica Online http://search.eb.com/ebi/article-202654
[71] N Venkatraman, V Ramanujam, Measurement of Business Performance in Strategy Research: A Comparison of Approaches- The Academy of Management Review, 1986
[72] Noel Capon, determinants of financial performance : a meta analysis
[73] Andy neely ,2003 ,toward the third generatio of performance measurement

2.4.3 Steps for evaluation

Defining scope
What makes one company more successfully reaching its goal is the basis question of business function. In performance analysis the key issues should cover organizational goals; variables influence the sustainable competitiveness of company built-in aspects of economic, environmental, and social dimensions. These factors link input to output and they can be found with literatures of theory probing and empirical findings. Rockmart [74] recommended the term "critical success factor" to define "the few areas where 'things must go right' for the business to flourish". These factors are potentially useful as variables in making a more precise performance analysis. Further measurement requires indicators that reflect how variable performed.

In addition, there are various linkages between financials performances and environmental, strategic and organizational factors[75], various methods such as econometric could be employed to find out the possible relationship among variables and determiners for performance.

Design or choose models
Model and tool is need for analysis performance with different focus .The choice or building of model is largely depended on the purpose of study, type of data available.

One method used by practitioners is the value driver, which shows the various levels of performance variables affecting the value of company. According to Thomas Copeland (1995) [76], on the generic level, where operation margins and invested capital are integrated, to calculate the return on invested capital (ROIC) is a better analytical tool for understanding the company's performance. On the business level, such item as customer segmentation is analyzed. Further analysis is on the operating level. Based on the input of financial information on generic level, the model is in principle a financial model .Yet in certain degree; it is also able to adapt performance measurements at different level and link short and long-term goals.

Another method is balanced scorecard. It was first described by Kaplan and Norton[77] build around the argument that companies gain sustainable competitive advantage not only dependent on developing of tangible assets alone. Since firms compete on a broader array of performance criteria[78], a balanced presentation enable the company to track both financial and no financial indicator in building dynamic capability for future growth and competitiveness. Kaplan and Norton's" balanced scorecard" combined measures of customer satisfaction, process performance, product or service innovation and finance.

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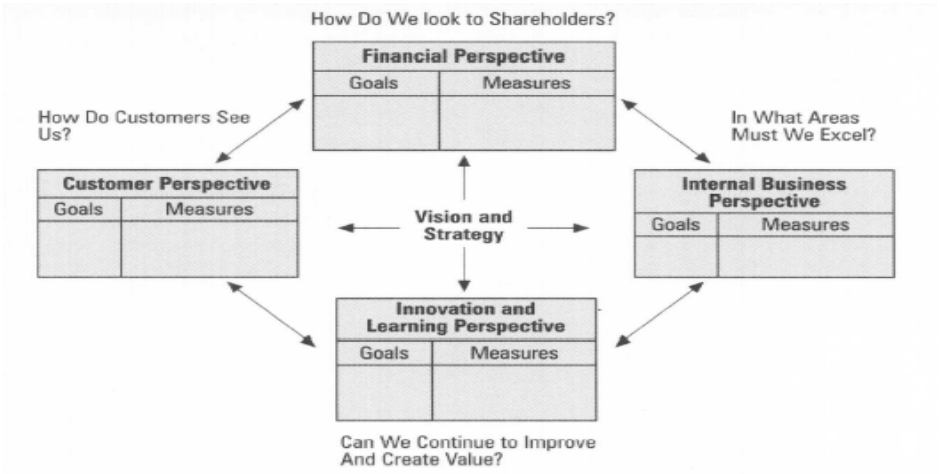
[74] S Bisp, E Soerensen, KG Grunert , Using the key success factor concept in competitor intelligence and benchmarking , Competitive Intelligence Review, 1998 vol:9 iss:3 pg:55
[75] Noel Capon 1990, determinants of financial performance : a meta analysis , Management science [0025-1909]vol:36 iss:10 pg:1143
[76] Thomas Copeland,1995 Valuation: Measuring and Managing the Value of Companies, 2nd Edition , p105
[77] Kaplan, R.S. and Norton, D.P., "The balanced scorecard - measures that drive performance", Harvard Business Review, January-February 1992, pp. 71-9.
[78] Brown, M.D., "Measuring corporate performance", Long Range Planning, Vol. 2 No. 27, 1994, pp. 89-98.

Kaplan and North also suggested using of correlation analysis to test the linkage in the scorecards.

Figure 2.8: The balanced scorecard key perspectives[79]



The causal links are the innovation and learning environment affecting the internal process, leading performance on customer perspective and finally reflecting in finical performance.

To sum up, the performance measurement starts with defining critical issues related to organizational goals. According to the purpose of study, the variables can be defined in associated with firm's sub-goals. To make measurement, a method will be choose in line with the scope of study and type of data available etc .By analysis the date, the logical linkages and significant factors related to performance will be found. Finally, the feedback of findings will help improve the organization's performance as well as the accuracy of future measurement.

[79] Khim Ling Sim; Hian Chye Koh, Balanced scorecard: A rising trend in strategic performance measurement Measuring Business Excellence; 2001; 5, 2;

Chapter 3: Analysis of the steel industry

3.1 Introductory remarks and analytical framework

Modern life depends very much on steel, which is the most widely used of all metal as engineering and construction material in the world. The increasing industry activity also needs more and more steel for industrial use. According to international iron and steel institute[80], total world crude steel on production was 960 Million Tons on December 2005, a rise of 3.8% compared to the same month 2004. Despite vast majority of steel produced in the world is carbon and alloy steel. There are many varieties of steel to fit particular's requirement.

Figure 3.1: Stainless steel products

Source: SMT [81]

Category of steel can also according to the shape of final products. It can be classified into long and flat product. Bars represent the former, tubes, seamless pipe, wire and latter are corresponded to plates, sheets, strips etc.

One important product lines is stainless steel and the more expensive stainless steels represents a small, about 3% of total steel production, but valuable niche market. With characteristic of corrosion resistant and retaining its strength at certain temperatures, Stainless Steel [82]contains at least 10.5% of chromium and it is a key element in all stainless family.

The stainless sector face challenges as stated before, a combination of globalize market selection, supply and demand, institution restrain are continue putting pressure to this sector. The purpose of this section is to find the drivers of the innovation and way to sustain the competitive advantage at sector level.

[80] http://www.worldsteel.org/?action=stats&type=steel&period=latest&month=12&year=2005
Brussels, 18 January 2006
[81] http://www.smt.sandvik.com/sandvik/0140/extranet/se02336.nsf/
(DocumentsInternetWeb)/EF396CE7B11922E0C1256E6300465EFD

To analyze steel industry with stainless sector in particular, the methodology employed in this chapter takes a point of departure from the system theory. Here the whole sector is divided into main blocks according to the theatrical framework.

- Institutional setup
- Factor of production
- Demand structure
- Competitive production structure
- Related and supporting industry
- Conditions for knowledge base and learning process

Innovation here plays a central role as it is presented as a block within the system as well as an action that might come out of the interactions. The main problem in this paper is to explore the role of innovation in sustaining the competitive advantage in steel sector. So within the framework of the system theory, the action studying here is innovation, which is supposed to process certain inputs leading to a competitive advantage output. Through the examination of the interrelations between the blocks, it aims at identifying the role of the different elements of the system in promoting innovation, or determinates of innovation.

3.2 Main blocks in the steel sector

3.2.1 Intuitional setup

Regulatory framework

Here EU was taken as examples to illustrate some regulatory frame work in steel sector.

Unified European market by ECSC [83]

One of the most important measures in post-war Europe period was the creation of the European Coal and Steel Community (ECSC). According to the agreement, member nations of ECSC promise to pool their coal and steel resources by make unified market available, lifting restrictions on imports and exports, and build a unified labor market. Following are some typical agreements.

The Article 46 of ECSC Treaty specifies that the Commission should provide detailed analyses of condition, general outlook for the steel sector and estimation of the production, consumption, exports and imports of steel, employment development and training requirements. The Article 60 of ECSC of Treaty bans the unfair competition and discriminatory price and obliges to publish price list. Article 61 of commission specifies set maximum and minimum price for common market and export .The Article 74 of ECSC Treaty is about set a quantitative limit to steel import. The agreement of ECSC has been an important step toward a health competitive in the steel industry and makes

[83] http://www.answers.com/topic/european-coal-and-steel-community

administrative guidance of steel industry possible but it also set barriers to protect outside competitors.

Environment and energy legislation
General speaking, it is a big challenge for the steel sector under the market competition to fulfill the EU's environmental legislation.

Standards
There are EU, US and special mills standards. It is a voluntary activity intended to developing technical standards, which will is a tool for manufacturers to promote their steel products.

Normative Framework
Steel production is an old and traditional industry together with the industries change. The Norms of the institution within steel sector is symbol of most economies. When the level of unemployment is particularly sensitive, governments will put every policies effort to protect against outside impact.

Compare with other industries, steel sector is capital intensive. By government investment and technological police, late industrializing countries are able to mobilize their resource to better development the industry. For example, in the Korea steel industry, it has been supported by state with high priority, giving support to preferential credit and infrastructure support, encouraging importation of know-how.

Today the global competition is an important characteristic of steel industry, however few government allows the destiny of steel industry to pure make force, which leads policies to encourage entry barriers. Also there are political reasons to set instructional obstacle to implement competitive advantage as the reluctance of government to lay off factory workers[84]. There are EU and US's efforts to protect their steel sector against the wave of globalization. The US reaction to EU policy in steel sector is strongly advised the European states to remove the barriers that restricted trade, nevertheless US imposes high tax on imported steel.

Further steel sector has a tradition of facilitating the participation of interest groups in policy discussions and setting out the objectives within a special sector of the economy. There are interest groups lobbying for certain regulation in a conflict with their interests.

It can be seen in discussions in resource based view the intangible assets of a certain firm is considered a valuable resource, as it facilitates the process of tacit knowledge acquisition and transfer within and among the collaborators, thus a competitive advantage is generated within the network. The Norms governing the institution of the industry embedded is the ways for enhancing coloration.

[84] J. F den Hertog,1999 Management of Change and Human Resources
http://www.eurofer.org/humanresources/web-en.pdf

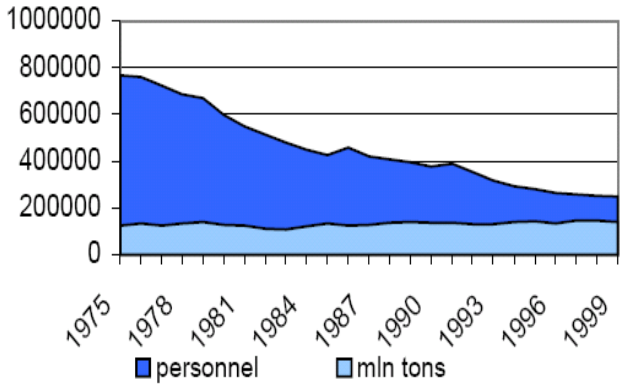
3.2.2 Factor of production

The main factors of production include labor, capital. It is assumed that Industry will stock its factor of production and seek competitive advantage and use those factors in abundance.

Labor

It is clear that a good quality labor force is a very important condition for the sustainable of steel industry. The traditional steel industry has a large-scale employer however that has been changed in order to support the measure of production costs reduction. Today the steel industry seeks to "achieving the most cost-effective production and selling of high-quality products with the smallest possible highly skilled, committed and integrated workforce"[85]. The following graph shows that in EU within the period of 25 years, the improvement of production per employee has reach 3.4 times, from 163 tonnes to 556 tonnes on average.

Figure3.2: Steel productivity in EU



Source: J. F den Hertog 1999

In general the industry belongs to middle tech and assumes their learning process mainly through learning by doing and learning by using. Although its expansion is mainly through developing a vast network of high-production mills, sales offices, and a Distribution Center, it still requires high quality labor in certain area such as their research department and equipment suppliers.

Capital

The steel industry is a particularly capital-intensive. The statistics shows [86] that cost of building stainless flat production line is about 1000 USD per ton of capacities, while long production line is about 50% higher. Product and international marketing development also need funds. In the normal case, the availability of sufficient capital loan are largely depends on the profit of industry. As the most of steel company has a growing market

[85] The iron and steel workforce of the twenty-first century, ILO, 1997, INTERNATIONAL LABOUR ORGANISATION

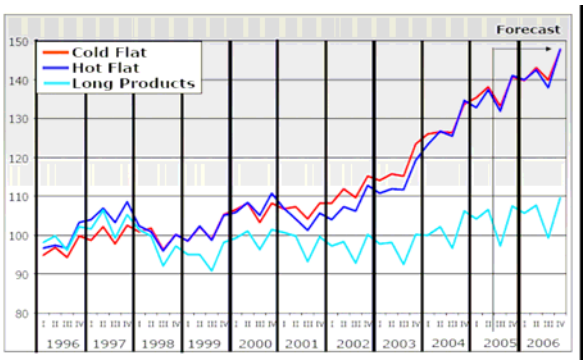
[86] SMR GMBH, consolidation in the stainless steel industry http://www.steelrx.com/consolid.pdf

capitalization rate, the recent increasing demand encourages the investment. It might supposed at the moment that availability of capital is not a big a problem especial for those existed company. Despite the coming of minimal, this does not necessarily indicates that steel industry has lower its entry barrier with respect to financing as the starting cost is still higher compared with other industry. In this respect, the suitable government industry policy will play a key role in the new investment.

3.2.3 Demands structure

Economic activity in the manufacturing sector grew[87] in 2006 January for the 32nd continuous month, while in general economy rose for the 51st successive months. Firm development is expected to continue in the US and the manufacturing area in Germany has been performing well and there are also sighs to be catching up in France and Italy.

Figure3.3: Global stainless steel demand index[88]



Demand for stainless steel is growing fastest and in the past decade, global demand has increased about 5–7% every year. The figure shows product mix statistic in the global market.

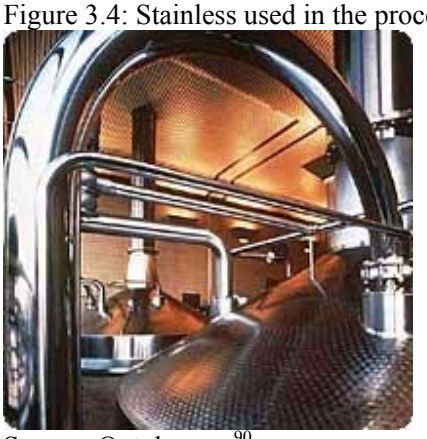
Stainless steel can be chosen for a number of reasons mainly due to its nature of corrosion resistance. It is widely used in the four growth specialist markets and the growth of related applications is the key driver of the stainless demand.

- Industrial usage
- Transportation
- Construction
- Consumer durables

[87] Manufacturing sector grows for 32nd month
http://www.manufacturing.net/ind/index.asp?layout=newsBreaking
[88] http://www.worldstainless.org/d/Global%20SCR%20INDEX%20FALL%2005.pdf

Industrial usage
The most demand of stainless is the Industrial usage mainly for the process industries, industrial machinery and equipment sector. In those applications, stainless steel offers many advantages such as corrosion resistance, Economy and safety, weight saving, and more environmentally friendly. Very large amounts of austenitic type stainless steel are used in food production and storage stainless because of the health, and sanitation consideration largely attributed to Non-contamination nature of stainless. Typical uses can be dairies, milk storage, and ham curing, frozen and salted fish storage.
The pumping and containment of oils, gases and acids has also created a big market for stainless product. Increasing demands for oil in the global market push oil and gas companies to make new investments to update their facilities on oil and gas manufactures. Special grades of stainless have been developed for the critical equipment of large scale urea plants, de-salination plants, sewage plants, offshore oil rigs and chemical tanker in the highly corrosive environments service environment.

Figure 3.4: Stainless used in the process industry



Source: Outokumpu[90]

The industrial machinery and equipment sectors consume a lot of semi finished stainless for marching parts. Their end users ranged from agriculture to nuclear power station etc.

Transportation
Stainless is used in transportation sector with huge volume and it is still increasing. The use of stainless can make the production process more cost effective, because stainless steel can form more complex components, it can reduce the number of parts and reduce environmental impact on the whole life cycle.

The primarily applications are for exhaust systems and catalytic converters with high volume. In recent year worldwide vehicle production still keeps its established production scale. With emergent markets continuing to growth, the stainless consumption in this sector is expected to have further development.

[89] http://www.outokumpu.com/pages/Page____5778.aspx
[90] http://www.outokumpu.com/pages/Page____5778.aspx

Construction sector
With the health world economy, the construction sector also benefits from growth. Benefited for its shine surface, the stainless are mainly used in the facades and building products. Another application is reinforcing bar , proving to have very good life cycle costing and free from the risk of carbon steel expanding and cracking the concrete .

Consumer durables
This sector uses a wide range of steel grades and sizes for a wide range of applications. The most common application is used in kitchen cutlery. There are other numerous applications from strip for compressor valves in refrigerator to extremely narrow tolerances material for razor blade.

3.2.4 Competitive production structure

Overview of supply
According to the news release of The International Stainless Steel Forum, there is a global increase of 1.8% of stainless steel. This indicated production of 25 million metric tons of stainless crude steel in 2005.[91]

Table 3.1: Forecast of 2006 stainless production

Forecast of 2006 stainless steel production (in '000 metric tonne)

Region	2004	2005 (p)	+/- %	2006(e)	+/- %
Western Europe/Africa	9,422	9,000	-4.5	9,500	5.6
Central and Eastern Europe	312	240	-23.1	280	16.7
The Americas	2,933	2,860	-2.5	2,950	3.1
Asia	11,897	12,900	8.4	13,750	6.6
Total World	**24,564**	**25,000**	**1.8**	**26,480**	**5.9**

Source: INSG, CRU International, Macquarie Research, November 2005

Global demand for stainless steel has grown strongly in recent years but there are regional unbalance of market growth for instance the main market Europe has experience modest growth. There is imbalance of capacity among regions, which encourages considerable trade flows between the regions despite some trade barriers. Three main stainless markets are in Asia, Europe and the Americas.

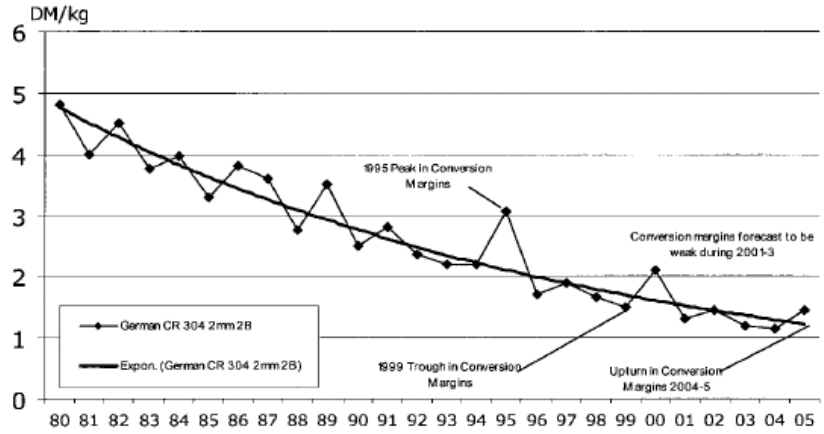
Due to the increase of Global stainless steel demand in recent years, there are new investments in new production capacity to meet the local demand. The above table shows the change of capacity in recent years and now those new production capacities has started to production. The latest news update is the start of production at the new Ugine & Alz Carinox steelworks and it will add the capacity to produce 1 million tonnes of stainless steel per year.

[91] http://www.steelonthenet.com/pdf/ISSF_Media_Release_05-Oct-05.pdf
The International Stainless Steel Forum (ISSF) ,Seoul, 4 October 2005

Further development of Stainless steel is its growing imbalance concentration in product mix, for instance the leading 10 producers of stainless flat having the 80% of market share and the biggest 10 producer of long stainless products only having 45% market.[92]

The competitive material such as coated carbon steel, aluminium, polymers and composition material can offer satisfied solution to certain application with more competitive price prose pressure to stainless sector.

Figure 3.5: Long term downward trend in conversion margins[93]



The figure shows that the conversion margin has decrease over the last 20 years, which means further and it a big challenge for the stainless sector.

Basic technology

Steel [94] is an alloy of iron and carbon includes less than 2% carbon and 1% manganese and small amounts of silicon, phosphorus, sulphur and oxygen and other alloy forming elements and. Production of primary steel by using iron ores and scrape, and production of secondary steel by using scraps only.

According to Anthony (1999) broadly three production sector exist to manufacture the entire range of those steel products

- The integrated sector by using iron ore, sinter, coal, limestone, small amount of scrap as raw material (primary steel route)
- Special steel sector with high quality alloy and stainless steel production by using scrap ,alloy and pig iron as raw material in EAF (secondary steel route)
- Minimal sector by using scrap as raw material (secondary steel route)

[92] SMR GMBH, consolidation in the stainless steel industry

[93] Pekka Erkkila 2004, trends and challenges in the stainless steel industry ,iron making and steel making, Vol. 31,no4

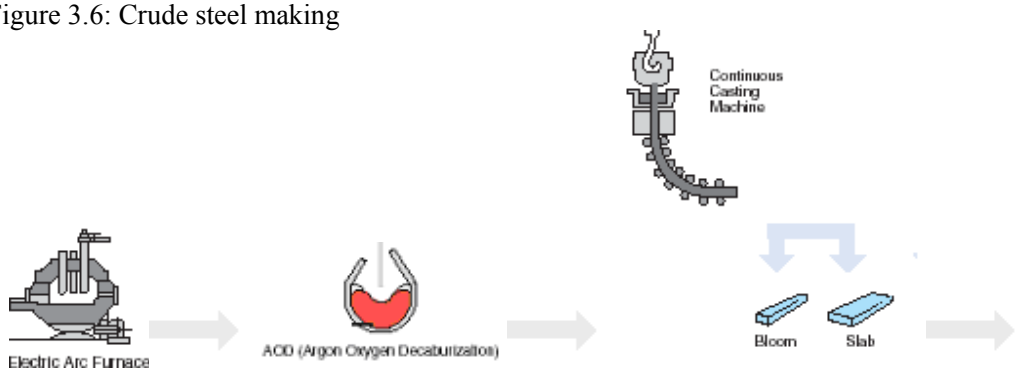
[94] " iron and steel industry ." *Britannica Student Encyclopedia* from Encyclopædia Britannica Online.

<http://search.eb.com/ebi/article-9275092> [Accessed February 16 , 2006]

Of the steel produced in 2004, 63% was produced via the primary route, 33.8% via secondary route (Source: World Steel in Figures 2005)[95]. Following discussion will focus on special steel production via secondary steel making route. Its production process is illustrated in the following graph. It starts with making of crude steel by input raw material into electric arc furnace for melting, decarburization in ladle equipment and then goes to continuous casting machine or ingot forming into bloom or slab, and finally it was sent to finished mills for final shaping for different products. It is a process with various materials and energy exchanges take place.

Crude steel marking

Figure 3.6: Crude steel making



Source: SMT

Electric furnaces.
This is the key process in special steel making and it wills determinate quality of finial product .An electric arc furnace is used steel scrap and flux. When melting, the flux forms a slag with silicon, phosphorus, and carbon impurities. In order to reduce the impurities in the steel, the slag is skimmed and more flux is added to combine with remaining impurities.

Ladle equipment
The purpose of ladle process is to remove Gases in the steel, adjust alloying contents and temperature for next process, at which equipment such as AOD is used.

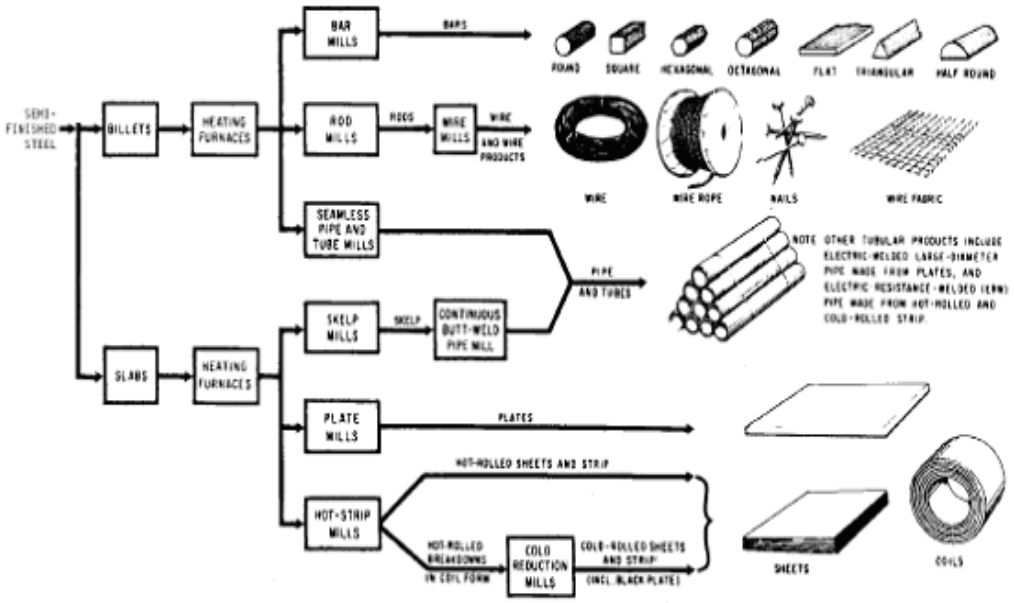
Continuous casting
Molten steel from ladle process is poured into a continuous-casting machine and it is cooled by passing through a water-cooled mold. Alternatively molten steel can be poured into ingot .At the end of process, the steel is cooled into bloom or slab

Finishing mills
The steel must still go through many processes before it is finally formed into desired final products. The differentiation route of production starts here. Here different process

[95] http://www.worldsteel.org

was used according to shape of final product. It is the place for mills to generate heterogeneous profit and competitive advantage.

Figure 3.7: Steel finishing processes by mill type[96]



Through the hot rolling, cold rolling processes, in the finishing mills the quality of steel from the continuous casting was improved, the mechanical working of steel was employed toward forming special shapes such as beams, bars, plates, and sheets prior to most finished forms of steel can be made. Finally end products such as wire, bars, tube, plates, sheets, strips, and welded pipe are made in accordance with the final specification and then they are inspected, marked and packed. Technological developments to improvement of processes and products, as well as improvement resource efficiency have been continuous with investments in new technology.

3.2.5 Related and supporting industry

Raw material supplier

It is the goals of the raw material sourcing function to achieve competitive advantage by maximizing secure of supply, optimising value of raw materials and ensuring cost-effective balance between primary and secondary supplies. If the raw material risk cannot pass to user, mill must find way to reduce production cost or development of new replacement grade.

[96] Lankford, William T., Norman L. Samways, Robert F. Craven, and Harold E. McGannon, eds. 1985.The Making, Shaping and Treating of Steel. Pittsburgh: United States Steel, Herbick & Held.

Scrap [97]
Re-cycled Scrap is the main source of raw material for making stainless steels. More than 90% of new stainless steel is produced from recycled scrap. The steel recycling system is work efficient and the market for steel scrap is well established. This re-cycling route has been established for many years and the economics of the stainless steel making industry heavily depend on recycling.

However most of stainless scrap now used is produced 30 years ago , which can not cover of growth of demand .the gap can be meet by recycling carbon steel scrap and adding of alloy mainly chromium and nickel.

Chromium [98]
As a key element in steel stainless making, the availability of Chromium is vital to stainless industry. The recent years have seen a strong recovery of prices of Chromium following several years of decline. About 17 million tonnes of marketable chromites ore were produced in 2004 but the chromites ore are quiet concentrated mainly in Africa, Europe and the CIS, Australasia and Middle East and America. Among those South Africa products about 43% of annual needs .The concentration pattern will be expected in the future and may become a bottleneck for stainless sector.

Nickel [99]
The nickel industry had recovered and faces a growing demand. Nickel consumption from stainless steel accounts for more than 60 percent of all nickel. Despite the increase demand and short of supply from time to time reflected on the recently nickel price, new reserves have been found but heavy investment will be necessary to renew and update production plant and equipment. A price mechanism to go well with market growth is required to stabilize the industry.

Energy supply[100]
Steel production by Electric Arc Furnaces (EAF) route is based on melting scrap using the energy from electric arcs. There is a significant imbalance between the EU and its major international competitors in the energy costs. It has been estimated that energy prices for industry in the USA for instance are 30-40 percent lower than those faced by European industry without any marked difference in specific energy consumption.

Equipment suppliers
Usually Equipment suppliers are specializing in certain machinery. For example[101] equipment suppliers VAI for melting and casting, Chugai Ro for reheating and annealing furnace, Siemens for control system and SMS Demag, Germany for hot rolling mill expansion. Those companies are supplier equipments around the world and put lots of technological development efforts.

[97] http://europa.eu.int/comm/environment/waste/pdf_comments/eurofer.pdf
[98] http://www.icdachromium.com
[99] http://www.lme.co.uk/nickel_industryusage.asp
[100] http://www.eurofer.org/positionpaper/energy/energy.htm
[101] http://www.outokumpu.com/

3.2.6 Conditions for knowledge base and learning process

'During a period of fifteen years beginning the mid 1930s, one of steel works (Horndal) of the Fagersta concern was neglected .No new investments were made except for a minimum of repairs and broken equipment (without modernization). In spite of this, there was an annual increase in person-hour production of two percent during this period. This is compare to a production growth per person-hour of four percent for the whole concern. In other plants of the company, significant new investments were made during this time.'

Erik Lundberg[102] bought in the 'Horndal effect' while made no attempt to explain the reason. One year later, Arrow [103]argued that this effect canonly be recognized to learning from experience productivity growth confined the 'learning curve'. Probably' Horndal effect' can be one of the early evident the essential of leaning related incremental change. Further Romer [104] argued that the distinguishing feature of the technology input is stock of human capital, non-rival, partially excludable goods, which determines the rate of growth.

As key inimitable resource, Human resource has become an essential factor in achieving competitive advantage in steel industry. The industry is becoming more knowledge-intensive. It has been estimated [105]that the total number of people engaged in steel R&D within the EU in 2000 was more than 8300. As knowledge labour, about 3.5% of the EU steel industry's workforce engaged in steel R&D in the EU.

The creation of knowledge and flow of information are crucial to the process of innovation. Innovation studies [106] have shown that innovation is a process of interactive learning between a firm and its environment, relating feedback instruments, standing for the complex interactions between different institutions in the system. Those feedback instruments are part of a constant process linking incremental change, error and modification. The common infrastructure for knowledge base and learning are human capital and financial resource available for R&D activities and policy support. Those indicates can be the number of employed skilled personal, R/D expenditure, number of international patents and policy to protect IP etc.(Furman 2001)

To maintain the technological leadership , research and innovation is important in steel industry ,which can also benefit from collaborative research and knowledge generate and share to enhanced diffusion of industrial innovation. For example, the European Coal and Steel Community had build up a network of steel R/D for research and technical development which includes the 134 research units of steel industry and its committed institutes to steel R&D, which represents about 2.4% of the workforce. The results can be evidenced by the improvement of competitiveness in whole sector.

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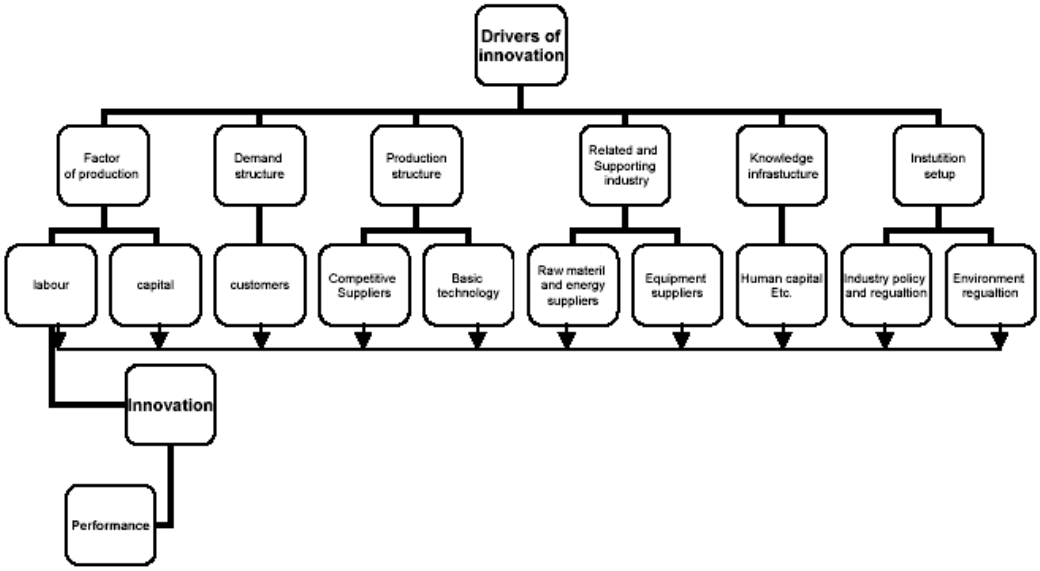
[102] Erik Lundberg (1961,131),translation by S.Herzenberg
[103] Arrow1962 ,The Economic Implications of Learning by Doing, The Review of economic studies [0034-6527] vol:29 iss:3 pg:155
[104] Romer,1991, "Endogenous Technological Change," NBER Working Papers 3210 http://scholar.google.com/url?sa=U&q=http://nber15.nber.org/papers/w3210.v5.pdf
[105] Eurofer http://www.eurofer.org/publications/pdf/2002-NetEURes.pdf
[106] Parker, Rachel, Foundations of technology development, innovation and competitiveness in the globalised knowledge economy**,** Prometheus, Sep2004, Vol. 22 Issue 3, p293, 17p

Following diagram summarizes the drivers of innovation. Those factors facilitate different kind of innovations in product and process leading changes in performance.

Figure 3.8: drivers of innovation at industry level



The subsequent discussion will focus on the interaction among drivers such as customers, competition suppliers, raw and energy supplier, environment regulations and knowledge base and leaning etc.

3.3 Sector dynamics

The evolutionary approach[107] explains dynamic of organization function and its long-term organizational evolution. It shows the interaction between organizations and their environment, which is characterized in reproduction, variety or innovation and selection of routines. George Price developed a method used for a precise analysis of the processes of selection as total evolutionary change equal to the sum of *selection effect* and *innovation effect*. Those findings give more multiform thinking in the underlying population dynamics.[108]

3.3.1 Supply and demand interactions

The most famous picture in economic is supply equal demand and they are also source of market power. As discussed earlier problem of capacity in the steel industry is usually root from imbalances such as rapid fluctuations in demand, regional supply structures and

[107] Sytse Douma, 1998, Economic approaches to organizations ,Prentice Hall,P204
[108] Andersen, E.S. (2004), Population thinking, Price's equation and the analysis of economic evolution, Evolutionary and Institutional Economics Review, 1: 127-148

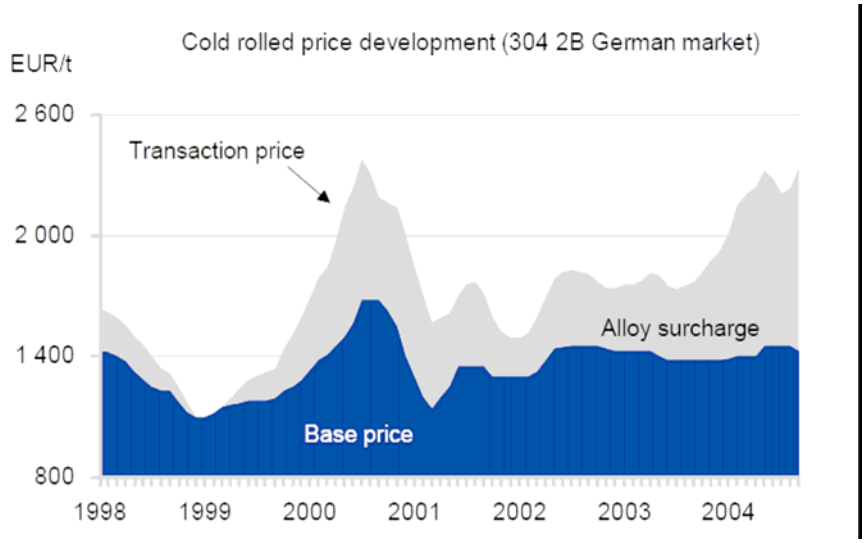
overall global overcapacity. On the short run, firms are possible to adjust their dynamic under the internal and external pressure. On the long run it is the economic cycle that decides dynamic balance of the supply and demand shaping the industry structure. With the unevenness of capacity in the geographic region as well as significantly reduction of cost for transportation, the global trade of stainless is increased .It can help release some unused capacity but also creates an atmosphere of the global competition.

The demand function is a means that 'records for each possible price of the good, the total amount buyers of good would choose to purchase '(Kreps 2004: 26). When a firm having power in an imperfectly competition market, it can decides the price of its product and sell according to demand, a firm is price creator. In a perfectly competition market, a firm is an a price taker of established market price and by means of supply and demand function the firm only has control over level of the supply. Some firms go to globalization but decrease the price to meet the competition, while others stick to local market to maintain their price level

3.3.2 Interaction in the Supply chain

Demand for stainless steel is subject not only to fluctuations in actual end-user demand because the large quantity of stainless is for expansion. Stainless steel depended heavy on the external suppliers for the raw materials. Those materials mainly nickel and Chromium alloy, scrap and energy which constitute the most cost of final product.

Figure 3.9: Alloy surcharge development[109]



Recently rising of raw material price, especial the nickel had increased a lot, has considerable influenced on stainless final price. If the price can not pass to the customer, it will result in lower the manufacturer's profit. Further speculation activities of stockists increase the instability of the market. Firm can choose to more cooperate with supplier or vertical merge to control the risk or choose to reduce production.

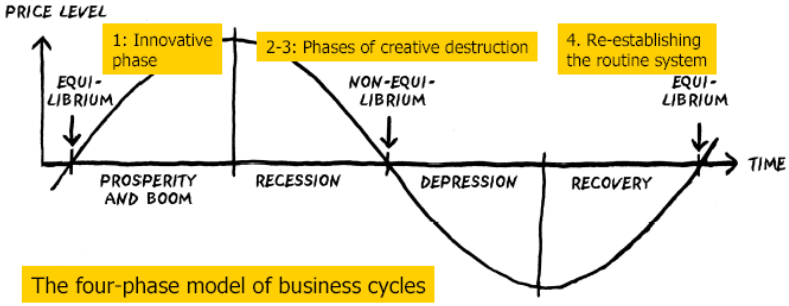
[109] http://www.outokumpu.com/18753.epibrw

3.3.3 Product mix development

According to Nelson's reviews (1995) [110], On long run, diversities on evolution on economic change can be analyzed to a great extent via the key evolutionary processes of selection and variety creation ,further interaction of factors in those processes , like economic variety driving economic selection or the other way round , will significantly shape industrial dynamics. There are complex set of interdependencies under the pressure the industry must make necessary adjustment, such as measure of product processed rationalization, Reduce cost and increase applications.

Malerba [111] states there are two different types of technological classes, Schumpeter Mark I and Schumpeter II to be related to technological advantage. There are different pattern influence the way of structured and organized the innovative activities reflecting in specific development path.

Figure 3.10: Business cycles[112]



Schumpeter Mark I is characterised by 'creative destruction' with little difficulty of technological entry and those innovative activities is mainly played by entrepreneurs and new firms. Increasing returns are the tendency for those companies who go ahead to go further ahead, for those loses advantage to lose further advantage and this is a system of positive feedback operating within markets, business and industries. This is typical of innovative phase of business cycle. However increasing return is an instable situation in knowledge base and backs those with market first and superb technology. [113]

Alternatively Schumpeter Mark II is characterised by 'creative accumulation' predominance among large established firms with relevant barriers of entry for new innovators. Product or companies that progress in a market will eventually run into limitation because the expected balance of price and market shares is reached through selection. This is especial true in scale intensive processing industry and there is typically standardized product, which is substitutable for on another. Those industries are a world of optimization, improving quality, and cutting down the cost.

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[110] Nelson, Richard R. ,Recent Evolutionary Theorizing About Economic Change**,** Journal of Economic Literature, Mar 95, Vol. 33 Issue 1, p48, 43p

[111] Franco Malerba, 1995, Schumpeterian patterns of innovation, Cambridge journal of economics [0309-166X] vol:19 iss:1 pg:47

[112] Esben Sloth Andersen, http://www.business.aau.dk/evolution/micro/mike/notes/MIKE_DE10.pdf

[113] Brian Arthur, Increasing Returns and the New World of Business , Harvard Business Review, July-Aug.,1996

As a mature industry, on the whole the stainless industry belongs to Schumpeter Mark II world. However the niche producers seek economic of scope and those general stainless steel producers seek the economic of scale, there are some character of Schumpeter Mark I of 'creative destruction' aiming to have increasing return.

One development is continuous enlargement of the standard products with high volumes seeking economic of scale. General Stainless makers serve the markets for quality standard stainless steel. The dominant grades are 300 series such as 304L and 316L types, which dominate the stainless market. The main customers of common Stainless are in the industrial segments such as process, construction. The purchaser can be end-users, fabricators and stockist. As standard product, it is high volume business in competitive market. The competitive price and reasonable delivery time is the key for the customer's purchase decision, while manufactures' cost efficiency in production is vital for their success. They continue expanding to seek economic of scale to reduce unit cost one way is to reduce the fixed cost is integrate, however it need years for those few producers to established their firm market position.

On the other hand, niche producers seeks the economic of scope, focusing on differentiae and segmentation of market to meet the detailed specification, such as chemical composition, mechanical properties and tolerance in demanding application. It can in flat and long form used in the key equipments used in facilities of making urea, petrochemical, chemical and nuclear reactors representing project type business. Niche producers require frequent coordination with their customer with the supporting strong R&D and know-how in delivering customized solutions. This is a typical interactive learning process between producer and user. The differentiated producer has certain market power for lack of demand substitute in market. When the businesses are choose to further specialization and an increasing focus on value-adding solutions, which might provide higher returns but attentions should be paid to maintain competitive cost structures by reduction of fixed cost. Niche manufacturer is a world of differentiation and further specialization, which provide firms in a better position to compete among rivals because their competitiveness includes certain element of intangible resource, which are rear and not easy to imitate.

Table 3.2: Product mix[114]

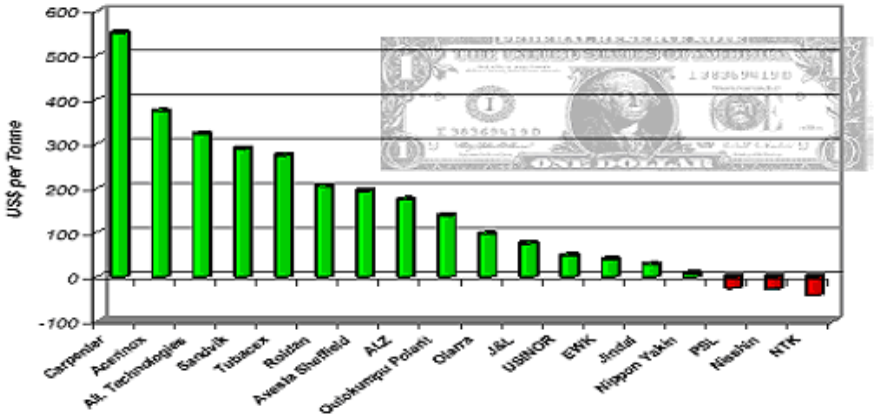
	Flat product	Long product	
Austenitic (300 series)	52.2%	22.5%	75%
Ferritic/Martensitic (400 series)	19.2%	4.8%	24%
	71.4%	27.3%	99%

[114] http://www.bhpbilliton.com/bbContentRepository/Presentations/MiddleburgFerrochromePresentation.pdf

There are a dynamic yet rather stable product mix with different product types and grades in the market with mixture contribution of general and special stainless producers. Those are the dynamic of evolution of industry in real world. The processes of evolution[115] decide the range of actually innovation and process adjusts the relative economic important of the competing alternatives. The key lies in dynamics and they are related to the makeup of competition, configuration of firms, their ability to adapt the environment, and their choice of generic strategies etc.

3.3.5 Different in performance

Figure 3.11: Profit or lose per ton of stainless steel products



Source: SMR[117]

Above picture shows that the performances of plants are different a lot with unequal efficiency spread in different regions.

The commercial grades are over-capacity on the global market; hence the average profit level is lower. There are sign to show the oversupply of standard grade in European due to the increase in global production capacity and slow growth in European demand**s.** Another reason influences the profit is the raw material price. For example, the historically high nickel price has slowed in demand in high nickel content austenitic stainless steel in recent years. The end user and designer institution have to actively looking for alternative stainless steel grades or other materiel for replacement in some applications, and there are also tendency of delaying the replacement in maintenance. [118]

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[115] Giovanni Dosi, Nelson, Richard R, An introduction to evolutionary theories in economics, J Evol Econ (1994) 4:153 172

[116] SMR GmbH Consolidation in the Stainless Steel Industry http://www.steelrx.com/consolid.pdf

[117] SMR GmbH Consolidation in the Stainless Steel Industry http://www.steelrx.com/consolid.pdf

[118] http://www.steelonthenet.com/pdf/global_steel_consultants_26-Jan-06.pdf

On the other hand, value added grades with demanding application expected more are still under capacity because those production need more know-How, new R/D and investment in facilities but they are. For instance, North America, Europe and Japan have very well-organized operations and their products are much high in quality, value-added despite their product cost can be US$100-150/tonne more expensive than those regions with cost advantage such as iron ore and coal, energy and labor. (Costa 1999).

3.4 Discussion of stainless sector

The following discussion will focus on the general pattern of middle tech sector and give an overview of innovation activities in stainless sector .It serves a basis pattern for case study analysis.

3.4.1 The character of innovation in middle-tech sector

The course of innovation can be distinguished by industry section. According to Pavitt [119] study, the industrial sections can be divided into Supplier dominated; Production intensive and Science based on their technology characteristics.

Table 3.3: Production intensive industry determinants, directions and measured characteristics

Category of firm	Source of technology	Type of user	focus of innovation	Diversification
Scale intensive	PE, supplier	Price sensitive	process	High vertical
Specialized suppliers	Design , development users	Performance sensitive	Product	Low concentric

Source: Pavitt 1984

Steel industry belongs to production intensive industry and it can further divided into scale intensive and specialized supplier. For the specialized suppliers, their dominated innovation is product innovation. Most of their technologies come from design and interactive learning of development of users which are performance sensitive. This is the situation of niche producers in stainless steel sector.

For the scale intensive suppliers, their dominated innovation is process of production. Most of their technological innovation comes from their upstream suppliers and their users are usually price sensitive. The standard producers in stainless steel sector belong to the scale intensive type having mature production practices, where technologies and market feedback conditions may change more slowly and they are usually managed to do as in the past however as carrier industries of technology, they also gain from new technology diffusing across the industrial.

'In low and medium tech industries, there is usually relatively little formal learning by science and technology. Instead innovation and adoption related learning activities operate in practical and pragmatic ways by doing and using'[120] .The bulk of new technologies developed by separate companies hence they need to have absorptive

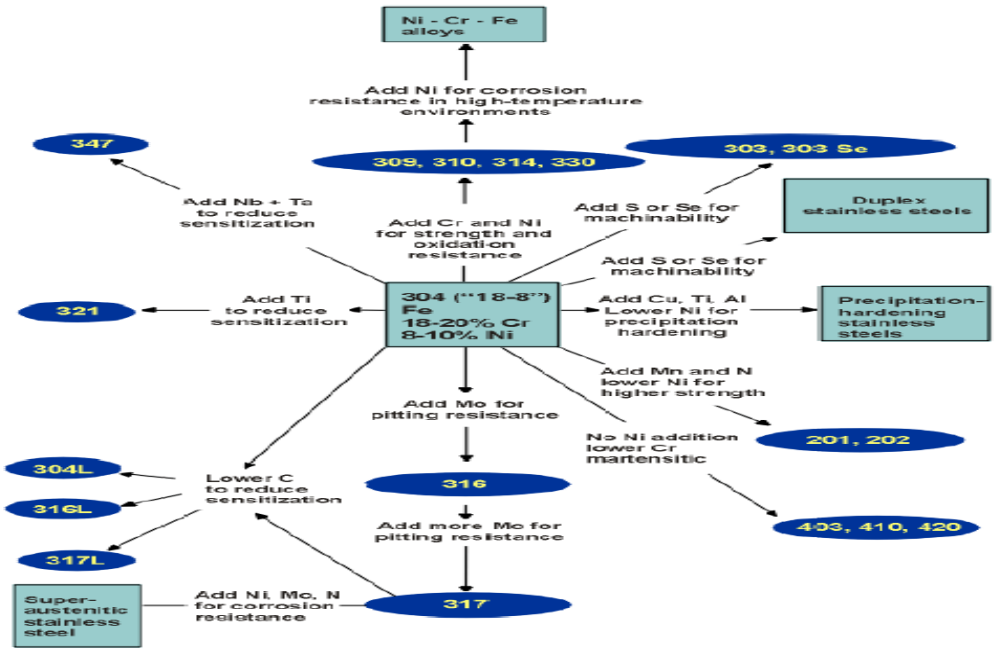
[119] K Pavitt .Sectorial patterns of thecnical change. Toward a taxonomy and a theory - Research policy, 1984
[120] Nick Vontunzelmann ,Virginia Acha,2005, innovation in low tech industry,the oxford handbook of innovation P417

capacities to make productive use of their upstream innovations. Stainless sector is faced more specific demands owing to the development of its downstream industries. With coming of new applications, Steel producer must develop specific capacities to generate not just from R/D but form broader based innovative activities that include engineering, continuous improvement processed and organizational innovations such as integrated service and supply.

3.4.2 Innovation in stainless sector

Product innovation in stainless sector

Figure 3.12: Stainless steel grade development[121]



Source: Edstrom

Stainless steels were developed in the beginning of 20th century, it was discovered that by adding chromium to iron, an alloy formed which make steel have corrosion resisted character. Years later, researchers also found that by the adding other particular elements such as nickel, molybdenum, and the corrosion resistant can be further improved. The first commercial production of stainless steel was made in early 1910s and it is austenitic stainless grade 304, which offered excellent corrosion resistance and good high temperature strength. According to the preferred alloy characteristics, elements are added or subtracted to 304 stainless steel. The figure above provides a roadmap of expansion of stainless steel grades family linking between compositional and property.

The further development of stainless steel can attribute to the different demands and the industry must respond quickly to its customer's requirements. Those examples include

[121] http://www.edstrom.com/Resources.cfm?doc_id=129

the military industry during World War I, the development of the food process industry. Those demands directly pushed the researching the new steel grade in the special service conditions.

Until recent year Steel grades for demanding application is still the priority for product development however without the development of new process, the potential requirements may never be met. Taking the process development as example, in 1970s the coming of new AOD process made the stainless producers possible the creation of low carbon grade 304L, 316L and duplex family to meet further the development of pulp industry.

Production process innovation in stainless sector

Over years, basis stainless route has not change a lot; followings are the most significant changes in its stainless steel sector (Costa 1999)

- Commercial application of electric arc furnace

Beginning 1890s, Electric arc furnace (EAF) led to the revolutionary use of scrap as main raw material in melting and purifying process. It also facilitates the coming of minimal for small-scale production with significant reduction of entry barriers in this sector.

- Continuous casting [122]

It revolutionized steel production by replaced the discontinuous of stainless casting technique in 1968. The advantages of method are the quick solidification and significantly reducing of home scrap more than 10%. This process also saves a lot of energy because it bypasses several stages in production. Now the continuous casting process is further developed and it is used strip casting in production scale operating in Germany, USA, Italy and Japan.

- Development of Refining technology to improve quality

The effort to develop low carbon stainless is an outcome in commercial use of new refining technology. The most important process innovation is the AOD (Argon Oxygen Decarburization). In the middle of 1970s, (AOD) technology was used for stainless steel production of converter-refining procedure for reducing the carbon content of the molten metal by blowing in argon and oxygen.

Process technological evolution is of fundamental important to the stainless steel industry because it can influence the cost of production, product quality and reduction of the environment impact and resource consumption. It also provides necessary conditions for advance new product development.

Latest trend[123] is to bypass or eliminate process intended for the cost saving.

- New technologies for streamlining existing facilities
- Innovative steel making and finishing route
- Process control and product quality assurance

[122] Bela Gold 1980, Evaluating technological innovations,LexingtonBooks,Massachusetts Toronto
[123] Eurpfer 1999, Technology Road Map to determine the research priorities of the European steel industry http://www.eurofer.org/publications/pdf/1999-RoadmapForResearchPriorities.pdf

Organizational innovation in stainless sector

Figure 3.14: Capacities development

Capacities of top 10 melting shops in 2001 and 2006 (projected), kt/year: source CRU

2001			2006		
Posco	Pohang	1273	Posco	Pohang	1736
AST	Terni	1000	Outokumpu Stainless	Tornio	1667
Acerinox	Palmones	932	AST	Terni	1550
Yusco	Kaohsiung	930	ALZ	Genk	1200
KTN	Bochum	760	Acerinox	Palmones	932
Outokumpu Stainless	Tornio	637	Yusco	Kaohsiung	930
Ugine	L'Ardoise	630	KTN	Bochum	760
ALZ	Genk	600	NAS	Carrolton	700
Outokumpu Stainless	Avesta	600	Ugine	L'Ardoise	630
Outokumpu Stainless	Sheffield	600	Outokumpu Stainless	Avesta	600
Average		796			1070

Source: CRU from Erkkila 2004

As the nature life cycle, product innovation seems to be the more essential part of technological innovation. As source of productivity growth and competitiveness, new product development has led manager and research to pay more attention to organizational change as leverage. Organization change as kind of important process innovation is also crucial for the advancement and applying technological innovations.

Challenges ahead

Due to the result of nature selection and change, the evolution of industry structure is becoming more concentrated and this is especial true for stainless flat producers. Because of its mature in technology, stainless sector put most of its efforts related to meet segmented demands and increase competitive by improving quality, enlarging applications and cost saving measures, however there is still considerable possibility for innovation by development of steel making and finishing technologies as well as product properties in particular (Erkkila 2004)

- Cost reduction to combat pressures from competitive materials.
- Conservation and most efficient use of raw materials and energy to

Minimise resource consumption.

- New production control technologies to improve performance, yield, quality, and Working conditions and to increase work safety.
- Recycling of end-of-life products to minimise environmental impact.
- New and higher quality steel grades to make the sector more responsive To market changes.

3.5 Summary

3.51 Strategies for sustaining competitiveness

Growth and profit are ideas of firms. The making of products is not the final goal of a manufacture and it has to decide how much of a product to make or sell and choose to maximize its profit. The profit obtained by a firm is determined by its revenue from

selling and its total cost function.[124] To increase sales and to reduce costs is the two basic ways of developing a firm's profit.As the firms always have strong incentive to reduce costs, it is a force to affect firms' competencies, behavior and its organization pattern.

There are generic market strategies for firms, overall cost leadership, differentiation and focus on the choice of narrow competitive scope within the industry .When market sees no difference among the goods from different producers, the good is commonly referred to as a commodity. When a product is differentiated, then the market does not view it as complete alternatives. A firm can choose orientation of its product and it reflects it generic strategy but it does not imply that niche strategy is always a better strategy.

'The objective in running a business is the long term, evolutionary success of the firm….need a broader vision of what it is we are trying to do.'[125]

The difficulty about specific strategy is its potential of sustainability and limitations. According to Porter (1985), strategies whether to focus on economic of scale or scope have risk of being the imitated by competitors, changing technology and evolution of demand.

Table 3.5: Risk of generic strategies

Risk of cost leadership	**Risk of differentiation**	**Risks of focus on certain segment**
Competitors imitate	Competitors imitate	Structure erodes Demand disappears
Technology change	Bases for differentiation became less important to buyers	Broadly targeted competitor overwhelm the segment
Cost focusers archives even lower cost in segments	Differentiation focusers achieve even greater differentiation in segments	New focusers sub segment the industry

Source: Porter (1985:21)

It is important for firms to posses some barriers that make imitation difficult. According to the resource based view, possession of certain intangible resource can make competitor difficult to imitate. People are more aware of that knowledge and competence are to a large degree considered to be the most significant resource of firms and economic. Also there is awareness that the knowledge process can help firms 'keep their sustainable competitiveness'[126]. Knowledge base and learning process provides necessary condition for firms to deal with challenges in competitive environment.

[124] David M. Kreps, Microeconomics for managers , New York, N.Y. : W.W. Norton & Co., 2003:p71
[125] Citigroup 's John Reed and Stanford's James March on management research and practice, academy of management executive, Vol 14,No1 2000
[126] DRUID Working Paper No. 98-22 'Tacit Knowledge, Organizational Learning and Innovation:
A Societal Perspective' by Alice Lam October 1998

3.5.2 Reviews drivers of innovation

To revisit the drivers of innovation, those are the factors facilitate different kind of innovation in product, process which finally change the performance.

The external environment affects innovation process

To look at environment, it is market forces and pressures reflected on tighten regulations that generate the innovation. The more challenging target demands and the increasing market competition triggers improvement of production process, structure adjustment of industry such as consolidation. The globalization pressure call for more efficient mills and it also triggers the organization change such as merge companies. Fluctuations in raw material & energy price and environment regulation further constraint industry development and it push industry make more efficiency use and explores new resources which require firms having enough information, finical and logistic support.

Relation between resources and innovation process

Innovation process calls for development of internal capability. The necessary conditions for realize those goals include the well development of related and supporting industry , skill labor force and accumulated knowledge infrastructure at industry level.

According to Cantwell[127] competitiveness can represent 'the possession of capabilities need for sustained economic growth in an international competitive selection environment' and such capabilities are produced during innovation. The author goes on to say that in the industry level, factors influence competitiveness can be resource or capabilities, institution, market or demand condition, and inter company networks. These arguments support the finings in this paper that fundamental drivers for innovation in stainless sector are its target demand, production structure and availability of rear resource rear such as Knowledge stock

[127]John Cantwell, Innovation and Competitiveness in Fagerberg 2005, the Oxford handbook of innovation, 2005 Oxford University Press, P544

Chapter 4: Sustainable development and Institutions in steel industry

4.1 Sustainable development and environment impacts

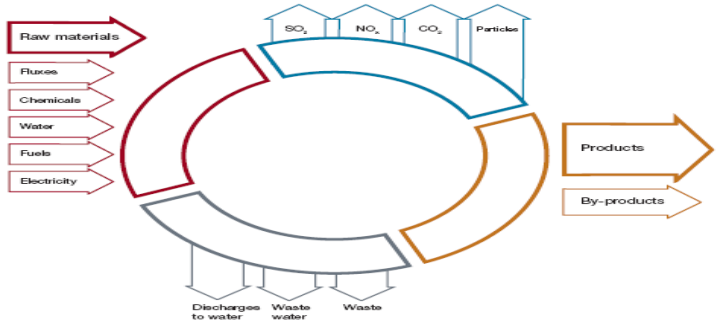
"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." [128]

It a common definition of sustainable development published in 1987 commonly known as Brundtland Report. It indicates environment and development as same issue and the principle of sustainable development path with the emphasis on the systematic, long-term use of natural resources. The report further elaborated that sustainable development process, as a change where the utilization of resources, the way of investments, the course of technological development, and institutional change should make compatible with the future as and present needs as well.

What sustainable development means to steel industry is 'achieved by a financially sound industry, taking leadership in economic, social and environmental sustainability and seeking continuous improvement.'[129]

4.1.1 Environment impacts in steel sector

Figure 4.1: The material balance of stainless production



Source: Outokumpu [131]

Above graph shows the material balance with the input of the raw materials (Metals and Ferro-alloys, Scrap and Miscellaneous), water, energy, through the process in stainless steel mill, stainless steel products are made together with emissions to air and water, waster and scrap.

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[128] Brundtland Report ,1987, the World Commission on Environment and Development
[129] http://www.worldsteel.org/?action=storypages&id=103
[130] Andy Hay, EUROFER Stainless Steel LCI study
http://www.nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/enviro/lifecycle/pdf/Hay-StainlessSteelFlatProducts-Presentation.pdf

[131] http://www.outokumpu.com/files/Group/Environment/Documents/Outokumpu%20and%20the%20Environment%202002.PDF

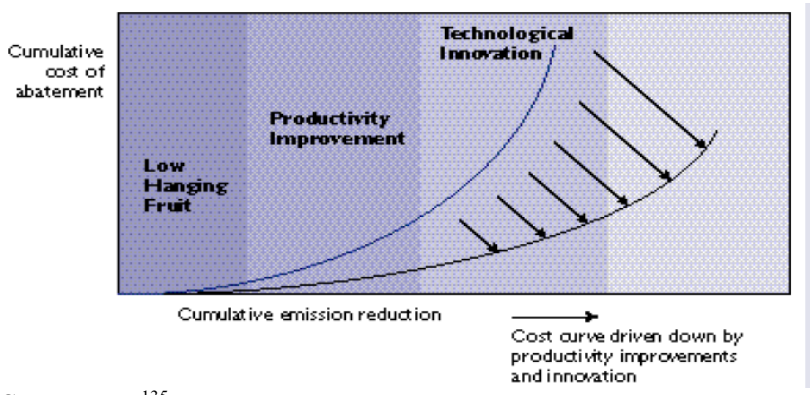
In steel making process, a lot of water being used mainly for cooling purpose, which generates contaminated water however now recycling, is become common and the impact has reduced. Further the reuse of waste has been increased and it results in reducing the amount of waste sent to landfills.

The steel industry is the largest energy user in the world. Its global energy consumption was about 18-19 exajoules (EJ), or 10-15% of the annual world industrial energy consumption (WEC, 1995). This associated CO2 emissions are anticipated to be 1425 Mt (De Beer et. al., 1999), equaling about 7% of global CO2 emissions[132] . The stainless steel sector's generation of CO2, NOx and SO2 is mainly associated with burning process and nature of chemical reaction with metal element when the raw material to be converted to steel.

4.1.2 Environment impact and technological innovation

In the early 1970s Ehrlich and Holdren developed a simple equation identifying three factors that created environmental impact called the global IPAT equation[133]: the environmental burden from human activities (I) can be approximately anticipated by the multiplication of the population size (P), the affluence level (A), and level of the applied technology (T). It has put the technological innovation and environmental impact in one mathematic platform. The challenge for innovations is to maintain the delicate balance between the increase human need, safeguard natural resources and ecosystems for the years to come.

Figure 4.2: Innovation, Efficiency and Costs: an industry perspective



Source: BP[135]

[132]Quoted from :AN INITIAL VIEW ON METHODOLOGIES FOR EMISSION BASELINES:IRON AND STEEL CASE STUDY http://www.oecd.org/dataoecd/15/59/2002541.pdf
[133] Chertow M. R., The IPAT Equation and Its Variants: Changing Views of Technology and Environmental Impact, Journal of Industrial Ecology, Volume 4, Number 4, 1 September 2000, pp. 13-29(17)
[134] DENNIS ANDERSON, Innovation and the Environment: Challenges & Policy Options for the UK http://www.iccept.ic.ac.uk/pdfs/Innovation%20report.pdf

[135] DENNIS ANDERSON, Innovation and the Environment: Challenges & Policy Options for the UK http://www.iccept.ic.ac.uk/pdfs/Innovation%20report.pdf

Above figure indicates relationship between the cumulative cost and cumulative improvement in environmental performance. Because using conventional approaches is becoming less cost efficient for the further abatement, it calls for innovative technology to pull down the cost curve.

It is possible for some measures to bring both economic and environmental benefits under specific regulatory settings .The stainless sector is continuing with research and development for processes technologies for improving energy efficiency. Environmental benefits can be reduction of particulate emissions, NOx, SOx etc., which might give economic incentive such as give reduction of externalities such as energy tax or otherwise more end of pipe treatment cost. Because technologies will develop into obsolete with replacement of newer and better solutions, as a mature sector, innovation are usually achieved by choosing process via optimise production flow and modify existed technologies.

4.1.3 Nature of environmental problem and its economic implication

When the economic activities of one actor affect the well being of another's, the former cause cost to latter. Turner [136] defined Externalities as 'unintentional side effects of production and consumption that affect a third party either positively or negatively'. Public goods, typical of joint consumption and non-exclusion offer an extreme case of externalities. Those kinds of goods are usually not being traded in the market, however there have a social cost caused by the prices signaling the wrong information, which is commonly underestimated or overlooked. There are several ways [137] to deal with externalities such as social norm, distributive cost by market and collective action. By far the most effective measure is collective action taken by governments by institution.

Environmental problems can be seen as examples of unregulated externalities. Firms make externalities of pollution in production, cost charged partly to polluters. The marginal social cost of contamination is not equal to the marginal private cost it paid. To be fair, they should compensate pollution equal to a market equilibrium but it is not necessary the case. On the regulation of pollution creates befits and cost. Social most favorable situation is that the marginal external cost of pollution equals the marginal cost of reduction pollutions. Despite of thinking the marginal impact on profit from polluting, to make it simple the marginal cost of reduction of pollutions can be viewed as cost of abating pollution by using of best available technology. (Krep 2003: 351)

The incentive to decrease emission can be the internalized externalities such as the polluter pays principle or appropriate environment regulations. Further to increase effective of allocation, knowledge of the most damaging factor to environment is also necessary.

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[136] Turner, R. Kerry, Environmental economics an elementary introduction, New York : Harvester Wheatsheaf Publications, 1994:p25

[137] David M. Kreps, Microeconomics for managers , New York, N.Y. : W.W. Norton & Co., 2003: p343

4.2 Environment regulation as a governance alternative

'Environmental regulation aims to promote environmental friendly behavior by making the environmentally friendly option seem more rewarding to the individual, in spite of his or her own short-sighted interests, and/or by facilitating the performance of environmental friendly behavior' (Thøgersen 1999:) [138]

Rules as a governance alternative to provide incentives, their advantage in the information process has been widely studies and these advantage and function are [139] reduction of uncertainty, ambiguity in decision making and cost of the information process in repeated action. Further Entry and Performance control of film can be the function of Regulatory regimes. Many studies show that one important social driver for improving environment is environmental regulations, which include Public environmental, Market and Self-regulation to normalize the social activities.

4.2.1 Types of environment regulation

Public environmental regulations
Government is the most important actor to influence the environment improvement in steel industries .One main role of government is to make Public environmental regulations. Public environmental regulations focus on local and regional environmental pollution, large producers, by restraints on process emissions and product life cycle, waste management regulations etc.

Command and control regulations are used to 'impose constraints on existing activities in society in order to remove undesired effects. The production and consumption processes as such were not under discussion. Continuity of production was the basis of the major guidelines for practical policy'. (Smink 2002). The strength of this type of regulation is easy for actors to understand and predict the future impact but it is expensive to enforce and relatively static
Economic instruments can driver for the environmental friendly behaviour. It apply polluter pays principle, example are Green tax taxes, tradable permit etc. By internalised externalities into firm's private cost, its can encourage economical efficiency; on the other hand company can decided the level and way of improvement according to its own estimation.

Until now, public environmental regulation is still an effective driver to push market actors for green innovation because regulatory pressure is a big restrain for competitiveness of firms. For instance strong stress on outcomes based regulation at the EU levels can effectively promote innovative responses from business. Some even think that 'reinventing environmental regulation is the only path to a sustainable future'. [140]

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[138] Smink, C.K. (2002), Modernisation of Environmental regulations. End-of-Life Vehicle regulations in the Netherlands and Denmark.
[139] Regulation and Organizations: International Perspectives, 1999**,** edited by Glenn Morgan, Lars Engwall ,Routledge P52,P86
[140]Karl Hausker www.csis.org/htmel/op990301.htm

Self-regulation
Pure self-regulation refers to the control of business conduct and performance by business itself rather than by government or market forces (Boddewyn, 1985).'Under self-regulation, government and industry jointly prepare regulatory or standard setting activities. Industry is enable to control itself, albeit government will exercise an oversight role, which involves a periodic review of the results of companies' internal control' (Smink 2002). It is communication and learning process of different organizations.

Self-regulation has become an attractive step forward. The more and more self-regulation within industry also echoes the increasing pressure and concerns from society. Example of self-regulation is the Environmental Management System, it can specify by the ISO 14001 and guided by the ISO 14004. The strategy for a company to implement the Environmental Management System is close related to their environmental attitude and relationship to regulations. Besides its ability of better control and knowledge of the carry control out at operational level is also an important fact. The internal and external pressure to environment impact can be resource saving, demand from authorities or other stakeholders etc.

Market regulation
Market actors are 'those actors who have a commercial relationship to the company, as they buy and/or sell products from/to the company'. 'The ways in which market actors exert pressure on companies with regard to their environmental performance' is called market regulation (Smink 2002)

4.2.2 Environment regulations in steel industry

The important international agreement is Kyoto protocol. The relevant legislations for the steel sector are the existing EU standards on wastewater treatment, air quality and waste management. Under the legislations, the industry has to implement the Integrated Pollution Prevention and Control Directive (IPPC) in its operations, which includes energy efficiency, matches the Best Available Techniques (BAT).

Kyoto protocol
According to the United Nations Framework Convention on Climate Change (1992) and the Kyoto Protocol (1997) were take on. The participants have carry out reduction of their emissions of greenhouse gases by at least 5% compared with their 1990 levels during the period 2008-2012. The European Union has undertaken to reduce emissions by 8%.

Energy
In COM (97) 30, The European Commission planned in March 1997 a Directive for reorganization the Community framework for the taxation of energy products. Later various alternatives have been discussed by the Council of Ministers. If it ratified, it might have serious impact on efforts made by the European steel industry over many years to rationalize and improve its performance.

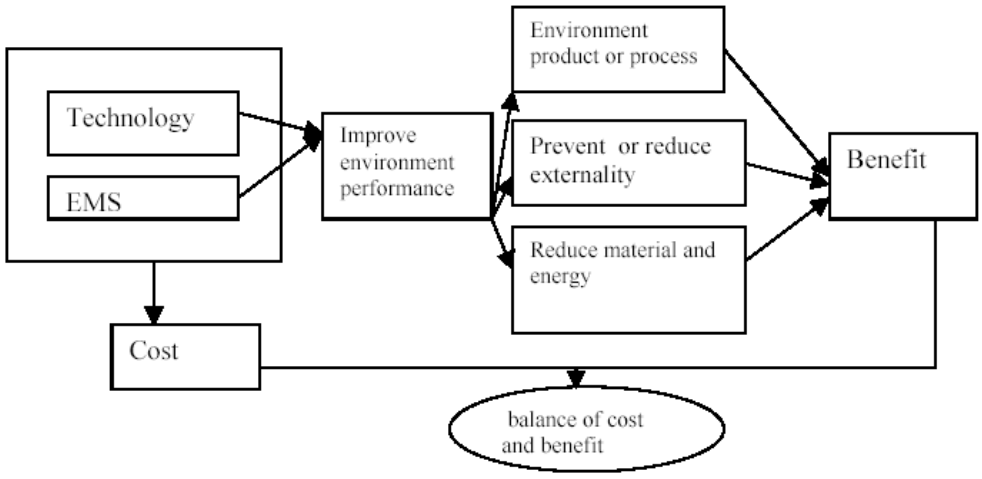
Waste
The European Union has imposed strict requirements for waste and landfills to prevent or reduce the negative effects on the environment from land filling. The relevant is the Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste .Further Council Directive 75/442/EEC of 15 July 1975 on waste is aim to limit the generation of waste by coordinate waste management

Water
On 23 October 2000, the "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy" was finally adopted. It set out a "Strategy against pollution of water" stipulate that all the polluted water may cause damage to human health or the environment .The steps to be implemented was outlines in the Article 16.

4.3 The coming of environmental strategies

The knowledge of environmental problem and strategies are changed with times accompanied by the development of environmental institutions and coming of green innovation. Cleaner technology is product and processes designed to reduce negative environmental impact. There is difference between end of pipe and cleaner technology. End of pipe is equipment connected to existing production process and it will usually mean the cost increasing .The clearer technologies integrate the production enhancing resource productivity and it has potential to decrease overall cost from commercial point of view.

Figure 4.3: Linkage of cost and benefit of environment investment



Source: Robert [142]

[141] Adapted from, Robert ,2001,the impact of environmental management on firm performance ,management science Vol 42, No8,August 1996

This is a possible strategy to integrate an Environmental issue to whole product life cycle and will bringing competitiveness. Above figure shows linkage of cost and benefit of environment investment .The latest development of process and product strategies has potential to bring economic benefit to companies. Porter and van der linde [143] argued that properly structured environmental regulation might not only benefit the environment and society but also regulated firms by stimulating innovation. 'When focus was on process-oriented strategies, the bottom-line of environmental regulations was 'pure' public environmental regulations. Now, when focus is on product-oriented strategies, the bottom-line is the process-oriented strategy.' (Smink, C.K. 2002). This will be benefiting both environment and competitiveness of firms.

Table 4.1: Environmental strategy and innovation in steel industry

Type of environment problem	Environmental strategy	Bottle lines of Environmental institution	Type of green innovation	Economic implications
water pollution most emission to air SO2,Nox,CO2 particle Waste ex. slag	Filter/End of pipe	Public regulation		Cost increase
Some Waste etc scrap Part emission to air +energy	Cleaner production technology	Public + Self regulation	Production + Organizational process (EMS) innovation	Cost saving

The above table shows that most of environmental solution in steel industry is still end of pipe however there are some measure like use of waste, energy saving combing process solution .On the regulation side, despite the domination of public regulation,
Most firms have environment system which means they already apply self- regulations, however there are little evident of using market regulation in this industry.

4.4 Discuss two alternatives for environment improvement in steel industry

There are growing interests in the environment issues worldwide and this lead to establishment of regulation and other policies in many countries. Furthermore, the growing environmental concerns have gradually created the pressure on firms. To reduce the further impact to their profit, companies have to consider how to lessen emissions in a long run. Companies may choose different environmental strategies, which are characterized by different responds regarding existed regulations, level of competition pressure, their knowledge and stage of environment technology.

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[142] Adapted from, Robert ,2001,the impact of environmental management on firm performance ,management science Vol 42, No8,August 1996

[143] Michael E.Porter: Claas van der linde 1995 , toward a new conception of the environment competitiveness relationship, the journal of economic perspectives, vol 9, and no.4

The Kyoto Protocol sets legally binding emissions targets and timetables for participated countries. To deal with the CO2 emission, many measures have been taken. In the following discussion, empirical date is used to estimate cost benefit of possible abatement measure. One discussion is about general strategy under the Emissions Trading Scheme; another is about an abatement option by increase use of scrap and its policy implications.

4.4.1 Kyoto Protocol strategies for steel industry

Is it worthwhile to make investment of new technology to reduce emission now or pay fine in the future?

Whole steel sectors[144] are covered by Emissions Trading Scheme. In the EU states, there will be fines of 40 euros per excess ton of CO2 emitted on companies beyond their targets, and it will increase to 100 euros three years after the entry. The recent CO_2 trading cost[145] in markets is range from 13 to 30 euros per ton listed [1]. As a reference, the Commission has mentioned that prices for carbon allowances are within the 8-10 euros per ton. One Statistics[146] has showed that in steel industry the average abatement cost for CO2 is 106 euro/ton. The abatement measure will become more cost efficient, if innovation is made in the best available technology.

The estimation is made in under above specific regulation settings with market interest's rate 5%. The time horizon is six years from 2007 till 2012. The present values of 2007 are listed under the different options.

Table 4.2: Estimated present values of different options for exceed CO2 emission in 2007

	Time horizon (2007~2012)	1.Euro/ton cost	2. Lowest estimation of options with PV2007 Euro per ton
1	Pay fines	[40]+[100]	447
2	Market quota	13~30	62~143
3	Invest average technology for abatement	~106	~505

From an economic point of view, it will be unrealistic to make any investment higher than 447 Euro per ton with present value year 2007.

On the short run, it is now much cheaper to purchase market quotas mainly due to the recession of Russian economy with inexpensive surplus quota. Further in most of EU

[144] http://www.euractiv.com/en/sustainability/climate-change-eu-emissions-trading-scheme-eu-ets/article-133629
[145] http://washingtontimes.com/world/20060502-122647-8250r.htm
May 2, 2006 , Richard Ingham AGENCE FRANCE-PRESSE, Pollution reports hurt CO2 emissions market
At the start of last week, CO2 was changing hands at $37.75 a ton, compared with $25.80 a ton at the beginning of the year. On Wednesday, the price fell to $29.45, and on Thursday, the price fell to $20.75. On Friday, it closed at $16.60 ahead of the May 1 holiday.
[146] Raymond, the cost of air pollution abatement, applied economics 1997.29, 759-774.

countries, ccertain energy-intensive industries as steel would be exempt from the requirement to purchase allowance to ensure it not operate at an international disadvantage. Those factors will not encourage firms to make substantial investment for clear technology, however there are still a lot of unpredictable about market quota when reach the year 2008, at the time EU starting to carry out its commitment to decrease the emission of greenhouse gases. Still on the long run, investment at reasonable cost can also be one of the alternatives to react the possible change beyond 2012.

The analysis shows a predicament for steel sector. It is common for steel firms to use existed facilities for decades and those existing processes are close to the theoretical minimum[147] regarding energy use. Further major changes on established process need heavy investment. Presently there are no new break-through processes on the perspective promising significantly lower CO2 emissions in steel making.

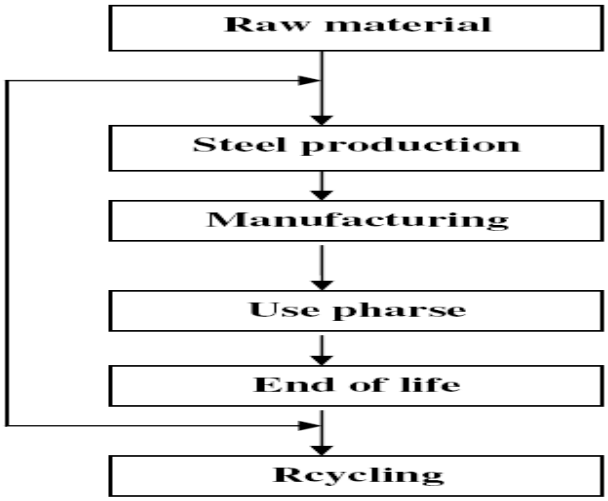
If Environmental solution is end of pipe, it often means rising cost in meeting environment regulation. If there is no significant technologic innovation, steel sector will be expected to buy more market quota or pay fines to enlarge its production capacity. The impact on the environment will obviously be increased and it will cast shadow on long term economic growth. At moment it will be partial solution for steel mill to make continue improvement in energy efficiency, however better designed environment regulations can encourage innovation especial in a market with the low quota price.

4.4.2 Abating CO2 emission by increasing scrap rate

Is it worthwhile to use more scrap to reduce emission for steel mill, what kind of regulation support is needed?

[147] http://www.eurofer.org/publications/pdf/2000-10EuropSteelIndClimateChanges.pdf

Figure 4.4: Life cycle of stainless steel [148]



Source: Fujii 2005

In the EAF process, its major raw materials are scrap or scrap substitutes which normally account for more than 90% of the metal input and the balance may use pig iron. One advantage of EAF process is its ability to recycle its end of life products. Stainless steel products can be **recycled** to almost 100% and it will not degraded when processed again , which means that the raw material contents including alloy element can be use again and again for the production of new stainless steel. Following analysis will estimate the impacts of recycling by using LCA data.

Table 4.3: Data of two extreme processes

304B grade stainless steel	100% primary case	100% recycled case
Energy (MJ/Kg)	73	23
CO2 (kg /kg)	7.1	3.9

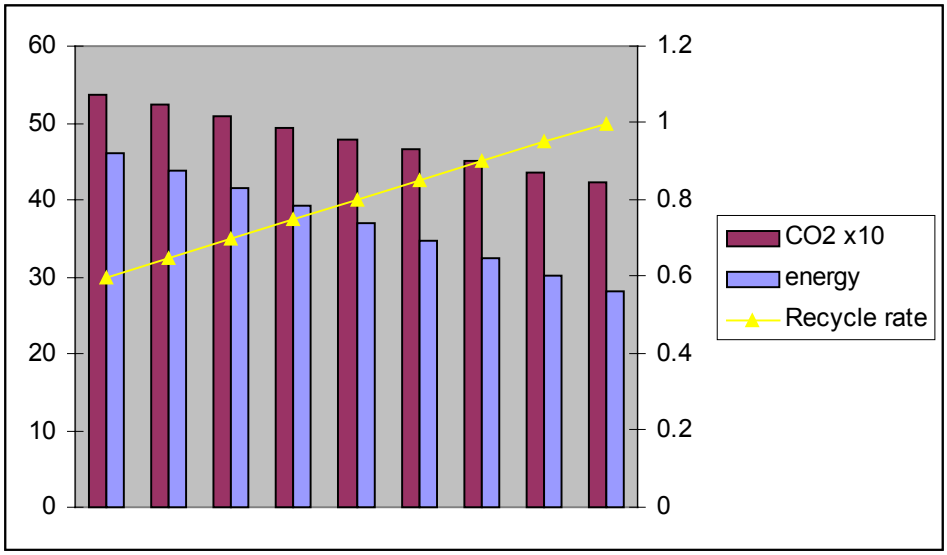
Source: Fujii 2005

The following single cycle equation ("IISI Appendix 5"equation) formula is applied to make simple energy and CO2 estimation in the whole life cycle of stainless steel.

[148] Hiroyuki Fujii 2005, How to quantify the environmental profile of stainless steel http://www.worldstainless.org/articles/how_to_quantify_the_environmental_profile_of_stainless_steel.pdf

X = Xprimary + (Xrecycled – Xprimary)×RR×Y
RR = Recycling ratio, Y = Yield

Figure 4.5: Relationship among recycling rate and CO2 & energy



The above figure shows the relation between recycling rate, energy consumption and CO2 emission. The increase in recycle rate will reduce the energy consumption and CO2 emission.

According to ISSF at present the global average scrap ratio for stainless steel is about 60%, yield of scrap assumed to be 90%. By using date in table 4.3 and single cycle equation, the following results are reached.

Table 4.4: whole life cycle results

304B (?)	Average 60% recycled case	Change of recycle rate of 10%	Market cost Euro (example)	Euro saving for LCL
Saving Energy comparing with primary route (MJ/Kg)	46	4.5	52Euro /MWH[149]	0.187
Saving CO2 comparing with primary route (ton /ton steel)	5.37	0.288	30	8.64
Saving by change recycle rate of 10%				**8.82**

[149] http://ec.europa.eu/energy/electricity/publications/doc/review/2006_04_qr07.pdf
1 MJ / 3.6 = 1 kWh

In above specified condition, when production of 1 kg of stainless steel, there is a saving of 46 MJ energy consumption together with 5.37 CO2 kg emission reductions comparing to primary route. Recycling scrap not only means raw material saving but also reducing use of energy leading to lessen emission.

In case of the recycle rate increasing 10%, there is a 4.5 MJ energy saving as well as a 0.288 kg/kg steel of CO2 reduction. However there are certain limitations of recycling process. When chosen to 100% from scrap, it will make control the purity and quality of the steel produced difficult. Above table also shows the possible cost saving. By an increase of 10% scrap recycling, it can achieve 8.64 Euro per ton CO2 cost saving while energy cost saving is only 0.187 Euro per ton.

These results are from the life cycle perspective, not mill alone. If not recycling, the primary stages such as ore process will consume energy and generate CO2 emission. Environment regulations should encourage the steel mill to use more scrap through positive incentive with total social benefit. On the holistic view, regulatory making is an interactive process and well designed regulations will help mills further use of their extra capacity to engage in international competitive.

4.5 Summary

The social efficiency will not achieve if firms' cratered private profit imposed external cost to society. The public regulation is still the most important among other regulations to protect the public interest due to its power of influence. Over the years environment policy has also change a lot, however the role of government is never diminished, the different is now more actors are involved in the institution arrangement process. For instance there is also pressures from industry to require government to make regulation in a more innovatively ways .It is commonly believed that a good environmental regulation should encourage innovation if it is 'positive-sum game'.

Regulatory making is an interactive learning process, government can also influence on sustainable interests by enforcement of law and innovative use of economic instruments. As Firms may stimulated by regulation to find innovative way of prevent environmental liabilities to avoid cost or even achieve cost saving by improving efficiency. Steel industry steel industry still needs revolutionary innovation in the process to find a better environment solution and reduce cost at same time. At the present stage continue improvement is still a solution. From the empirical findings in analysis of two abatement options, it is suggested that regulations making should encourage firms to use environment friendly process on the whole life cycle .This require economic incentive from government such as reducing scrap tax level and restricting firm to buy cheaper emission etc.

The policy innovation should meet the customer need for creating new market and supplier, making improvement in industries' network activities and improvement of environment within economic and social settings. Porter and van der linde (1995) identified that an appropriate public environmental regulation can meet as least the following purposes

- Regulation signals companies about likely resource inefficiencies and potential technological improvements.
- Regulation focused on information gathering can achieve major benefit by raising corporate awareness
- Regulation reduces the uncertainty that investments to address the environment will be valuable.
- Regulation levels the transitional playing field
- Regulations is needed in the case of incomplete offset

Chapter 5: Sandvik material technology case analysis[150]

The discussion will focus on the determinants to innovation process at firm level and strategies of system of innovation firm can use to contribute to improve sustainable competitiveness.

5.1 Key drivers of Innovation

5.1.1 Market pull

A key driving force for innovation is that customers are increasingly demanding stainless products in more stringent requirements in reliability, performance, productivity and cost-effectiveness. Factors underlying the demand for SMT's products include investment capital spending in the process, energy and electronics sector as well as the production of industrial and consumer goods. Those demands for more advanced materials and products are results of increasing level of automation, combined with for energy-efficient products and processes, plus a general increase in environmental awareness. With the push of Customer's need of cost efficient solution and SMT are under pressure to put efforts on product development. SMT focused on a number of strategic customer segments with higher growth and profitability, but also face pressure from its competitions because now stainless production is a mature process, niche advantage if not updated quickly, can be imitated fast and soon become commodity. The question is how to reduce the cost of new product to reap in the competitive market among competing material and producers. The key is the knowledge of market potentials.

Market[151] has unique position in establish the sustaining competitive advantage of business since it is the place firms to know the customer's requirements. This kind of knowledge creation is essential for product innovation because the nature of risk and uncertainty of innovation, lacking of knowledge in predicting the requirements of the specific group customer is key cause of the poor performance of new product. The market knowledge can be gain by open subsidiaries closed to customs or distribution center, which will give correct feedback regarding product mix and a strong position in different **market** segments.

5.1.2 Firm specific knowledge bases and learning process

Another key driving force for innovation is Push by firm specific knowledge bases and learning process, which forms the innovation infrastructure and quality linkage .The ongoing change of how to organise work in the processing industry, which requires increased knowledge and skill, has led the steel industry to invest a lot of money in various methods of education and training. According to Nonaka[152], individuals and

[150] The main references in this section are from SMT website especial its annual reports unless otherwise stared. http://www.smt.sandvik.com/

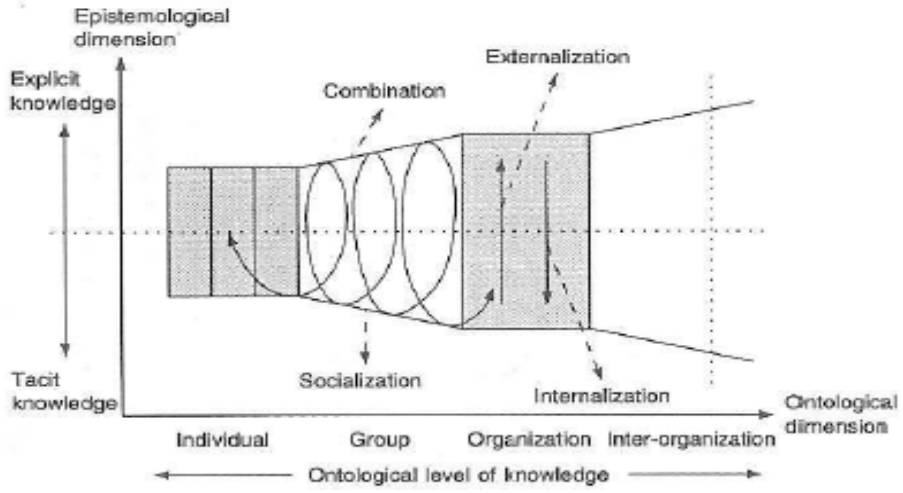
[151] Dale Littler, marketing and innovation, The Handbook of Industrial Innovation. Bodmin: Edward Elgar, 1994, p239.

[152] Nonaka , A Dynamic Theory of Organizational Knowledge Creation, Organization science yr:1994 vol:5, iss:1 pg:14

organization have a possibility of grow together through knowledge creation. It can be done in the course of communication between explicit and tacit among different levels, a spiral development, which can be created and transferred in four ways.

Socialization: from tacit to tacit knowledge, learned by direct communication or replication.
Externalization: from tacit to explicit knowledge
Combination: from explicit to explicit knowledge, a process of combining explicit knowledge into more integrated one
Internalization: from explicit knowledge to tacit knowledge

Figure 5.1: Spiral of organizational knowledge creation[153]



Source: Nonaka and Takcuchi 1995:73

Organization knowledge as an upward spiral process, starting at individual level of tacit knowledge and moving to different collective level of knowledge center or 'organization memory '[154] on its externalization and amplification of its four mode of exchange. This implies that solution for problem of originated individually can be shared and transferred to organization. It is also innovation process through Leaning by doing, learning by using, learning by search process, for instance embodies knowledge is knowledge of experience which are created via learning by doing.

Learning by doing [155]concept refers to the leaning effects obtained in the physical production or practices and generate know how to the actors through trial and error. The experience accumulates with the production amount and increases the production

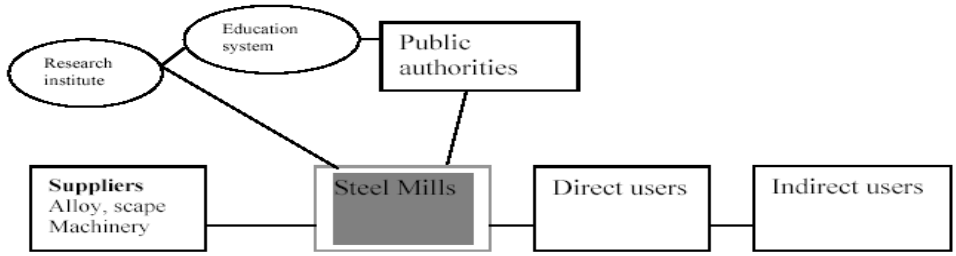
[153] Nonaka, I. and Takeuchi, H. (1995). The knowledge-creating company. New York, Oxford:Oxford University Press.
[154] Lehner, F. (2004). Organisational memory. In J. H. E. Andriessen & B. Fahlbruch (Eds.),
How to manage experience sharing: From organizational surprises to organizational knowledge. Oxford (UK): Elsevier Science Ltd. It imply the organization's employees, its written records ,or date contain accessible knowledge
[155] Von Hippel E. & M. Tyre (1995), "How learning by doing is done: Problem identification and novel process equipment", Research Policy, vol. 24, no. 1.

efficiency through improved skills and reduced the average cost. This relationship is often showed by the learning curve where the average cost is a decreasing function of the production capacity. “Learning by doing” mainly contributes to the tacit knowledge stock. For example, SMT´s facility for materials research is located in close to the company’s manufacturing units .SMT new product development process has supported by facilities for full-scale production trials and testing, as well as knowledge, represented by researchers, engineers and skilled workers with the combination of academic and practical insight.

Learning by using is closely related to learning by doing and contributes to the stock of know how, not directly through the production, but by the utilization of the good or technology. Rosenberg (1982) expands the concept to “learning by using” and argues that the contribution from “learning by using” to the know-how stock indeed is significant, when talking about products of high complexity consisting of interdependent components from different sub-suppliers. This is the case why the weaknesses of the product or technology often will wait until they have been experienced pressure of real life. The users become a part of the development and incrementally innovation of a principal design through interactive learning. This means that there is a close relationship between the “learning by interacting” concept and the “learning by using” concept.

5.1.3 Interaction learning between actors as Quality of linkage in the system

Figure 5.2: various linkages of steel mills



Source: based on Geels[156]

Innovations are a result of a very complex process containing different procedures, knowledge, skills, and resources, competencies that derive from different partners or actors. Collaboration is necessary, because it’s nearly impossible for a firm to have everything that an innovative activity needs. As long as firms can’t provide the competences, resources and knowledge to make innovative activities inside the firm,

[156] My own drawing on steel industry ,based on Geels 2004 ,From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory, Research policy [0048-7333] vol:33 iss:6 pg:7

there is a need for collaboration with external actors. John R. Baldwin [157] is of the opinion that the most important sources of innovation are collaboration with research and development divisions (universities, research centres), collaboration with customers or suppliers (vertical collaboration) and finally collaboration with other firms that are neither customers, nor suppliers.

Collaboration between firms can take variety forms. The collaboration can be horizontal and vertical .The higher education institutes and research institute, other companies, as supplier, customer and competitor are also the source of input. It is assumed that partner can receive material benefit than they act in opportunism for the following reasons

- Increase scale and scope of activity
- Share cost and risk
- Improve ability to deal with complexity
- An asset against the environmental uncertainty
- offers flexibility and efficiency

In the real world of business collaboration can substantially rewarded via share cost, conduct complexity of science and technology and Enhanced learning ability. As Mr Ad Raatgeep, Marketing & Sales Manager, Tube Division, explains:

'The key to a successful partnership is an open exchange of information to exploit synergetic effects to the maximum. Through such a close and long-term co-operation we can better assist our partner in gaining an edge over the competition, and ourselves gain insight into end-user challenges we might otherwise miss.'

Co-operation with Technical centres

Process of innovation is not limited to the individual firm. Collaboration consists of activities, which required two or more partners put in differential resource and know-how to agree complementary aim. Firms form a strategic alliance when they want to create a new product or technology, so they co-operate in order to achieve their goals.

A good example is SMT the co-operation with Stamicarbon, and leading engineering company in the urea industry. Through cooperation with technical standard, SMT developed 2RE69 for urea reactors. Later Stamicarbon enhanced its process by reducing the oxygen content during urea production, with continues collaboration a new material Safurex was development to offer higher strength and better corrosion resistance, as well as suited for Stamicarbon process and design. This new material will expects to become the new standard for urea production and this will further benefit both SMT and Stamicarbon in explore this new market.

[157] Baldwin, John R.: "The Importance of Research and Development for Innovation in Small and Large Canadian Manufacturing Firms", paper published by Statistics Canada, Ottawa, 1997.

Vertical collaboration

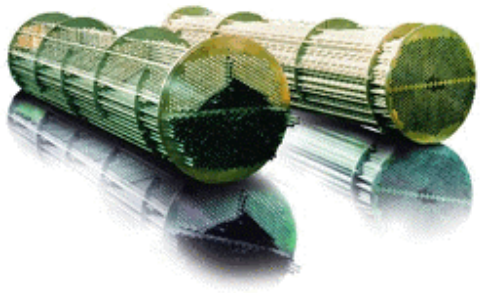
Further the link between user and supplier[158] is important as the linkage is a key element in the innovation system and it is more than simple learn form market. User and supplier interaction includes a learning process of learning by doing, learning by using and learning by interaction and diffusion, which give rise to a the speed and flexibility of new product development and process improvement .The share of knowledge is by keeping this kind of linkage in organization and stress on learning. Close link between user and supplier is a better strategy for the following reasons

- Performance better than focus on other market activity
- Facilitate product update on time
- Maintain flexibility in the value chain

Metal businesses [159] are direct or indirect link to the other industries as the chemical, and machinery. For example in pulp & paper industry many reactors are working under very corrosive condition and this lead to the special duplex stainless grade. The research in turn result in the wide application of this kind value added stainless and give industry huge profit.

SMT has a long tradition of developing products in close co-operation with customers and now go forward in actively finding applied solutions. “We strengthen our leading position within advanced materials and high-value-added products developed in close cooperation with our customers.” says Peter Gossas, president of SMT.

Figure 5.3: zircaloy cladding tube



Source: SMT

For example, the basic technology for zircaloy cladding tube manufacture has been developed by SMT in the early 1960s including a later on patented cold-pilgering .Large scale commercial production in an integrated process was started at in 1965. SMT’s independent position in this area has been a result of its working with many different end user, designer and fabricators, which give SMT valuable experience from types of fuel designs to most of the technical cladding tube specifications. With this interactive

[158] Brian Shaw, user /supplier links and innovation P275, in the handbook of industrial innovation: The Handbook of Industrial Innovation. Bodmin: Edward Elgar, 1994

[159] Ivarsson, Inge, Competitive Industry Clusters and Inward TNC Investments: The Case of Sweden, Regional Studies, Feb99, Vol. 33 Issue 1

learning, SMT has produced a variety of zirconium alloy cladding tube types and property combinations than any other manufacturer. **SMT** is the leading independent manufacturer of Zircaloy Nuclear Fuel Cladding Tubes and now manufacturing experience is over 50.000.000 meters as a high value added product.

Horizontal collaboration

Figure 5.4: New stainless steels for improved machinability

Source: SMT

The following is an example of **Horizontal collaboration** inside the group. For many years, SMT has found their development, working alongside sister company, Sandvik Coromant, a world leader in machining tools. The aim of this cooperation provides a unique chance to offer stainless materials and tools with an optimum compatibility. Through this cooperation, SMT gained experience in the chip forming during machining, which is supreme in the steel industry. This combination of knowledge has led to the development of stainless steels possessing improved machinability. Also Sandvik Coromant customer is benefit from this new generation of material solving long standing problem of stainless machining.

5.2 Innovation management focus on knowledge

According to the resource-based view of the firm, strategic assets are the important determinants of an organization's ability to maintain a sustainable competitive advantage. Innovation as an important business process involved searching, selecting, and implementing, which requires management.

The ongoing change of how to organise work in the processing industry required increased knowledge and skill, has led the steel industry to invest a lot of money in various methods of education and training. The ongoing change of how to organise work in the processing industry required increased knowledge and skill has led the steel industry to invest a lot of money in various methods of education and training.

Organizational knowledge is a strategic asset as a resource valuable to an organization's ability to innovate and compete. Because knowledge exists in different forms, both within the individual employees and organization, knowledge management as a means for capture and spread the knowledge in the organization.', Nowadays Knowledge management is becoming increasing important for the following reasons [160]

[160] J.H.Erik andriessn, managing knowledge process in Robert M. Verburg (2006), Managing technology and innovation ,Routledge P263

- To improve an organization ‘s capacity to achieve business goal and to innovation
- The rapid market changed and short life cycle of project, the knowledge hold by many company need to be regularly updated
- Rapid turnover of employees.

Because development and improvements are undertaken with the close cooperation of its customers, SMT have make efforts to improve knowledge management to have better internal process to internalise tacit knowledge. Just like other firms, SMT knowledge management evolved from information management with database to transfer of best practice. It encourages individual to socialize their knowledge, also systems make codify the knowledge of individuals to be able to share within relevant organizations. These are evident by use of in SSBS control system, which activities can be controlled, evaluated and measured according to the same principle within the Group. However the Information technologies cannot a substitute for social interaction because it makes sure to smooth the progress of good routine. For example[161] a study at the sales and marketing affiliates of Sandvik showed despite ‘ plenty of knowledge transfers going on, but they often ended up being transfers of “mediocre” or “worst” practices rather than best practices.’ This is because the transfer taking place between subsidiary which knew each other well. To overcome those shortcomings, bbesides computer knowledge base, company also had put efforts at improved internal information process such as information meetings and regular bulletins and the staff magazine.

Figure 5.5: Electro polished Tubes

Source: SMT

Another example is the **Vertical collaboration** throughout the production chain for particular product and finally leads to acquisition. Bresman’s survey[162] including Sandvik group shows ‘the knowledge transfer process in acquisitions is noticeably different from the process under other modes of governance, because of the rapidly-evolving relationship between the two parties’.

[161] JULIANBIRK ENSHAW, Making Sense of Knowledge Management http://www.iveybusinessjournal.com/view_article.asp?intArticle_ID=275

[162] Bresman, Henrik, Birkinshaw, Julian, Nobel, Robert, KNOWLEDGE TRANSFER IN INTERNATIONAL ACQUISITIONS , By: Journal of International Business Studies, 0047-2506, September 1, 1999, Vol. 30, Issue 3

From early 1990s, there are the increased quality requirements for high purity tubes and fittings within the Semiconductor Industry. Those demand has created a need of continues improvements of these products. Since 1960s, Swedish company Calamo had electric polished technology to Optimization of the electro polishing, passivation and cleaning processes but has not ability to control of the raw material. In this case, SMT are cooperated with Calamo to develop Steel grade especially for general semiconductor applications, as a result two Steel grades for Low Manganese and low Sulphur applications have been developed under the management of SMT R&D center. In the middle 1990s semiconductors market was growing quickly, in order to keep technology in-house and advance this higher value added market, SMT decided to acquisition of Calamo. By making new investment, using existed sales chancel and international network of SMT, SMT has developed whole series of products for high purity Stainless Steel Electro polished Tubes and fittings for the Semiconductor fabrication to one of the leading companies with respect to quality, capacity and cost advantage.

There are experiences generations of way of management, According to Mouritsen [163], first wave of knowledge management is focus on creative individual, codifying knowledge or externalization it as an important organization strategy. The recent second wave's is focus on network of knowledge resource to develop in an organizational context. Further there is an attempt to find ways of composition, application and development of knowledge resource by using intellectual capital information. SMT as a company focuses on product niche and new product development should continue accumulate and better management its knowledge resource to enhance sustainable competitive advantage.

[163] Jan Mouritsen, The 2nd wave of knowledge management: The management control of knowledge resources through intellectual capital information , Management accounting research [1044-5005] Mouritsen yr:2005 vol:16 iss:3 pg:371

Chapter 6: Comparative analysis between SMT and Tubacex case[164]

To be able to make benchmark, a main competitor of SMT, Tubace was introduced because stainless seamless tubular are their main products which form basis for comparison. It intends to answer how system of innovation gives to improve to the change of performance and kind of strategies contribute to performance improvements at firm level.

6.1 Performance indicates reviews

Balanced scorecard method is used to measure case firms' the performance. This method was first described by Kaplan and Norton[165] build around the argument that companies gain sustainable competitive advantage not only dependent on developing of tangible assets alone. Since firms compete on a broader array of performance criteria[166], a balanced presentation enable the company to track both financial and no financial indicator in building dynamic capability for future growth and competitiveness. Kaplan and Norton's"balanced scorecard" combined measures of customer satisfaction, process performance, product or service innovation and finance.

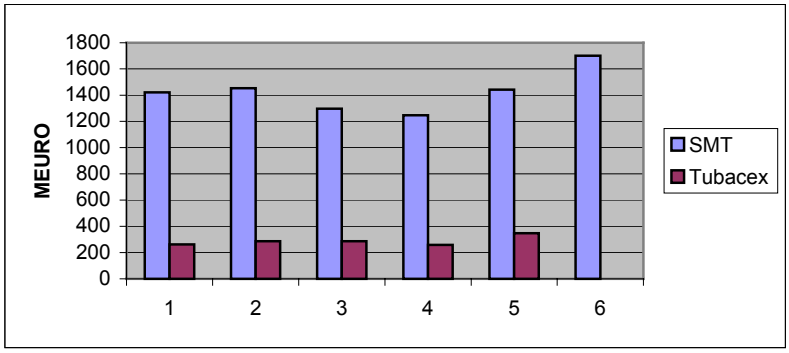
Variables are chosen within four aspects of balance scorecard related to organizational goals. In deciding the indicators, the key concerns are the available of the date for both cases. To be more objective, quantities date especial in their official reports are preferred, otherwise a score is estimated according to written information or survey results. A simple graph put date of both cases is used to measure historical performance. Finally by using pattern matching methods, casual relation and key determents of performance are evaluated.

[164] The main references in this section is from Tubacex and SMT website unless otherwise stared.
http://www.tubacex.com/
http://www.smt.sandvik.com/
[165] Kaplan, R.S. and Norton, D.P., "The balanced scorecard - measures that drive performance", Harvard Business Review, January-February 1992, pp. 71-9.
[166] Brown, M.D., "Measuring corporate performance", Long Range Planning, Vol. 2 No. 27, 1994, pp. 89-98.

6.1.1 Finical indicators

Sales

Figure 6.1: Sales in Meuro from year 2000 to 2005



As described in sales, over the years both companies have grown in sale .In recent year, the average sales figure SMT is 3.95 times higher than Tubacex.

Productivity

Labour productivity is one of indicator of operating efficiency

Table 6.1: Estimation of Average productivity figure in recent year[167]

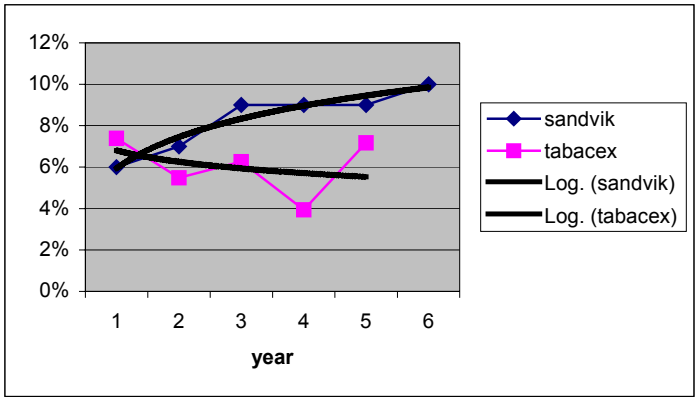
	Number of employee	Labor productivity Kero/per employee	Value added Keuro/per employee
SMT	8000	178	14.7
Tubacex	1517	189	11.5

The above table shows that Tubacex is more productive in terms of labour productivity, while given the value added per worker, SMT is performed better. This implies that SMT's products are more value added whereas Tubacex products are low cost solution for customers. Form social economic point of view; SMT is a better development model because of its much more employment.

[167] Here the number of employee only use latest figure ,while other average figure from 2000 to 2005

Profit

Figure 6.2: Operating profit development from year 2000 to 2005

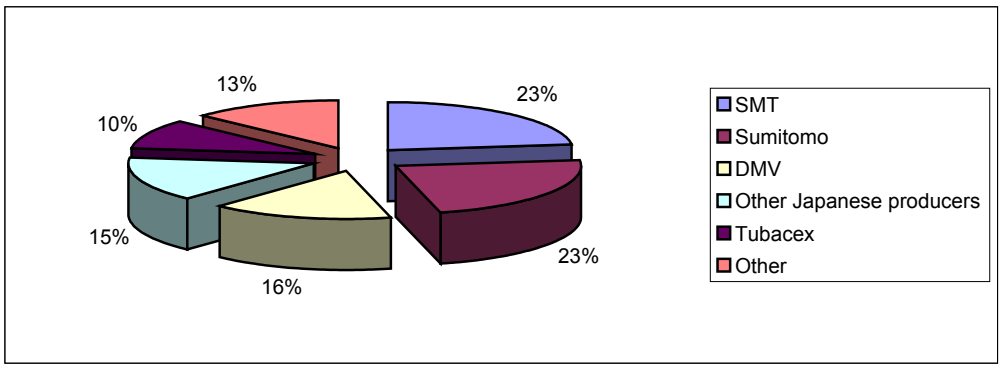


As displayed in the diagram, both companies show signs of growth in recent years. SMT is in a stable growth with average of 8.3% operational profit, while Tubacex profit level is catching up with the average of 6.1 % operating margin.

Obviously SMT is more profitable but the figure is still lower comparing with its sister company in the same group. There is ongoing program for SMT to increase efficiency and improve profitability.

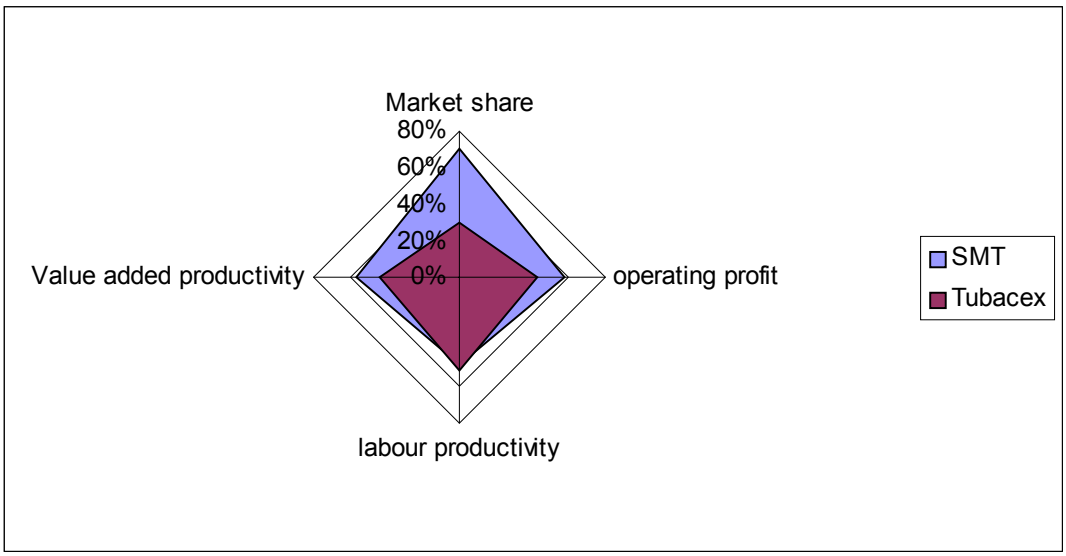
Market share

Figure 6.3: Marker share of stainless seamless tubular producers



Recent years figure shows that SMT has market share around 23% to 26% in volume base having a leading position in stainless seamless tubular market, while Tubacex share is around 10%. Both of them face strong competitor DMV in the European market.

Figure 6.4: Benchmark of finical performance[168]

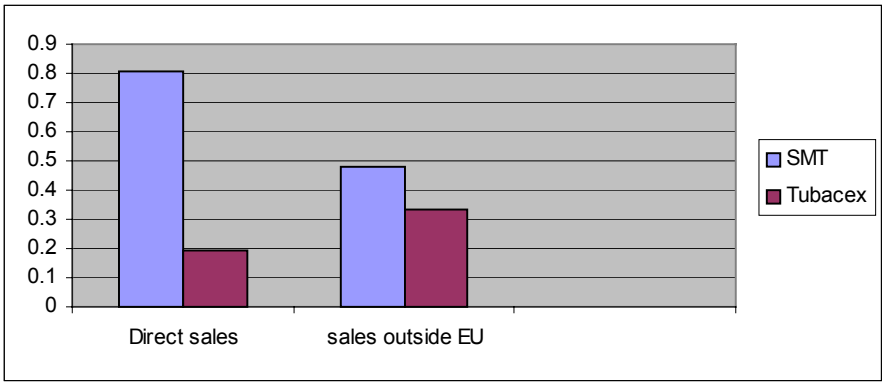


The above diagram summarized the benchmark on finical performance. As it can be seen, generally speaking SMT has performed better especial in terms of values added productivity and market share. Tubacex do particular well in labour productivity. To further increase its performance, it important for SMT to increase its employment productivity.

6.1.2 Customer perspective

SMT has direct market Sales coverage in 55 countries with more than 50% in EU market. In the contrary, Tubacex only have direct market exposure in 13 countries despite it is a leader in its home market with 66.8% of its sales in EU.

Figure 6.5: Direct sales and sales outside European



The relative percentage of direct sales and their sales figures outside European assume that having more direct sales subsidiaries may leads to the increase market share out of

[168] Indicators with figures available are converted into relative percentage . For each indicator here, the average values of two compared firms are 50%.

home country. It also implied that Tubacex may have more efficient sales subsidiaries in term of sales volume.

SMT's strategy is to use established central stock distribution system to sale through its own subsidiaries. Direct sales mean more communication with customer, which is important for customer satisfaction and quality service. Tubacex concentrated on specific export markets with fast growth and low risk and try to distribute as much their products as possible through self-governing stockiest. Unlike SMT having many no-tubular products, Tubacex is only focused on stainless seamless tubular product and its specific customer segment.

6.1.3 Internal business process[169]

Quality performance
By sharing the reputation of high quality supplier, SMT uses improved standard production process to make stainless seamless tube. Conversely Tubacex uses a specific production method which enables its press to achieve larger extrusion capacity; however it also generates certain quality problems in particular regarding the hot finished tubes' eccentricity. This sometime damages Tubacex's position as a quality supplier, which has led it to compete mainly at the lower end of the market; however this situation can be changed by making further investment in cold finished production line.
(SMT score =7, Tubacex score=4)

Lead time performance: Capacity
Both companies have enough capacity and have less delivery problems.
SMT has reserved its capacity because theoretically its 75 Ton AOD furnace is able to double its present production capacity of 200 000 Ton crude steel, so is Tubacex 50 ton AOD with production of 150 000 ton crude steel . To be more efficient, both mills should make better use of their capacity.
(SMT score =6, Tubacex score=6)

6.1.4 Innovation and learning

Knowledge stock
Tubacex has only focused its activity on the stainless seamless tubular market since 1987. On this respect Sandvik has more experience as its modern stainless seamless tubular production can be traced back at least to 1960s.
(SMT score =7, Tubacex score=5)

R/ D expenditure
With 250 people, SMT has one of Europe's largest R&D facilities for stainless steels and special alloys. It's investment in R&D and quality assurance has continuously been 4% of the Group's sales for many years. Even with no Tubacex R/D figure on hand, as reference the leading stainless company Outokumps only spends 0.6% of sales on R/D.

[169] Qualitative indicators score were estimated by using range from 1 to 7 ,score 1= not true at all , 7= very true

(SMT score =7, Tubacex score=5)

Product development
SMT has in total about 900 steel codes for production. Every year some 200 codes are optimised, added or withdrawn, which indicates more than 20% of its grade updated every year. In contrast Tubacex limited its efforts to enlarge special steel grade, only a few mostly high nickel alloys such as UNS S31254, Alloy800, Alloy825 and Alloy20 are added in its production.
(SMT score =7, Tubacex score=4)

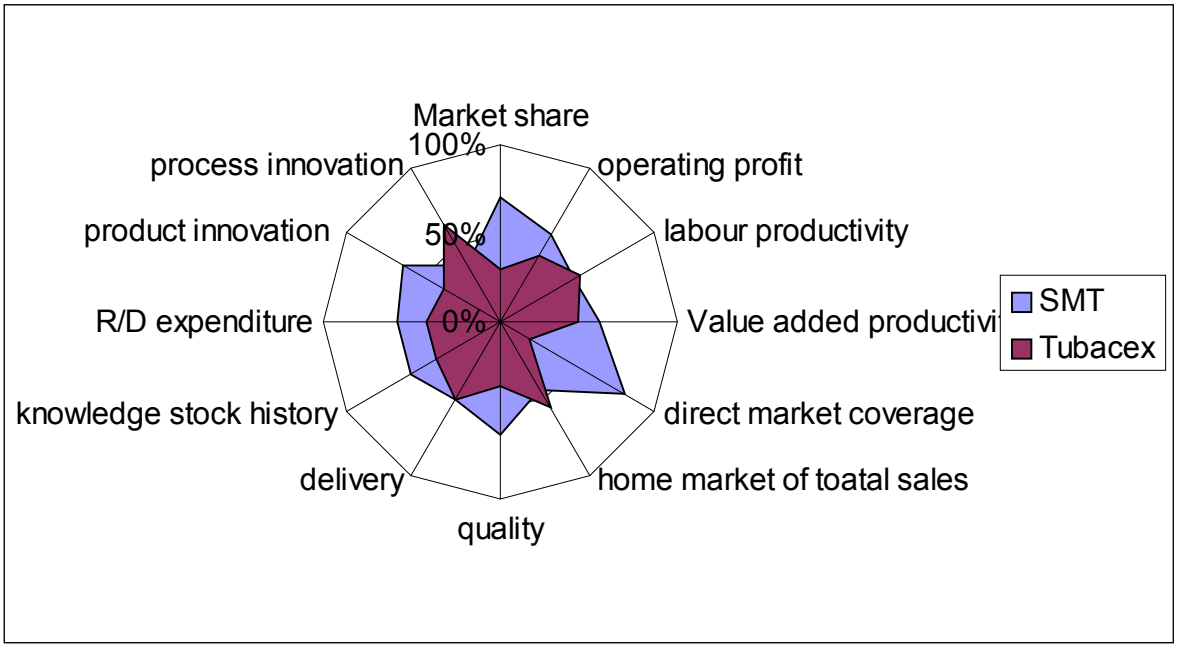
Process innovation
Most of SMT's equipments were installed in 1960s with mature technology and its strategy is continues improvement in production process. Tubacex have relatively new and efficient production facilities of 1980s."Tubacex has on purpose designed its manufacturing route with an initial cost saving on raw material and hot finishing partly counterbalanced by an additional cold pilgering step which solves the so-called eccentricity problems"[170].
(SMT score =4, Tubacex score=7)

6.3 Estimation of performance by using balanced scorecard

In applying Balance scorecard method, indicators with figures available are converted into relative percentage. Qualitative indicators were estimated by score ranging from 1 to 7 and then it is converted into relative percentage. For each indicator in two comparing firm here, their average relative percentage is always 50%

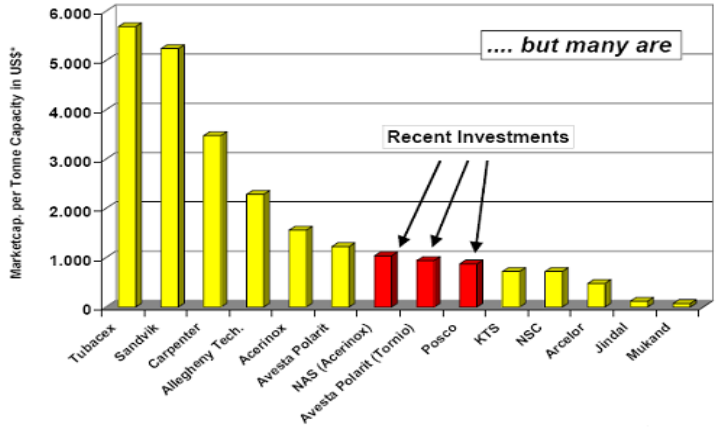
[170] Council Regulation (EEC) No 4064/89,Commission Decision of 31.01.1994,declaring a concentration to be compatible with the common market (Case No IV/M.315 - Mannesmann/Vallourec/Ilva)

Figure 6.6: Estimation of balance scorecard



The diagram demonstrates a balance scorecard with indicates discussed. SMT performance better in most of indicates especially on its financial aspects, R/D activities in new products and knowledge base. However Tubacex have unique advantage in the important indicators such as labor productivity, innovative process, more strong home market position and those constituted its competitive advantages. Despite its relative small in scale, it is no doubt a dark house in the stainless seamless market, which is evidenced by its market value[171] to be highest on a per-tone capacity basis.

Figure 6.7: market value on a per-tone capacity basis



Source: SMR GmbH Consolidation in the Stainless Steel Industry

[171] http://www.steelrx.com/consolid.pdf

Here market value includes both tangible and intangible assets such as production facility and intangible asset such as brand name, established distribution channels, known customers and know-how. Both companies having far more market value than most recent investments on per ton base, it implies both firms have high share of their intangible asset.

6.4 Discussion

The discussion will cover the two cases by explaining the main empirical findings on innovation related to their path, knowledge process and organizational contexts.

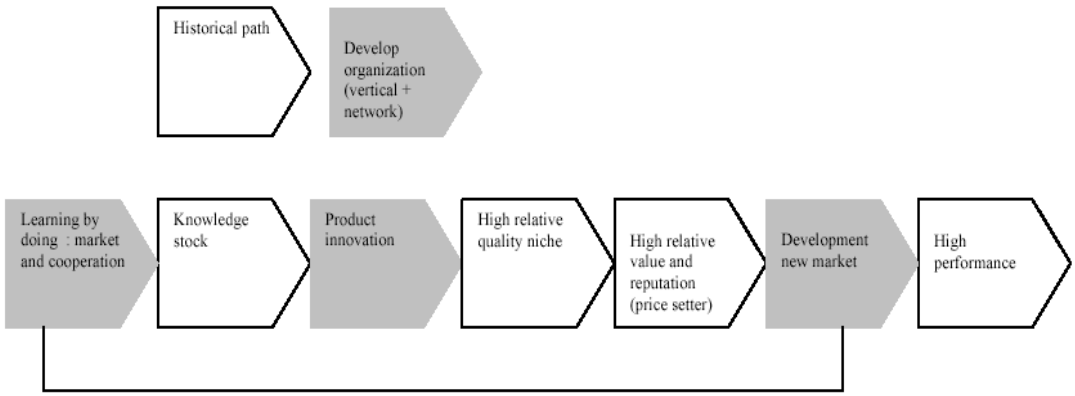
6.4.1 Position, path and process

Teece[172] argued that competitive advantage depends on the managerial and organizational process, created by its specific asset position and path existing. Path is the strategic alternatives existing to firm and opportunities a head. History is important because it influences the future innovation. These important to innovation include accessibility of knowledge, accumulation of know-how, ability to learn, and historical pattern of development.

Path and position as strategic alternatives

Companies identifying themselves to meet its customer's needs and create solutions for commercial success must base on their know-how of existing materials and production technologies.

Figure 6.8: SMT path

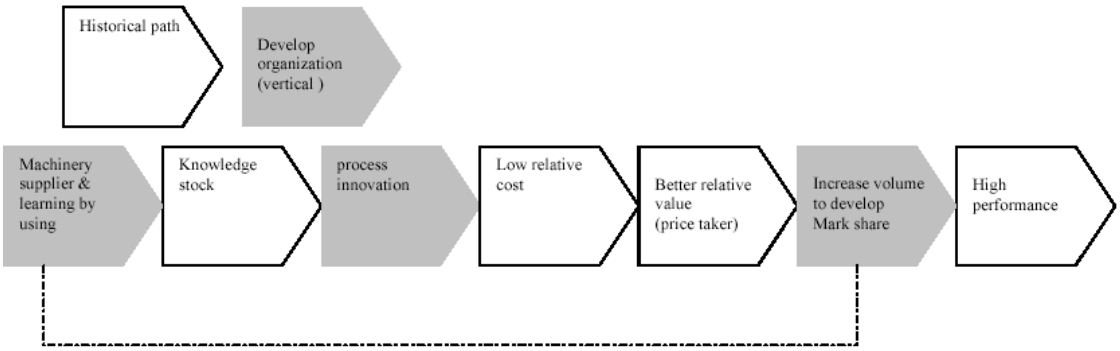


As state earlier the core competence of SMT is mainly in stainless grade development such as Seamless tube and pipe intended for certain industries segments, those competence will lead to new materials, finding new applications or improving the properties.

[172] Teece, D. and Pisano, G. (1994), 'the dynamic capabilities of firms: an introduction', Industrial and Corporate Change, Vol. 3 no. 3, 537-556.

As rich in knowledge base with history of more than one hundred years, SMT have taken a position that apply an incremental innovation .it focus on new product and applications development in a value added niche market as in its vision '*operations focused on high quality and added value, investments in R&D, close contact with customers, and exports'*

Figure 6.9: Tubacex path



On the other hand as relatively new established firm at 1960s with relatively efficient production process, Tubacex have taken a position that focuses only on tubular product in commodity market and provides its customers with low cost solutions. Just as in its vision 'optimizes *of the current productive capacities at the Group's plants and seeks commercial excellence and customer service'*.

Despite two firms are different in their development paths, SMT and Tubacex cases show that process and product innovation can lead to better performance through different strategies with coming organizational support and knowledge process.

Managerial and organizational process
Knowledge process and organization structure are interconnected. Organization structures reflecting on firm's generic strategies and it follow by innovation activities. Innovation depends on a supporting organizational context to generating knowledge.

Firm's organization innovation often match with firm's specify goal. Buzzell[173] has reviewed vertical integration with pluses and minus. The benefits are reduction of transaction cost, guarantee supply, improved coordination, and increase technological capabilities, while the limitation can be capital requirements and falling flexibility. It is justified empirical findings. Tubacex is a total integrated its subunits keeping its core activities- stainless seamless tubular products. SMT is concentrated on different niches and is gradual extension of its vertical product line in its downstream supply chain. By keeping its extensive network, SMT consider vertical expansion a selection only when potential market is attractive enough.

[173]Buzzell, Robert D**.,** Is vertical integration profitable? Harvard Business Review, Jan/Feb83, Vol. 61 Issue 1, p92, 11p

On the tacit level, it is the role of specific activities to move strategy into reality. Because Renewal, revision and refocus are a never-ending processes to enhance firm's competitiveness. If an organization views its future competitive advantage based on continuous learning and use of knowledge, its ability to adapt behaviors to changing circumstance improved. There are different ways of organizing learning process. Push by new market demand, SMT focus on the product development by using the established production process as much as possible, but it also make a lot of investment on market orientated R/D and further vertical expansion to meet demands of target market .It has better interaction with downstream actor, but SMT still keeps most of knowledge in house by organizational support, which makes it possible to better use of its core competence for the coming demands via **learning by doing**. Despite its achievement, a better knowledge management, more efficient productivity will improve its sustainable competitive advantage because the steel maker's should "achieving the most cost-effective production and selling of high-quality products with the smallest possible highly skilled, committed and integrated workforce"[174].

On the other hands, Tubacex had put lot efforts on process improvement in order to realize its low cost strategy through **learning by using** approach. Despite Its core competence is know-how in production, improvement of production efficiency will reaches its limitation without technological more diffusion from its equipment suppliers. Because knowledge of equipment supplier is main knowledge source of innovation, more collaboration with equipment supplier and relevant research institution certainly will lead to improve its quality and give its customer more cost efficient solutions. These will the sources of its sustainable competitive advantage.

Despite SMT out-performance Tubacex in most measurement, both companies need to deal with tendency of decrease entry barriers, globalization and shorter product life cycle, decrease price because new products, process will soon become standardized. Demand is a key for both of them and they should focus on their own path by learning and innovation. With different priority according to their specific vision, SMT and Tubacex should continue investment on R/D, training, market development and improve their production process to advance in their profit , lower cost to meet new challenges such as environmental and energy problems.

6.5 Summary of two case studies

In this firm level study, two cases are introduced. The main case study is SMT, it is chosen as main unit of analysis to conduct detail discussions of key driver of innovation linkage to its competitive strategies. In order to study the performance, its competitors Tubacex is introduced as parallel case study. It provides an opportunity to understand linkages between performance and its key underlying connection to sustainable competitiveness strategies.

[174] The iron and steel workforce of the twenty-first century, ILO, 1997

6.5.1 Outline of empirical findings

Table 6.2: Summary of empirical findings

	Main Drivers of innovation	Innovation and learning	Core competence	Internal process	Competitive Strategy	Suggestions
SMT	Market pull of special solution	A lot of New products	New product development	Valued added products with High quality	niche focus	Further Improve its production and knowledge management process
	Knowledge base pull (learning by doing)	Organizational process towards vertical expansion		Value control	Price setter	Improve its productivity
Tubacex	Market pull of commodity	Litter new product s	Cost efficient production	Above Average quality with low cost solution	Cost and segment focus	Improve quality
	Knowledge base pull (learning by using)	Total integration of the production processes of existed units		Cost control	Price taker	Enhance interactive learning especial with its equipment suppliers

Above table is the summary of empirical findings. On the whole the above empirical findings match the pattern of sectional technological trajectories. As discussed that SMT fits most specialized supplier characteristic, while Tubacex fits scale intensive type.

6.5.2 Drivers of innovation

For the two case studies, general speaking the triggers of innovation process are

- Market demand
- Firm specific knowledge base
- Ability to have Quality linkage between related actors.

The Demand is key for both of firms. Still focusing along with Firm's unique the historical path and its existed core competence are factors leading to different kind of innovations. Father having close linking with specific part of their supply chain through continues learning and innovation, which will lead firms to increase sustainable competitiveness and improvement of performance.

From the Cantwell and Sanna Randaccio's (1993) statistic results[175] of the world's largest industrial firms, *at firm level* the determinants of cross company growth can be growth of own industry demand, growth of own industry technological opportunities, firm specific

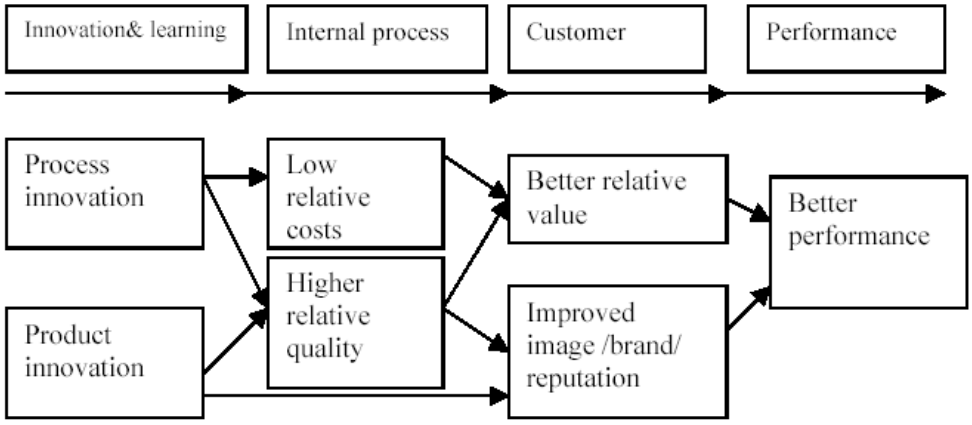
[175] John Cantwell, Innovation and Competitiveness in an Fagerberg 2005, The Oxford handbook of innovation, 2005, Oxford University Press

technological competitiveness, degree of market power, relative multi-nationality within own industry, increase in multi-nationality over period. It supports empirical finding in this paper.

6.5.3 Firm's strategies, innovation and performance

Innovation contributes to performance through its internal process by meet customer demand. Production process innovation can improve quality and reduce cost, while product innovation can change the relative value of goods and reputation. Organizational innovation provides necessaries for Innovation process in developing knowledge stock. Those factors all contribute to the better finical performance.

Table 6.10: Relationship between innovation and performance



Source: based on Clayton 2002 'brands, innovation and growth', from knowledge management to strategic competence

The above figure shows the relationship between innovation and performance. It also describes their causal relationship, which is used by balance scorecard method. Process innovation can improve quality and reduce cost, while product innovation can change the relative value of goods and reputation. Those factors all contribute to the better market performance. (Tidd 2005)

According to firm's specific resource and its environment, there is need of a clear generic strategy among overall cost leadership, differentiation and focus but none of those strategies can guarantee success. As discussed at industry level development barriers to make imitator different can be source of sustainable competitive advantage. On this respect, it is the intangible resources that play important roles in formulation the barrier .Intangible assets accumulation requires ccontinuous learning, better knowledge process and an ability to adapt firm's behavior to changing circumstance. On tacit level, the generating knowledge can through Learning from market and collaboration .This prefer strategies can be enhanced by knowledge management in a proper organizational supportive context.

Chapter 7 Conclusions and Comments

This project took the departure in an analytical framework formed by three blocks: the Porter's diamond model based on microeconomics competitive advantage, resource based view for idea driven growth and system of innovation, because these theories have common elements to determinate the innovation process. The idea of this model has been used to find the drivers of innovation in sector system in empirical ground[176].

A framework is developed in an approach including a sector view allowing for an analysis of specific conditions and factors influencing the innovative activity on sector level. A casual linkage among those drivers of innovation, innovation activities and performance is established. Balance scorecard method is used in the benchmark of the performance of two case firms.

7.1 Reviews of research questions

Main research questions has been to explore innovation process on sustained competitive advantage and strategies for performances improvement in the steel sector

The main research question is divided into four sub-questions:

7.1.1 What are main factors contribute to innovation process to sustain competitiveness on different levels?

In the steel industry, the factors facilitating innovation are demand characteristics, competitive production structure, related and supporting industry such as raw material and energy suppliers, equipment suppliers, conditions for learning and knowledge base and institutions such as environment regulation .The industry dynamics also shape the innovation in its populations.

In the SMT case, the key drivers of innovation are demands, the firm's specific resource, and their ability to make linkages amongst actors in sector. As supported by the two case studies, it is the linkage in the supply chain motivating innovations through generating knowledge.

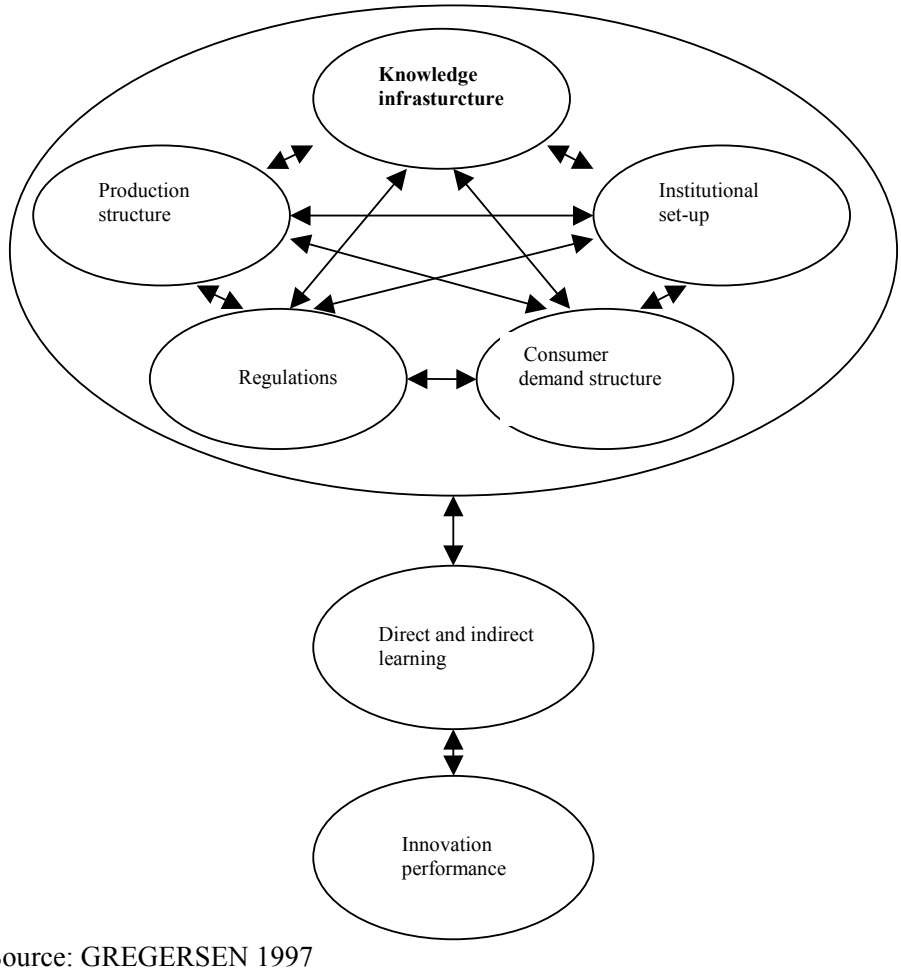
Increased competitiveness is determined by the environment and possession of capabilities for growth in competitive environment, which echoes in performance or in other words, those are the result of innovative activity pushed by internal and external forces. Further interactions amongst those forces also play important roles to move innovation forward, which can be explained by system of innovation.

[176] GREGERSEN 1997 , Learning Economies, Innovation Systems and European Integration Regional studies [0034-3404] 1997 vol:31 iss:5 pg:479

7.1.2 How can system of innovation contribute to sustained competitive advantage leading to the change of performance in the sector?

Innovation is an interactive process. The chief components of system of innovation are organizations , institutions and interaction among actors among of organization or between organization and institutions. It is the quality linkage performs an essential function in system of innovation as more clearly illustrated in following diagram. The sector system emphasizes innovation feedback between market actors and firms as well as environment influences. It is the relationships between producers and users, firms and institutional environment, firms and knowledge infrastructure.[177] This kind of interaction can be explained in resource-based view as a relational capital or social capital, an important source of sustaining competitive advantage.

Figure 7.1: Main factors affecting learning and innovation



Source: GREGERSEN 1997

[177] BA Lundvall ,Innovation as an interactive process: From user-producer interaction to the National Innovation - Technical Change and Economic Theory, 1988 - Pinter

For example in the discussion of environment regulations in steel industry, regulatory is an interactive process and their benefit also discussed. Right interaction will benefit for both firms and society.

The interactive between actors in the supply chain can be enhanced in a number of ways by organization support. One strategy is horizontal integration and another way of organizing is through the extensive use of network, which can reduce the capital requirements. The choice of collaboration in supply chain depends on the balance of the environment, and innovative way collaboration is the key for company success. In SMT case, market force plays profound roles on pushing innovation .Its key for success is knowledge generation and management through learning by doing. In Tubacex case, it is innovative process through learning by using and continues organizational adjustment that play a key role .Its further improvement in the efficiency in production process depends on activities such as having more close association with R/D units and supplies of machinery.

Those interactions are amongst an evolutionary process combining selection and innovation effect. Selection effect is path dependent or might be locked in by historical event but it not necessary path efficient[178]. Innovation contributes to sustainable competitions and finally performance through its internal process by meet customer's demands. Active linkage is an important permeates of innovation. Stimulated by interactive linkages between actors, Process innovation can improve quality and reduce cost, while product innovation can change the relative value of goods and reputation.

7.1.3 What is the role of environmental regulations in motivating innovation contributed to sustainable development in the steel industry?

In the steel industry the main environment impacts are emission and waste which is a topic of primary interest for society, whereas the most important concern for firm is the continuity of their profit making. Through the change of rules of game, regulation is able to protect the public interest by internalizing social cost into firm's private cost. The public regulation is still the most important among other regulations.

Over the years environment policy has changed a lot with the coming of new environmental solution. Those changes will be external shocks to existed equilibrium of individual firm's competitiveness position. Steel firms need more strategies to face the challenge.

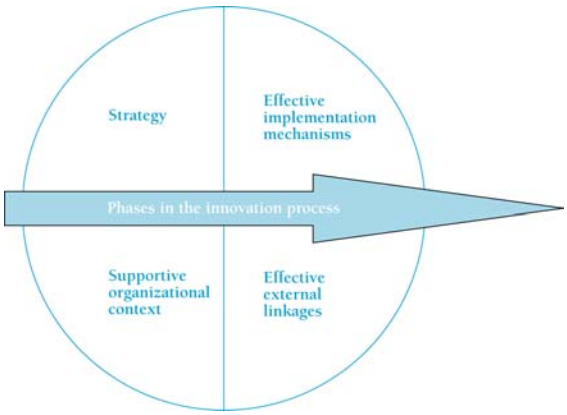
By stimulating innovation, a well designed environmental regulation can benefit from its more social benefit as 'positive-sum game', which is evidenced by empirical analysis. Innovation can achieve sustainable development for both firms and society as whole through interactive learning process between regulatory makers and firms.

[178] W. Brian Arthur, competing technologies ,increasing returns, and lock in by historical events, the economic journal ,Vol 99,no 394,1989 P 116-131

7.1.4 What kind of strategies could contribute to performance improvements on sector?

Success innovation is strategy based. To realize the success of innovation, effective external linkages and effective implementation methods are also required, and so do a supporting organization setting enhancing learning[179].

Figure 7.2: An Integrative Approach to Innovation Management



Source: Tidd 2005: 560

Successful innovation needs a clear strategy. Competitive strategy is determined by strategic alternative available to firms and competitive positioning in the industry, managerial process and technology. History is important because most strategies are path dependent. There are generic strategies but they can not guarantee firm's sustainable competitiveness. Having barriers to make replication difficult is essential for success.

To realize the success of innovation, effective external linkages are also required. Actors in a system are interactive and innovations also rely on effective linkages. It can be developed from collaboration and communication among market actors which offer opportunities for learning.

It is the role of effective implementation mechanism to make change a reality. Firm's competitive strategies should reflect on in its vision and followed by generic strategy. Successful activities are resulted in good performance. On the tacit level, it is the task of innovation activities to realize its goals. It is important issue for a firm to have a clear generic strategy and this is proved by the empirical study of two successful firms.

Finally, a supporting organization context is critical part of innovation activities. According to pervious discussion, competitive advantage come form core competences generated in knowledge base and learning process.An effective collaboration is a process

[179] Managing Innovation: Integrating Technological, Market and Organizational Change. 3rd Edition. Joe Tidd, John Bessant and Keith Pavitt, page 560

of synergy creating knowledge via interaction, which required the knowledge management and structure to support better practices learning from market and collaboration.

To sum up the discussion, demand is a key driver of innovation in stainless sector and firms should focus on their own path; on specific close linking in their supply chain by continue learning and innovation. In order to keep constant or increased returns, differentiation producers focused on new product development should pay more attentions on interactive learning from their direct and indirect users in the market .For those firms focused on cost, the making wise investment on production process innovation is the key to successes and they should pay more attentions on interactive learning with their suppliers. This will lead to increased sustainable competitiveness towards improvement their performance.

7.2 Justification of theories

7.2.1 All in the same family

System approach is used in discussion of factors related to innovation in industry level. Innovations depend on institutional context, resource in industry and industry cluster. Further there are interactions among its components. It followed by discussion of characteristics of innovation in middle-tech industry regarding its process, product and position. To move forward, two cases on stainless sector are used as unit of analysis. The innovation activities of product, market and process, different actors and their interaction are discussed.

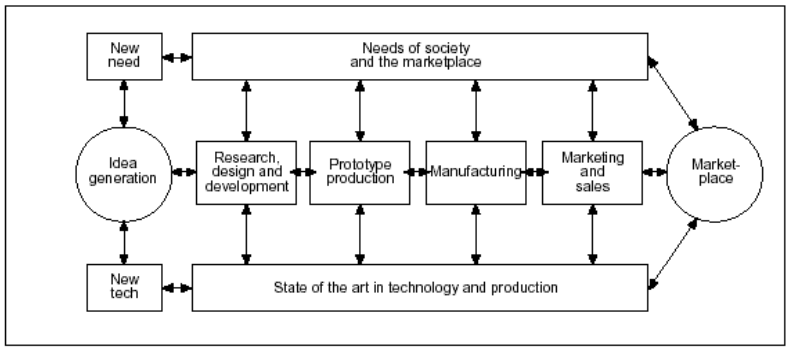
Indeed these two levels of analysis are in the same family. In the industry level, the whole producer network is a player, while in the firm level individual firm in the producer network is the unit of analysis .On firm level; its direct competitors are from the parallels firms or components in the supply chain. The paper shows that two levels have similar contexts as drivers of innovation with difference boundaries.

7.2.2 Understanding the nature of innovation

The innovation is a process with its identical profiles. Rothwell has made reviews[180] that the nature of innovation process evolving five generations of models. The early model was appeared in 1950's, which views innovations as simple technology push or market pull process. There are clear limitation of those liner models when dealing with interaction in real process, and then the model emphasized feed back was appear in early 1970s up to mid 1980s with best fit practice, though it was essentially a sequential process. The following figure is an example.

[180]Roy Rothwell, Towards the Fifth-generation Innovation Process, International Marketing Review, Vol. 11 No. 1, 1994, pp. 7-31

Figure 7.3: Coupling model of innovation



Source: Rothwell 1994

According to Rothwell, from early 1980s time early 1990s, the growing changes of industrials force firms to establish new types of alliances and to seek bigger flexibility and efficiency in responding to market changes. The model at that time stressed on integration and parallel development. Present leading edge model is so called the fifth-generation innovation process and its main element is lean innovation, which marked by [7]

- Greater overall organization and systems integration
- Flatter, more flexible organizational structures for rapid and effective decision-making
- Fully developed internal data bases
- Effective external data link

For stainless sector, the innovation process has elements of those models. Because the steel industry is at middle tech in nature, demand push is still an important factor, whereas technology push is mainly from its in-house R/D and their machinery suppliers. The increase competition from the market requires integration and flexibility. To have whole picture of innovation process, it is essential to view innovation in connection with downstream and upstream players, which typical for an industry with close linkage with other players in its supply chain.

7.2.3 Recommendations

Conducting this case study is basically to examine the validity of assumptions and data in reality. In order to sustain our arguments throughout the paper with empirical findings, more companies with data from different sources and various approaches such as quantitative methods should also be used which is something that couldn't be carried out due to time and resource limitations.

Future research agenda

In case enough date is available, further statistical analysis can be conducted on two cases study results. One possible topic is the effect of drivers of innovation on a firm's innovativeness and performance, which can increase our understanding about factors in relations to the chance that firms will innovate and their performance. Following is a list

of possible indicators for more assessment linking between drivers of innovation, innovation result and performance to test a number of theoretical assumptions.

Table 7.1 Indicators for more assessment

Drivers of innovation			**Innovation indicators**	**Performance indicator**
Demand structure	**Production structure**	**Knowledge infrastructure**		
Level of Price sensitivity	Size of firm	R/D expenditure	Number of new Product	Operating profit
Level of Performance sensitivity	Product mix	Number of patent	Level of process improvement	Return on capital employed
Size and potential of Market	Production Cost	Number of Knowledge workers	Kind and Level of integration	Sales and growth
	key competitions and their market share	Linkages in supply chain	Kind and level of linkage	Market share

The data can be collected from survey and interview. Then several different statistical models can be applied while working with data. To increase robustness of statistics analysis, the theoretical assumption should break down into several sub-models. For example one possible sub-model studying linkage between innovation and collaboration, the results will gain insight into the relations between collaboration and the chance that firms will innovate. Finally the combination of sub-model will help build a more representative model. Further system dynamic simulation method is able to use those models to predict sceneries which will give more insight into the strategic management practice.

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Annexe : Survey

Part one: How well your firm manage innovations

	Below you will find statements which describe 'the way we do things around here' the pattern of behaviors which describes how the organization handles the question of innovation. For each statement simply put a score between 1 = not true at all to 7 very true). Score 1= not true at all : Score 7= very true	Score (1 ~7)
1	People have a clear idea of how innovation can help us compete	
2	We have processes in place to help us manage new product development effectively from idea to launch	
3	Our organization structure does not stifle innovation but helps it to happen	
4	There is a strong commitment to training and development of people	
5	We have good 'win-win' relationships with our suppliers	
6	Our innovation strategy is clearly communicated so everyone knows the targets for improvement	
7	Our innovation projects are usually completed on time and within budget	
8	People work well together across departmental boundaries	
9	We take time to review our project to improve our performance next time	
10	We are good at understanding the needs of our customers/end-users	
11	People know what our distinctive competence is- what gives us a competitive edge	
12	We have elective mechanisms to make sure everyone (not just marketing) understands customer needs	
13	People are involved in suggesting ideas for improvements to products or processes	
14	We work well with universities and other research centers to help us develop our knowledge	
15	We learn from our mistakes	
16	We look ahead in a structured way (using forecasting tools arid techniques) to try and imagine future threats and opportunities	
17	We have effective mechanisms for managing process change from idea through to successful implementation	
18	Our structure helps us to take decisions rapidly	
19	We work closely with our customers in exploring and developing new concepts	
20	We systemically compare our products and processes nub other firms	
21	Our top team has a shared vision of how the company will develop through innovation	
22	We systematically search for new product ideas	
23	Communication is effective and works top-down, bottom—up and across the organization	
24	We collaborate with other firms to develop new products or processes	
25	We meet and share experiences with other firms to help us learn	
26	There is tap management commitment and support for innovation	
27	We have mechanisms in Place to ensure early involvement of all departments in developing new product/processes	
28	Our reward and recognition system supports innovation	
29	We try to develop external networks of people who can help us for example with	

	specialist knowledge	
30	We are good at capturing what we have learned so that others in the organization can make use of it	
31	We have processes in place to review new technology or market developments and what they mean for our firm's strategy	
32	We have a clear system for choosing innovation projects	
33	We have a supportive climate for new ideas — people do not have to leave the organization to make them happen	
34	We work closely with the local and national education system to communicate our needs for skills	
35	We are good at learning from other organizations	
36	There is a clear link between the innovation protects we carry out and the overall strategy of the businesses	
37	There is sufficient flexibility in oar system for product development to allow small' last-track' projects to happen	
38	We work well in teams	
39	We work closely with 'lead users' to develop innovative new products and services	
40	We use measurement to help identify where and when we can improve our innovation management	

Part two: How your firm manages incremental innovations

	Simply put a score between 1 (= not true at all) to 7 (= very true) against each statement. Score I = not true at all: Score 7= very true	Score (1 ~7)
1	We deploy 'probe and learn approaches to explore new directions in technologies and markets	
2	We actively explore the future, making use of tools and techniques like scenarios and foresight	
3	Our organization allows some space and time for people to explore wild' ideas	
4	We make connections across industry to provide us with different perspectives	
5	We make regular use of formal tools and techniques to help us think 'out of the box'	
6	We have alternative and parallel mechanisms for implementing and developing radical innovation projects winch sit outside the 'normal' rules and procedures	
7	We have capacity in our strategic thinking process to challenge our current position - we think about 'how to destroy the businesses!	
8	We have mechanisms to bring in fresh perspectives - for example, recruiting from outside the industry	
9	We make use of formal techniques for looking and leaning from outside our sector	
10	We focus on next practices' as well as best practices	
11	We have mechanisms for managing ideas that don't fit our current business- for example, we license them out or spin them off	
12	We use some form of technology scanning/intelligence-gathering —we have well developed technology antennae	
13	We have mechanisms to identify and encourage 'intrapreneurship' — if people have a good idea they don't have to leave the company to make it happen	
14	We have extensive links with a wide range of outside sources of knowledge — universities, research centers, specialized agencies — and we actually set them up even if not for specific projects	

15	We make use of simulation, etc. to explore different options and delay commitment to one particular course	
16	We work with fringe users and very early adopters to develop our new products and services	
17	We allocate a specific resource for exploring options at die edge of what we currently do — we do not load everyone up 100%	
18	We have reward systems to encourage people to offer their ideas	
19	We have well-developed peripheral vision in our business	
20	We use technology to help us become more agile and quick to pick up on and respond to emerging threats and opportunities on the periphery	
21	We have alert' systems to feed early warning about new trends into the strategic decision-making process	
22	We have strategic decision-making and project selection mechanisms which can deal with more radical proposals outside of the mainstream	
23	We value people who are prepared to break the rules	
24	We practice 'open innovation '- rich and widespread networks of contacts from whom we get a constant flow of challenging ideas	
25	We practice 'open innovation '- rich and widespread networks of contacts from whom we get a constant flow of challenging ideas	
26	We are organized to deal with 'off-purpose' signals (not directly relevant to our current business) and don't simply ignore them	
27	we deploy targeted hunting' around our periphery to open up new strategic opportunities	
28	We have high involvement from everyone in the innovation process	
29	We have an approach to supplier management/ \which is open to strategic alliances	
30	We are good at capturing what we have learned so that others in the organization can make use of it	
31	We have processes in place to review new technological or market developments and what they mean for our firm's strategy	
32	Management create 'stretch goals that provide the direction but not the route for innovation	
33	Peer pressure creates a positive tension and creates an atmosphere to be creative	
34	We have active links into a long-term research and technology community we can list a wide range of contacts	
35	We create an atmosphere where people can share ideas through cross-fertilization	
36	There is sufficient flexibility in our system for product development to allow small fast-track' projects to happen	
37	We are not afraid to cannibalize things we already do to make space for new options	
38	Experimentation is encouraged	
39	We recognize users as a source of new ideas and try and 'co-evolve' new products and services with them	
40	We regularly challenge ourselves to identity where and when we can improve our innovation on management	

Adapted from Tidd(2005:564)