



DOCTORAL PROGRAM IN MANAGEMENT, ECONOMICS AND INDUSTRIAL ENGINEERING

Chair:

Prof. Mariano Corso

The Ph.D. programme in Management, Economics and Industrial Engineering (DRIG) offers students advanced training and preparation to conduct research in the field of management, economics and industrial engineering. It aims to develop professionals who are able to carry out high-profile research in these fields in universities and international research institutions, manufacturing and service companies, regulatory authorities and other public bodies. The programme allows the student to develop a sound methodological background and multidisciplinary knowledge by attending courses designed to provide a multiplicity of visions, theories and approaches, a broad cultural panorama and the ability to study problems in an innovative manner, combining various analytical perspectives.

The commitment of the Department of Management, Economics and Industrial Engineering (DIG) to research and scientific cooperation with other academic institutions and major industrial and service companies creates an ideal environment in which for students to acquire leading-edge knowledge and cultivate their own research interests in a broad range of research subjects.

The program is taught in English. It is composed of three different types of training activities.

Main courses include:

- methodological courses relating to aspects relevant to research in management, economics and industrial engineering;
- thematic courses whose aim is to introduce students in state-of-the-art research in specific fields relating to the above mentioned disciplines: Business strategy, Organization & human resources, Finance, Economics and management of innovation, Industrial Organization, International economics, Regional and urban economics, Supply chain management, Operations, Facility management, Logistics and others.

Elective courses and training in specific themes

these activities are customized according to the specific research interests of students. Their aim is to extend the scientific knowledge of students in specific topics and to introduce them to the international research community through the presentation of research work in international conferences.

Thesis

The aim of the PhD programmes at Politecnico di Milano is to instil

in candidates a research-oriented mind-set, along with expertise and skills relating to a specific research topic.

In order to develop a research-oriented mentality, candidates must acquire the ability to solve complex problems, including a thorough analysis of the problem, identification of an original solution and the ability to evaluate the solution and its applicability in given contexts. Ph.D.s who possess these abilities will have greater opportunities for advancement in research positions, both in the academic environment as well as in public and private organisations.

The main goal is the development of an original research contribution. The Ph.D. thesis should help increase knowledge in the applicant's research field. It also needs to be consistent with the research topics studied in the department in which the student is completing their Ph.D. studies.

The doctoral program covers three years. Students are required to spend at least one semester in a foreign research institution. The Department of Management, Economics and Industrial Engineering is qualified as hosting institution of the PRIME Network of Excellence established by the European Commission within the 6th Framework program. Hence students have access to the mobility support measures aimed at promoting international collaboration between the doctoral programs in the network. In addition, students are encouraged to attend doctoral schools and workshops organized by other institutions and to participate in international scientific conferences. Presentation of an original research work in an international conference is mandatory for admission to the final exam.

In previous years, students have been hosted by well known foreign academic institutions such as

CRIC-University of Manchester, SPRU-University of Sussex, University of Reading, University of Nottingham, London Business School, Trinity College Dublin, Université Henri Poincaré Nancy, Georgia Institute of Technology, New York University, École polytechnique fédérale de Lausanne, Imperial College London, Ecole des hautes études commerciales de Paris (HEC), Cranfield University, University of Warwick, Chalmers University Göteborg, ETH Zurich, Harvard Business School, Columbia University, MIT, UCLA and others.

The Faculty of DRIG includes, in addition to professors of the Department of Management, Economics and Industrial Engineering of Politecnico di Milano, several foreign professors: Adolfo Arata, Universidad Tecnica Federico Santa Maria, Valparaiso, Chile; Neil Gandal, Tel Aviv University, Israel; Benoit Iung, Université Henri Poincaré, Nancy, France; Bertrand Quélin, HEC-Paris; Tereza Tykvova, Zew, Germany; Mike Wright, University of Nottingham, UK; Frank Rothaermel, Georgia Institute of Technology, GA, USA; Irvine Lapsley, University of Edinburgh, UK; Bruno Cassiman, IESE Business School, Spain; Alan MacCormack, Harvard Business School, MA, USA; Dirk Czamitzky, University of Leuven, Belgium; Erik Hultink, Delft University of Technology, The Netherlands; Christopher Lettl, Aarhus School of Business, Denmark; Christopher Worley, University of Southern California, CA, USA; David Coghlan, Trinity College Dublin; Stephen Tallman, University of Richmond, VA, USA.

The program has developed several research collaborations with private manufacturing and service firms, regulatory bodies, and other public research institutions: Value Partners, TXT e-solutions, D'Appolonia, Consorzio MIP, Fondazione Rosselli, Consorzio Politecnico

Innovazione, IRER, Società Banknord GE.PA.FI. SIM, Siemens, Fondazione CEUR, Fondazione Politecnico, ANIMP-OICE-FONDAZIONE LUIGI DE JANUARIO, PIRELLI & C., EUROCONTROL, C.T.G. Italcementi Group.

Typical career opportunities opened up by the doctoral program include the following ones:

- researchers and lecturers in Italian and foreign universities;
- officials of research and training bodies operating as a link between universities and private sector companies;

- researchers in economics and management working in the research departments of private corporations, financial institutions and public bodies;
- consultants in leading management and strategy consulting companies;
- managers and entrepreneurs of innovative companies.

The research projects that are presented in the following section are typical examples of the research work carried out by DRIG students.

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IMPLEMENTING ENVIRONMENTAL SUSTAINABILITY IN MOBILE NETWORK OPERATORS COMPANIES

Nikola Asurdzic - Thesis Advisor: **Marco Macchi** -

Thesis Discussant: **Alberto Portioli Staudacher**

1. INTRODUCTION

Climate change has been described as “the biggest global health threat of the 21st century” by *The Lancet*, one of the world’s oldest and best known general medical journals. The mobile telecom sector can be seen as both a solution to the health threats posed by excessive carbon dioxide emissions and climate change environmental decline, and as a contributor to the problem.

2. BACKGROUND AND MOTIVATIONS

Potentials for choosing physical asset management for purpose of this research and for solution to deal with procedures of HBTS implementation can be seen through the fact that asset management activities permeate to many levels of an organization, and are not confined to a central group. The purpose of the physical asset management function is to provide resources and expertise to support the acquisition, in-service support and disposal of the physical assets required by the organization. Advantage of using PAM approach in this case would be also connected to the fact that asset management activities and responsibilities impact on a wide range of roles within an organization are not confined to a specific department. The asset management groups would in

fact have key roles in acquisition and development decisions, acquisition and development projects, and in creating and managing organization-wide systems for equipment support for new and existing assets.

3. GOAL, SCOPE AND RESEARCH QUESTIONS

Part of the research put the spotlight on environmental comparison based on LCA approach between renewable power solutions for BTS-site and standard/conventional BTS-sites, both connected to an electrical grid. The results of this research served as a basis for further research process of forming the unique guideline for HBTS implementation by MNO company. In order to support both sides, managerial and technical, we intersected above mentioned data and information obtained from LCA analysis with PAM approach. The conclusions, discussions and derived *guideline* from this research could be useful for improving the knowledge of MNO companies and also helping MNO employees to gain more understanding of the power alternatives currently available and most suitable strategies for their implementation.

4. METHODOLOGY

Methodology consists of three types of the research, namely:

- First case study - Type of

the research: explanatory – exploratory multiple – case study

- Second case study - Type of the research: Modeling and simulation
- Third case study - Type of the research: Validation phase

5. RESULTS AND DISCUSSION

Results from the case study showed that the strategy of implementation of HBTS may be carried out in parallel technology implementation phases. The first phase concerned only the implementation of standard base station equipment not related to the power section, while the second phase consisted of the implementation of hybrid part of the BTS equipment.

Results on Physical Asset Management usage in case of Hybrid Base Transceiver Stations

In the next points, a critical discussion is provided considering the main evidences useful to give some feedbacks, as required for the exploratory case study, and in relationships to the research questions.

- In the detailed design, the special team opened a tender for technical assistance in the project of the implementation of hybrid part of the equipment. This tender was open to third parties due to the lack of technical knowledge about hybrid equipment among telecom departments.

The process of technical solution analysis has to be in-sourced in order to save CAPEX and time as well. This can be done by educating personnel, training and gaining technical knowledge and experiences with the hybrid part of the equipment. In this manner telecom management will be ready to enable effective implementation of "green" technologies, such as HBTS.

- The next step in procurement stage was to open a tender for equipment procurement and construction. OEM has to be contacted in order to supply the suitable parts of the equipment such as PV cells and wind turbine with all the supporting elements. The process that can stay in sourced in this case is construction and mounting of the hybrid parts since MNO personnel have enough technical knowledge, experience and tools for these actions. This is the next step in enhancing MNO management in order to enable effective implementation of "green" technologies.
- The last phase of the implementation and use process of the hybrid part of the equipment where a third party is engaged is the maintenance process. In the case study conducted, contract for the maintenance was signed at the time of the procurement process between MNO company and OEM or equipment vendor. Since hybrid equipment technical features do not differ from telecom equipment, in this case maintenance department of the MNO company can be put in charge of the maintenance process. This is

how OPEX and time can be saved in the process of HBTS implementation. By providing in-sourced maintenance for hybrid part of the equipment, management will set a more effective and suitable state for implementation and operation of the HBTS.

Results on comparative Life Cycle Assessment of Base Transceiver and Hybrid Base Transceiver Station

Comparative analysis of BTS and HBTS models for two life cycle stages was conducted. HBTS has a greater negative impact on the environment than BTS across all impact categories. HBTS has a greater impact throughout all of the impact categories compared to BTS. Impact categories that are most burdened are: *global warming, non renewable energy and respiratory inorganic*.

Among others, the following categories can be separated as influential: *carcinogens, non-carcinogens and terrestrial ecotoxicity*. After the inclusion of the use phase the impact of BTS on the environment became greater in the following categories: *ionizing radiation, respiratory organics, aquatic eco-toxicity, terrestrial eco-toxicity, land occupation, global warming and non-renewable energy*. The impact of HBTS remained larger within the following categories: *carcinogens, non-carcinogens, ozone layer depletion, aquatic acidification, aquatic eutrophication and mineral extraction*.

Payback period

the payback period for the investment in equipment of PV cells and wind generator for the particular location assumed in this study is around 14 years

(more precisely 13, 88 years);

6 CONCLUSIONS

The outcomes of this PhD dissertation make several contributions in order to understand the environmental sustainability in MNO companies, and expand knowledge on how promoting and enhancing the adoption of green practices in a MNO company's settings. First of all, the dissertation contributes to offer new empirical evidence of the process of the sustainable practices adoption by MNO company, having a particular focus on the introduction of a green technology as the Hybrid Base Transceiver Station. Afterwards, it is worth remarking that the dissertation identifies some internal barriers that prevent green practices adoption such as; knowledge and information gap in sub – stages of hybrid base transceiver stations introduction especially focusing on the detail design stage where MNO company seek for a support from the third party strategic supplier. Last but not least, the thesis would help contributing to protect the environment in shaping the organizations' strategies towards the environment. Knowledge and information from this study can serve as an incentive and also as the guideline to MNO companies for the implementation of green practices. The adoption of green practices would contribute to lower environmental load caused by MNO companies and thus, improving the overall image in the field of environmental protection, because as the say; "think globally, act locally".

MULTICHANNEL MARKETING: A GENERALIZED FRAMEWORK, AND THE ANTECEDENTS AND CONSEQUENCES OF ITS IMPLEMENTATION

Shan Chen - Supervisor: **Prof. Giuliano Noci**

From 1997 to 2014, the worldwide internet users are estimated to have grown nearly 20 times; in developed countries, the internet penetration rate is estimated to be 77% in 2014. Mobile internet, from 2007 to 2013, has grown seven times worldwide; especially in developed countries, mobile internet users have reached about 75% of the population¹. Businesses spotted the potential and opportunities amid the rapid diffusion of Information Communication Technology (ICT). In EU-28, there are nearly 40% consumers who actively make purchases through internet by 2013; also nearly 40% of the enterprises make purchases online; 40%, 25% and 5% large enterprises, medium-sized enterprises and small enterprises respectively are making turnovers through internet commerce². Internet has made some spectacular successes, for example, most recently, the Chinese e-commerce company Alibaba which operates a wide range of internet-based services, has made the world's biggest ever IPO in September 2014³. However, it is not only about commerce. Empowered by ICT, businesses create new customer touchpoints which influence and transform consumer behaviors, which in turn set new expectation and demands to all

the businesses competing in a market. For example, consumers nowadays have access to larger than ever before amount of information through internet from official, third-party, or even user-generated sources; and the web indeed has become one of the most important touchpoints that consumers rely on to search for information⁴. As such, since the late 90s, we see the approach of "multichannel marketing" emerged and rapidly gained importance in both marketing practice and marketing research. As ICT has potential impacts on a wide range of marketing activities, a large amount of multichannel marketing research has sprung up and has provided a great deal of knowledge in this area. However, ICT is still evolving in fast pace. For example, while internet had been the one of the hottest innovations in the 90s, it has become almost a standard and given the spotlight to mobile technologies just a decade later. While marketing research in this area is always tempted to keep up with the pace of technological evolution, it inevitably leaves the current knowledge fragmented and un-generalized. In a quick glance of the extant research, we find a lack of comprehensive understanding of multichannel marketing framework that is

generalizable and applicable to different types of businesses.

Thus, the objectives of this research which is composed by three consecutive studies are:

1. With the first study, we review the state-of-the-art literature in multichannel marketing in order to systemize the current knowledge, to build theoretical foundation for the following studies, and to refine the research question for the empirical studies.
2. With the second study, we propose a multichannel marketing framework, integrating the knowledge from current research and the marketing practitioners' viewpoints, which is comprehensive, generalizable and applicable to any type of businesses.
3. With the third study, we investigate the antecedents and consequences of implementing multichannel marketing, which provides firms practical implications.

In the first study, throughout the whole period of this research being conducted (2012-2014), we reviewed some 130 papers published between 1996 and 2014 on peer-reviewed and reputable journals; the results are discussed in two broad themes: consumers' behavior in multichannel environment, and firms' behavior in multichannel environment. Based on the

literature review, we conclude that the future research in multichannel marketing lies in several areas. First of all, as technology development continues unravelling, new marketing channels or new applications in current marketing channels will keep emerging; so will the research opportunities on these subjects. Second of all, among the most influential papers in multichannel marketing, a substantial amount are theoretical studies which have played important roles in building the conceptual foundation of research in this field. However, as multichannel marketing becomes commonly adopted by firms, there is a need for stronger empirical evidences. Last but not least, a more global perspective on multichannel marketing is needed in order to benefit firms of different characteristics and objectives. In fact, at the very end of this research period, we see a couple of freshly published studies addressing the issue of strategic alignment of multichannel marketing. A combination of the latter two areas for future research is where we set the context for our following empirical studies.

The second study started in the late 2012. It has taken a qualitative approach, where we conducted in-depth interviews with marketing and/or general

managers from 32 Italian firms of diverse characteristics (in terms of size, type of products, type of customers, and industries) in order to tap a wide range of experiences in implementing multichannel marketing. The interviews are analyzed against the literature. This study has two main contributes: firstly it proposes a multichannel marketing framework composed by three dimensions: channel variety where individual channels are aggregated into nine types; channel usage intensity for distribution, information provision and/or relational communication; and channel integration perceived by customers and perceived within the firm. Secondly it reveals the firms' motivations of adopting multichannel marketing, which are summarized in three types: economic-driven, customer-driven, and compelled by competition.

The third study started in the late 2013. Building upon the framework proposed by the second study, it investigates the relationships between multichannel marketing practice and its antecedents and consequences in a quantitative approach. The results suggest that different motivations of firms in implementing multichannel marketing influence the multichannel

configuration; and the influence from firms' motivation is much more significant than the influence from environmental forces. The results also suggest multichannel marketing's short-term performance dip may even be expected due to investments and extra costs associated with implementing multichannel marketing; however, empirical evidence also suggests that firms active in multichannel marketing show stronger improvement in effectiveness of utilization of their assets. To our knowledge, it is among the first times such relationships being investigated. In this dissertation, these three studies will be presented in the following as full-length research papers, with respectively introduction to areas of investigation, description of methodologies applied and data collection, description of data analysis, then presentation and discussion of results, research and managerial implications if any. After the three papers are presented, we will conclude the whole research.

¹ International Telecommunications Union

² European Commission, Eurostat

³ Bloomberg, "Alibaba's banks boost IPO size to record of \$25 billion"

⁴ Nielsen, Osservatorio Multicanalit', 2013

ALLOCATION OF RISKS WITHIN PUBLIC-PRIVATE PARTNERSHIPS:

A Holistic Framework and Its Application to Energy from Waste Projects

Laura D'Alessandro - Supervisor: Marco Giorgino

The ever-growing demand for public services simultaneous with a reduction of public resources results in inability to meet demand for infrastructures. Given the ongoing austerity measures adopted across the EU, the solution is neither the use of debt nor increasing tax and so there is a need to find alternative sources of funding. Hence, it is desirable to seek the private financing of public utilities and service infrastructure through Public-Private Partnerships (PPPs). PPP was launched in 1992 in the UK, originally as Private Finance Initiative (PFI) where successive governments promoted the involvement of private sector in the construction of infrastructures and the subsequent provision of public services utilizing those infrastructures. Even if there is not a universally agreed definition of PPP, it can be considered as a form of collaboration between public and private sector. Since it was launched, PPP debate is assuming a growing importance. The allocation of risks is considered a key element for achieving value for money (VfM) and the success of a PPP project depends crucially on its risk allocation agreement. The main aim of this research is to investigate the allocation of risks in PPPs by using a holistic approach based on

the recognition of the critically important distinction between management and bearing of risk and thereby the relevance of risk governance within a dynamic business context.

A critical review of different contributions over time reveals the approach to risk allocation in PPP is too simplistic and based only on a technocratic approach to the allocation of each risk to the party best able to manage it, ignoring the ability to effectively bear the risk at its occurrence. Furthermore, the risk allocation agreement is not able to face the dynamism of context. Contractual incompleteness is not proactively managed because there is a lack of consideration of risk governance aspects.

The literature also reveals that the analysis of risks in PPPs varies from sector to sector. Hence, distinguishing between social (e.g. prisons etc.) and economic infrastructure (e.g. toll road etc.), this research focuses on Energy from Waste (EfW) PPP projects. EfW cannot be considered either purely social or purely economic infrastructure due to the impact of regulation in the waste management industry being concerned not only with economic regulation but also environmental regulation which has implications for social risk arising from pollution events. Hence, EfW can be interpreted

as a hybrid form of PPP in terms of risk sharing. The literature lacks scientific articles on this main topic of risk sharing in this specific sector and so an original contribution to knowledge can be made by empirical research in this field of study. This contribution includes:

- a more holistic analytical framework for considering the allocation of risks within PPPs,
- the appropriate arrangements for governance of those risks within PPP contracts extending over two or three decades and which are therefore inherently incomplete because they cannot foresee all eventualities affecting risks,
- empirical research results derived from a comparative analysis of risk sharing in EfW schemes in different countries, and
- evidence-based recommendations for policy and practice.

A comparative analysis on three EfW PPP projects in Italy and the UK has been developed to understand the risk allocation criteria adopted. Subsequently, an in-depth analysis in one EfW PPP project in Italy has been done.

Research results reveal that risk allocation in PPPs is reflected in a contract where the greater part of risks are transferred from public to private sector on the basis of a risk catalogue

of all potential risks identified. However, the adoption of this criterion seems to be not enough as public sector often has to bail out the project when the private sector cannot cope with the allocated risks. Notwithstanding the inability to statistically generalize from case studies, the empirical results derived from the three EfW cases analyzed suggest that the risk allocation criterion adopted in PPP has not been fully understood in the literature and it has been implemented in a myopic and linear way in practice instead of dynamic and non-linear. In fact, the unique criterion adopted for allocating risks is the ability to manage risk whilst the public sector seems to underestimate the relevance of risk bearing dimension. The allocation of risk based on the party best able to manage risk does not consider the ability to bear those risks at their occurrence ignoring the dynamism of context over 20-30 years and the complexity of a PPP. In fact, as revealed by comparative analysis, the bearing of default risk pertains the public sector independently of the contractual specifications. Hence, risk transfer seems to be more apparent than real. Aware that PPP contract is necessarily incomplete, this study went beyond the conventional tick box exercise adopted for allocating risks between public and private sectors which can be suitable only in a static context. The first original contributions to knowledge provided by this study is the recognition of risk bearing as an additional criterion for allocating risk. The literature review also reveals a gap in academic research

concerning the adoption of a dynamic model of risk sharing. In fact, the dynamism of the context and its impact on risk sharing agreement is not recognized in the static public sector comparator or other such assessment of value for money. The case studies make clear that contractual rigidity is in sharp contrast with the dynamism of context, suggesting that further work on governance aspects is required, especially those that can be important in managing contractual incompleteness over time. Hence, considering the literature gap and the case studies results, an in-depth case study analysis has been done by extending the analytical framework in order to handle contractual incompleteness over-time. A new holistic approach to risk sharing based on a new paradigm has been developed: managing and bearing risks within a dynamic model of multidimensional risk governance. An original contribution to knowledge is the adoption on the innovative framework to analyze the allocation of risks in an EfW PPP project in Italy, where there is a lack of scientific contributions focused on risk allocation in this specific sector and in this specific context. The new framework has been applied revealing that a risk allocation agreement based on risk management and bearing can better safeguard the interest of actors involved over-time. Furthermore, according to a the literature gap identified, case study reveals the adoption of a technocratic approach to risk governance taking into consideration operation-

level of risks only without considering the strategic-level. This can exacerbate the issue of incomplete contract. Aware that PPP contract is necessarily incomplete, starting from the distinction between technocratic and multidimensional approach to risk governance, this study proposes a new research stream by reinterpreting PPP as strategic alliances to overcome contractual incompleteness in the cases of social and hybrid infrastructures. More specifically, this study recognizes that the adoption of a technocratic approach to risk governance, based on consideration of operational-level of risks, is related to the tangible characteristics of the contract without considering the strategic role played by the interpretation of intangible characteristics of contract. In this regard, the consideration of only tangible characteristics to set treats a PPP as contractual partnership and not as strategic alliance. Nowadays, PPPs, PFIs, PF2 can be interpreted more as contractual partnerships than as strategic alliances.

HOW TO DESIGN AND IMPLEMENT THE SPENDING REVIEW: AN ANALYSIS ON THE EXOGENOUS AND ENDOGENOUS FACTORS AFFECTING THE EFFECTIVENESS OF THE SPENDING REVIEW PROCESS

Angelo Erbacci - PHD Supervisor: Prof. Giuseppe Catalano

The objective of this work

The thesis conducts a scientific analysis on the international practices and uses of a specific managerial tool: the spending review. In basic terms, the spending review can be defined as a policy instrument that organisations (generally public sector entities) apply in order to control and reduce their spending. In recent years the theme of spending review obtained an increasing relevance on the international scenario, particularly since the advent of the global financial crisis. However, despite the increasing relevance that the spending review has obtained, only an emerging academic literature investigates the phenomenon of the use of spending reviews. The thesis aims at filling this gap of knowledge by investigating how an organisation may effectively design and implement a spending review. The focus of this work is on the use of spending review by central governments. More specifically, the objective of this work is to investigate *how a central government may effectively design and use the spending review*. Indeed, the viewpoint that drives the thesis is to examine how an organisation may methodologically implement this instrument.

Methodological approach

To reach its purpose, the thesis follows a theory-building approach. This methodological choice has been set considering the lack in the academic literature of a detailed theoretical framework under which analysing the design process of the spending review. The process of research is based on three different steps. As first step, the thesis defines the spending review, by proposing a conceptualisation of the main features involved in its process based on a review of the academic literature on cutback management in public administrations. Establishing a clear definition of spending review is an essential condition for outlining the elements of the effective design of a spending review. Indeed, in the absence of a single univocal definition, different policies may be included under the label of a "spending review", leading to mistakes and confusion about its use. Then, (as second step) the thesis identifies and analyses those determinants (exogenous and endogenous factors) that may affect the effective use of this tool. To this end, following a meaning-oriented approach to qualitative content analysis it performs a cross-sectional comparison on five international experiences of spending review implemented in OECD countries.

Finally (as third step) the thesis carries out an explanatory case-study based on pattern-matching logic. This logic compares an empirical pattern (the Italian spending review of 2012) with a predicted pattern (the theoretical assumptions previously developed by the thesis following the theory-building approach).

Research limitations

The main limitation of the thesis consists in the small pattern of empirical cases of spending review examined. This limitation is consistent with the low number of spending reviews at the level of central government up to now present around the world. Indeed, the use of the spending review is spreading in many advanced countries but, in numerical terms, the population of spending reviews is still quite small. Moreover, the thesis is based on qualitative analysis and as such it can't be directly generalised elsewhere. On the other hand, following a qualitative methodological approach built upon a big amount of evidence collected, the analysis can deeply focus on its research questions, by discovering qualitative issues specific of the institutional and political environment that generally accompanies the spending review process. For this reason, the thesis may result

to be of interest also for the countries not comprised in the empirical pattern and for the institutional debate.

Key findings

In the first part of analysis, the thesis develops a definition of spending review as a managerial process (an *ex ante* analysis of evaluation) that organisations can adopt to carry out a selective approach to address decline (by identifying non-linear savings). Then, by following this definition, the thesis builds a taxonomy that outlines two different archetypal designs of this tool: the *strategic* and the *technical* spending reviews.

In the second part of analysis, the thesis identifies a theoretical model composed by two endogenous factors (*organisational* and *process dimensions*) and two exogenous factors (*political* and *social dimensions*) that may influence the decision-making process of the spending review. The cross-sectional comparison confirms the validity of the four factors since in the majority of empirical cases the dimensions directly affect the spending review process.

Finally, as third part of analysis, the thesis outlines some relationships across the exogenous and endogenous factors and discovers the centrality of the organisational

dimensions in affecting the final effectiveness of the spending review process. Moreover, this part of analysis shows the importance of the dynamic of time (in terms of timing within the spending review must be carried out) as elements altering the effects of the exogenous and endogenous factors on the spending review process. In this sense, the thesis reveals that when recovery interventions are needed especially in the short period, the spending review is not the best strategy to achieve these outcomes.

The potential value of this work

Investigating the features of the effective design of the spending review tool represents a high potential target both for scholars, public sector managers and politicians. Indeed, from an academic perspective, this work ambitiously aims at covering an undefined area of research on which, up until now, only an emerging literature operates. While, from a practitioner perspective, a research on the spending review tool may represent a first term of reference for politicians, managers and public sector analysts through which addressing their need of information, data and guidelines regarding how to design, implement and effectively use

the spending review instrument. Along these perspectives, the most important contribution that this work offers is the development of a first theoretical framework that detects those factors that have an influence over the effectiveness of the spending review, confirming an emerging view that sees organisational change management and neo-institutionalism as two complementary and not rival approaches. In this way, the thesis provides a first theoretical base that can be used by practitioners to direct the ways the spending review is designed, implemented and utilised.

FAMILY BUSINESS PERFORMANCE. THE PERCEPTION EFFECT: EXPLORING THE INTERNAL POINT OF VIEW

Sanson Roberto Gonzalez Mosso - Supervisor: **Prof. Marco Giorgino**

The main contribution of this research project is the identification of the conceptual framework called "perception effect" in the family business performance, in the particular case of family business without the obligation to submit audited financial statements.

The perception effect will define the tendency of the future business performance due to the influence on the current behavior. The construct of perception effect comes from the analysis of empirical evidence from Mexican case studies and interviews with independent business advisors. Mexico is considered an emerging market. In recent years emerging markets represent an important component of the world economic growth. Emerging markets are highly dominated by family businesses, whose performance improvement would benefit the economy in general. Family firms (FF) are very important for the economy to which they belong: placed in different sectors, they vary in size, age, objectives and nationality, among others. The principal theories used in the literature to explain the family business performance are the Agency Theory, the Stewardship Theory and the Resource Based View Theory. The Agency Theory deals with one of the more common characteristics

of family firms: the overlap of ownership and management; the Stewardship Theory calls for the altruism of family managers following the benefits of the organization rather than their own; the Resource Based View (RBV), looks into the particular resources coming from the family involvement. Those theoretical efforts have been useful to identify some of the complex dynamics that are present into the different types of family business. The influence the family brings into the business affects its performance through the coexistence of both financial and non-financial goals, although, in the literature, the assessment of family business performance is mainly based on financial measures.

The current studies on this subject are mainly related to succession, corporate governance and strategic management, leaving a gap for more research in other related topics, as in the case of business performance – particularly, the use of financial information provided by family managers, as well as the system utilized to assess the business performance. Perception has an important influence in the decision making process of family managers. This is true particularly in the case of family businesses without the obligation to submit financial statements due to the lack of

control of information – both financial and non-financial: family managers take core decisions under the perception effect.

The financial reports are part of the performance measurement system (PMS) of a firm: knowing the current performance, it is possible to take decisions in order to keep or improve the business' position. When a family firm is not obligated to submit audited financial statements, the financial information they deliver might not represent a priority, leading to the replacement of the financial assessment with selected measures for the "perception" of performance. Little research exists about performance measurement system design and implementation in family firm. The current studies pay attention to the analysis of financial outcomes, leaving aside the reliability of this information, specifically for those family firms that, not being public companies, are not obligated to present audited financial statements. The present work has the objective to contribute filling the gap by analyzing how the performance measurement system is implemented as well as how the financial information coming from this system is employed in order to take internal decisions.

This thesis aims to provide family managers with some insight on the importance of an adequate use of financial information and of a formal performance measurement system that might be useful to lead the company to the desired place, in terms of business performance. The academic community will achieve a perspective that extends the literature about family business performance, with particular reference to the use of financial information and the establishment of a performance measurement system, by pointing out the important effect of perception into the business performance. The limitation of this work consists in the absence of a measurement of the actual impact of a structured PMS. The use of complete and accurate financial information would influence the decision making process but, at the same time, will entail other costs, as tax payments and the implicit cost of control. Another important limitation is that the study considers only the Mexican environment, although it might be representative of the general conditions faced by family firms in emerging markets. Family firms without the obligation to submit audited financial statements may not have an established and organized PMS. This kind of family firms might consider as a PMS a set of activities aiming to collect, process and analyze information on the actual situation of the company, as well as the trends in some core areas of the business. The informal activities deal with incomplete information, with the consequence of low quality

decisions. The use of automated systems and technological tools might be underexploited. Raw financial data can be confused with processed reports, preventing the creation of historical information; decisions are taken on a day-to-day basis. This study points out the importance of the PMS establishment in a FB in order to improve the quality of the decision making process and of the business performance. The family and business goals are not necessarily established in an explicit way, translated into financial and non-financial measures and followed for their accomplishment. Family and business goals are clearly “perceived”, implicitly translated into financial and non-financial “measures”, the accomplishment of which are easy to be “felt” by the main shareholders. Family goals might represent the main objective of some FBs, but they might also compromise the business survival. A clear and objective PMS, might help to improve the quality of the decisions, leading to a better business performance over time. This research contributes also to the FB literature and business practice in understanding the possible benefits of the establishment and implementation of a formal PMS in a FB during a generational change. It highlights the importance of a formal PMS in creating a history on different indicators that permits the tracking of the business performance, helping FBs overcome their weaknesses and generate better financial and non-financial outcomes, with positive effects within the

general economy. Future research may be focused on the presence of multiple family nucleuses with conflicting goals inside a single FB, affecting the design of the PMS, as well as the selection of measures and consequently influencing the business performance. A multiple case study may be conducted to confirm or reject some of the findings of this work regarding the influence that the family goals exert on the PMS design of the business. For future research, it would be important to understand the impact of formal and established PMS in the FB assessment because, if the process to collect and analyze information is not reliable, the assessment might lose its validity. If FBs provide incomplete information, the validity of the assessment of good or bad performance might be compromised. This research has been conducted at the Politecnico di Milano, Italy, under the supervision of Prof. Marco Giorgino; during the period abroad, at the Columbia Business School, New York City, USA, under the supervision of Prof. Eric Abrahamson. The empirical research was conducted in Puebla, Mexico.

METHODOLOGY TO DEFINE AND IMPROVE PERFORMANCE INDICATORS FOR VIRTUAL ENTERPRISES, WITHIN AN INDUSTRIAL SERVICE ECOSYSTEM

Mohammadreza Heydari - Supervisor: **Prof. Marco Taisch**

In the context of collaboration, service sector is becoming more and more relevant in building successful enterprise networks among potential business partners that want to join a temporary and less hierarchical collaboration network in order to grasp the market opportunities. In recent years, collaborative networks, such as Virtual Enterprise (VE), has been providing as a competitive advantage and started changing business environments. In this regard, VE has been identified as a proper solution for single manufacturing enterprises to survive in increasingly market turbulences but also to increase the possibility to better achieve common goals. Therefore, the collaboration process happens within a VE lifecycle to share internal knowledge (i.e. information), resources, costs and responsibilities among partners in order to evaluate and to implement shared activities and resources to attain common objectives. If should be noted that the success of a virtual enterprise is difficult, due to coping with an unpredictable environment, seating on highly dynamic structure and having a short life cycle. In particular, assessing the collaboration activities among various partner (e.g. different cultures, sizes, tasks, roles, etc.) are the main reasons of this difficulty.

However, single manufacturing enterprise might not be skilled to join a VE solely without setting control mechanisms or frameworks that monitor the success of collaboration among partners, in order to measure the efficiency and effectiveness in achieving common objectives. This study investigates VEs at practical implementation level in order to provide an appropriate mechanism and methodology that supports decision makers to manage and assess the service performance within a VE. The basic idea behind of the proposed method (i.e. PI Toolset) is to support decision makers to be able to identify, control and continuously update which collaborative activities (i.e. Functions) are necessary for service performance within a VE in order to reach the objectives. In order to accomplish this objective, on one hand the study has been shed light to VEs characteristics and it has analyzed (e.g. Lifecycle, Members, Models, Interactions, Structures and etc.) both conceptual and practical perspectives. On the other hand, various traditional Performance Measurement Systems (PMS) have been reviewed to select the proper assessment method according to VEs features and manufacturing service enterprise attributes. Indeed, the selected PMS has

been used to extract the most appropriate service driven Performance Indicators (PIs) in order to evaluate collaborative actions and common outcomes of partners within a network of manufacturing service collaborative ecosystem. Meanwhile, in order to have a precise and structured analysis the selected PMS has been extended by synthesizing decomposition methods such as decisional models and abstraction methods (i.e. MDSEA). In this regard, the proposed methodology has provided a unique structure to categorize the generated PIs in different levels of decisions and abstractions (see Plan, Govern and Execute categorize in VRM). Furthermore, a PI Toolset has been defined to provide a simple and useful tool for end-users; this essentially consists in a combination of three methods, i.e. Service Monitoring Framework, Service PI Method and Service PI List proposed. Finally, in order to maximize the methodology efficiency, the proposed PI Toolset has been implemented, tested and validated through various real pilot cases in terms of different market, culture, size, etc. Therefore, the PI Toolset has been developed and optimized in a continuous -back and forward process, taking advantage of both use

case practical applications and scientific industrial collaborations.

Keywords: Collaborative Network, Virtual Enterprise, Manufacturing Service Enterprise, Performance Measurement Systems (PMS), Performance Indicators (PIs) and PI Toolset.

SUSTAINABLE VALUE CREATION IN MANUFACTURING THROUGH MAINTENANCE SERVICES

Maria Holgado Granados - Tutor: **Marco Garetti** - Supervisor: **Marco Macchi**

Due to the increasing demands for integrating sustainability within business, manufacturing firms are paying more attention to improve their performance in terms of economic, environmental and social criteria. In this context, the role of maintenance is changing and, in fact, maintenance is perceived as a key business function for achieving longer equipment lifecycles and more sustainable performances within manufacturing companies. An enlarged role of maintenance function is envisioned to contribute towards the integration of sustainability in manufacturing by keeping the equipment performing the required functions while minimizing material and energy consumption.

Manufacturing is also experiencing another emerging trend called servitization, which is seen as a process of creating value by adding services to products and implies a transition from product-centric offerings to progressively increase the content of services in the offerings. This involves the adoption of a more customer centric approach, addressing concrete customer needs with more tailored solutions instead of just products. These services are closely related to maintenance whenever the solution is offered by

equipment manufacturers to their industrial clients and they can be provided throughout the whole equipment life cycle. Furthermore, a service-orientation in manufacturing has been suggested as one of the possible strategies towards sustainable manufacturing. This PhD research investigates on how industrial maintenance can be an enabler of more sustainable manufacturing operations through its role in the provision of industrial services. It focuses on the particular case of maintenance services in the Business-to-Business market, where the service providers are either Original Equipment Manufacturers or Maintenance Service Providers and the customers are the industrial users of manufacturing equipment that acquire those services. Particular attention is given in this work to new forms of maintenance services developed thanks to technological innovations, which bring opportunities to enhance sustainable value within the provided service. The transformation of equipment manufacturers towards servitized manufacturers brings new challenges that are being studying in literature. In this regard, this PhD research focuses on three of the elements of the transformational model – customer, value, new offering

– as main research themes. Considering the potential variation of servitization aspects in different industries and application areas, this research investigates different customer's contextual situations and requirements. Thus, it considers different manufacturing sectors and geographical aspects within the research as the customers of the services under concern are the industrial users of manufacturing equipment. Customer value has to be understood as the value obtained by the industrial user from the acquisition of maintenance-related services. In this sense, there is an important contribution of this PhD research regarding the understanding of value-in-use, in the particular case of customers of maintenance-related services. Special consideration is made to the creation of value-in-use under the perspective of industrial sustainability, thus, encompassing economic, environmental and social criteria. The new offerings related to maintenance and support services, developed under the servitization trend, need to be understood as a means to offer sustainable value to industrial users. In this regard, the study of maintenance technologies and the e-maintenance concept is reflected on as technological innovations are a strategic

pathway towards sustainable manufacturing. Moreover, the design of the new offerings as an integrated solution for the customers is also a key aspect, thus, this PhD research contributes to support servitized manufacturers on product-service configurations.

All in all, the purpose of the PhD research is to advance the integration of sustainability into manufacturing operations through maintenance service provision. This has been pursued by contributing to the understanding of industrial maintenance from a sustainability perspective in manufacturing plants and by looking for a systematic method to incorporate sustainable value into new service offerings from a service provider perspective. This PhD thesis is organised as follows.

Chapter 1 introduces the background, the motivation as well as the overall problem addressed in this research.

Chapter 2 describes the research design. It introduces the main objective and the research questions that have led the thesis project towards its achievement as well as the methodology followed during the different stages of the PhD research.

Chapter 3 presents first the main literature review done for this PhD research, followed by a study on the current practice regarding maintenance services focalized on the Italian manufacturing industry. Eventually, a short section summarizes the main findings and states the gaps found in literature and between literature and actual industrial practice.

Chapter 4 introduces the

research findings regarding the contribution of industrial maintenance to more sustainable manufacturing operations and a proposal of a framework to map this contribution. Implications for users / owners of manufacturing equipment are manifold as the findings inform on concrete contributions of maintenance to product competitiveness, innovation and quality, delivery punctuality, operational cost reduction, manufacturing flexibility and process innovation. Moreover, the findings indicate that maintenance contributes to more sustainable operations by enhancing economic, environmental and social performance along equipment life cycle as well as at different stages of the manufacturing processes.

Chapter 5 concerns the investigation of value creation within maintenance function in manufacturing and aims at providing a tool for understanding the logic behind different choices in maintenance function. In this sense, the concept of Maintenance Business Model (MBM) is introduced and framed within a proposal of a maintenance management framework. The chapter ends with a discussion and a conceptual example of choices within the MBM inspired by the findings of previous chapter 4.

Chapter 6 studies the technological composition of technology-based maintenance services and proposes a value analysis method for assessing how different tool categories contribute to a set of predefined service value dimensions. Both results are useful for servitized

manufacturers willing to propose their customers a service solution that includes innovative tools or applications. They can serve as guidelines to understand the type of technologies to be included in the service offerings in order to improve their pursued value dimensions.

Chapter 7 explains the rationale for the proposal of the value-driven design methodology for performance-based maintenance services and describes its steps in detail. It has been tested in an industrial context through a case study that is described and analysed in **Chapter 8**. This methodology supports servitized manufacturers to identify different solution alternatives adapted to their concrete customers' contexts. It has been observed that the methodology itself brings also benefits to the industrial user as an analysis and prioritisation of their equipment according to their desired operational values.

Chapter 9 summarizes the results of this research by identifying its main contributions to knowledge and indicating its implications for practitioners. The methods proposed in this PhD thesis can support both the service providers and the industrial users to integrate sustainable value into their service offerings and their manufacturing operations, respectively. Eventually, the limitations of this research and future lines for further research are discussed.

INFOMOBILITY AND OPEN DATA: ARE THEY EASY PARTNERS?

Silvia Malpezzi - Supervisor: **Prof. Giovanni Azzone**

This work focuses on the theme of Infomobility - i.e. the use of ICTs in the field of transport systems for supporting transportation management and providing new travel information services, with the final aim of increasing the sustainability levels of mobility systems. Infomobility is a global phenomenon that has attracted the attentions of policy makers and operators from different sectors (transportation, automotive, etc.). The relevance of this theme has been recognized also by the academic world. Researchers have argued that a greater information to users and managers of mobility systems has an important role in reducing the traffic congestion levels and travel times, and in improving travel safety. Nevertheless, at present, the effectiveness of Infomobility systems is still questioned. An interesting trend that is emerging to address this problem, but that has not been deeply investigated by academics until now, is the Open Data (OD) approach. OD is a very topical information management approach that requires the free circulation of information for the use, re-use and re-distribution of it by the public. The OD approach seems to be much suitable for the Infomobility sector. Indeed, where Infomobility aims

at supporting the transport network planning and control, and at assisting travelers before and along the trip, OD aims at enabling a more transparent evaluation of the operators' activity, at increasing the quality of data for supporting decision making of all the information users, and at subsidizing the development of new information services.

With the aim of investigating the impact of the OD in exploiting the Infomobility potentials, this work addresses the following goals:

- Providing an overarching Infomobility definition and identifying the key elements outlining these systems in order to clarify the meaning of this term that has been still blurred in both the academics and practitioners' environments.
- Identifying the critical elements that determine the Infomobility Quality, in terms of capability of achieving the Infomobility goals. Even though it is often emphasized the dissatisfaction for the present Infomobility exploitation and the need for improving their effectiveness, the assessment of the Infomobility Systems capability to provide mobility managers and travelers with the information that they need is a theme still unexplored.
- Investigating the potential contribution of the OD for

Infomobility. Up until now, studies on OD have analyzed projects not specifically related to this sector. Some authors just mention transportation as one of the possible application fields of OD. Moreover, it is still not clear how the potentials of OD can be realized at local level through specific projects in the Infomobility sector.

Two research instruments have been employed in order to support different phases of this research. A literature review on Infomobility, Transport Information Quality and Information Quality literature. Two case studies: the former with the aim of providing a broad picture the Infomobility value as possible answer to mobility problems and a basis on which articulating the definition and framework of Infomobility. The second one consisting in a cross-case analysis of two different Infomobility systems where an Open Data approach is adopted. They are in two cities, Amsterdam and Milan, embedded in the European institutional context where more and more countries are emphasizing transparency and openness of Governments' activities by making public information more easily accessible and available for re-use. Hereafter we discuss the main results achieved through this

research.

First, the work answers to the high level of fragmentation and heterogeneity that characterize the research in the Infomobility literature and provides a useful support to policy makers in designing more effective strategies and interventions on the mobility system. Indeed, it not only clarifies and outlines the Infomobility theme, but it also identifies the most critical elements of an Infomobility system. The analysis reveals the existence of overlapping areas, reciprocal influences and blurred boundaries characterizing different application fields. These circumstances highlight the potentials of properly defining the link between different services and of integrating data useful for different purposes in order to avoid possible redundancies. To this aim, this research suggests the convenience of making easier and more effective the coordination among different actors operating along the value chain. However, it could be very challenging because of the coexistence of public and private subjects diverging in terms of sets of values, management approaches and decision-making criteria.

Second, it addresses the unexplored theme of the Infomobility Quality assessment. The Infomobility Quality framework aims at supporting practitioners in the Infomobility system design and analysis. The research suggests that not only the intrinsic quality of the transport information, but also the fitness of the information contents with the users' requirements and the characteristics of accessibility,

privacy and security to this information are potentially determinant elements of the quality of Infomobility initiatives. Third, the analyses of the real potentials of OD in supporting the achievement of the Infomobility goals provides an innovative contribution to the academic literature and some insights to support the decision of adopting the OD. Enabling a free circulation of data for the use, re-use and re-distribution of them, OD entails a high level of information accessibility and, in turn, a higher control and improvement of the intrinsic quality of the transport information, a more effective transport system management and the creation of new information services that better fit the travelers' needs. However, the research further confirms how the main criticality within the Infomobility sector is the reluctance of the Infomobility actors in sharing information to each other, a problem that is much emphasized when OD is adopted. An institutional context characterized by a high level of commitment and decision power of transport authorities and operators much determines an answer to this issue. Then, technological standards and shared data formats are also required to enable the data and information flow along the Infomobility value chain. This research shows how Interoperability initiatives, implying the adoption of technological standards and information sharing rules, but also allowing information providers handling data and information services and maintaining the total control and ownership on them, could

be a very interesting alternative to OD. Indeed, when this solution is implemented, data holders, who are increasingly aware of the marketing and travellers satisfaction advantages of providing the public with a great amount of information, are more inclined to share real time information services. This work, dealing with the great complexity characterizing Infomobility, opens up several new research questions that could be further explored. Particularly, it could be deepened the need of leveraging on real-time and multi-modal information services for really fitting the travellers' needs, and different types and levels of data integration could be investigated in terms of mechanisms that enable them for increasing the three dimensions of the Infomobility Quality.

ENTERPRISE RISK MANAGEMENT IN LISTED FIRMS: STATE OF THE ART AND THE RELATIONSHIP WITH SHAREHOLDER VALUE

Barbara Monda - Supervisor: **Prof. Marco Giorgino**

Risk, uncertainty and unpredictability deeply characterize human experience. The ability to assume and manage risks is particularly relevant in entrepreneurial context and is a fundamental component of managerial responsibilities. In the past, risk management activity followed a silo-based perspective, with independent, fragmented units focused on specific aspects of risk, such as financial or insurable risks.

In the XXI century, however, managers must be capable to navigate in an always riskier and dramatically rapidly changing world. Financial crisis, huge accounting frauds, terrorism attacks, natural disasters, increase in competition, new emerging business models, technological evolution and increased shareholders' and stakeholders' attention towards companies' activities challenged traditional risk management models, highlighting the necessity of new approaches suitable to manage this kind of complexity.

In the recent years, Enterprise Risk Management (ERM) has emerged as a new risk management approach aimed at managing the portfolio of risks that faces an organization in an integrated, enterprise-wide manner. It is increasingly considered an essential

component for firms' success and growth since it adopts a more strategic, integrated and proactive perspective that enables companies to increase firm value not only by protecting against negative events but also by exploiting opportunities. Unlike traditional risk management, where individual risk categories are managed from a silo-based perspective, ERM involves a holistic view of risks allowing taking into account correlations across all risk classes.

This thesis deals with Enterprise Risk Management in listed firms and aims at investigating the effects of ERM adoption on firms' value and financial performances.

The main hypothesis underlying this work is that firms benefit from the implementation of advanced and integrated risk management systems in terms of shareholder value and stability of share prices, and such benefits increase as the degree of implementation of ERM increases.

According to CoSO, ERM is intended to promote awareness of the sources of risks and address them by improving strategic and operational decision-making. As a result of improved efficiency, firm performance should increase, volatility should decrease and cost of capital should be

reduced, thus firm value should increase. Another hypothetical benefit of ERM is the creation of synergies between different risk management activities: by integrating risks across classes and departments, firms are supposed to be able to avoid duplication of expenditures (e.g. insurance) by exploiting natural hedges.

After an introductory chapter, the first paper of this dissertation, organized as a collection of three papers, identifies the theoretical rationales for corporate risk management, identifying the conditions under which firms benefit from investing in risk management activities and highlighting the managerial implications of the interdependencies of the effects of different risk management strategies.

Despite the theoretical motivations, if and to which extent ERM creates value is yet to be proven. In fact, although the theoretical rationales for RM/ERM date back to some decades ago, empirical studies of ERM are still scarce. Academic research in this area is still limited, also because of the difficulty in developing a robust measure for the quality of ERM systems adopted by firms. Most of the available studies provide support for the hypothesis that ERM improves firm value, but

results are not unique. Moreover, the existing studies show some limitations, the most important of them being the fact that they are based on the CRO hiring as a signal of ERM adoption but do not further investigate different levels of ERM implementation among firms.

Developing a maturity model for ERM is challenging because it requires finding a quantitative measure for something that is qualitative in nature, and for the lack of previous literature. For these reasons, in the second paper a Delphi procedure has been used to reach consensus in a panel of international experts on all the parameters and scores composing an index to measure ERM maturity, which has been named Enterprise Risk Management index (ERMi[®]). ERMi[®] is a maturity model in the form of a questionnaire with closed-end questions, which gather information on 22 relevant ERM parameters; the value of ERMi[®] is a linear combination of the 22 parameters and is measured on a 0-100 scale. Data to compute ERMi[®] can be provided by firms or collected by analysing publicly available corporate documents of listed firms.

Using this purposely-built measure, in the third paper an empirical analysis is conducted to investigate the complex relationships among ERM

adoption, its determinants, firm market value and share price volatility, controlling for size, industry and profitability. The main question being answered is if, and to which extent, investing in a “good” ERM system creates value for listed firms. The methodology employed is Structural Equation Modelling, thus solving the endogeneity problem that plagues many previous works. Employing ERMi[®], a continuous variable, also allows overcoming another limit of most previous works, the use of a binary variable for ERM adoption, classifying firms as adopters or non-adopters, thus failing to consider the level of implementation of ERM, while it has to be noted that ERM implementation is certainly not a mere on/off status. Overall, this dissertation contributes to further clarifying the rationales and the best practices for ERM implementation and verify them empirically; it also provides statistically significant results about the effects of Enterprise Risk Management, demonstrating the high correlation between ERM implementation and firms’ market value, and the high correlation between ERM implementation and stability of share prices.

In other words, the empirical results confirm the hypothesis

that ERM creates value. Firms with better ERM systems in place, all else constant, are valued higher than firms with less mature implementations. Additionally, the share price of firms with mature ERM systems is less volatile than poorer adopters.

As discussed in the conclusions of paper 3, the empirical results are obtained for a sample of large listed firms, but in principle can be extended to all listed firms, given that they reflect the preferences of investors in the stock markets and the nature of investors does not change with the size of firms.

Concluding, this thesis provides a thorough overview of the topic of Enterprise Risk Management, the motivation for firms to implement ERM, the expected benefits, the real benefits for shareholders. Although the empirical analysis investigates the matter in the largest firms listed on the main stock exchanges, some of the results can be extended to all listed firms.

This work makes clear the importance of ERM for firms and gives an insight into the characteristics of firms that, in principle, should gain the maximum benefits from ERM adoption.

ENTREPRENEURSHIP AND INNOVATION DYNAMICS IN SUPPORT OF SUSTAINABLE DEVELOPMENT

Boris Mrkajić - Ph.D. supervisors: **Paola Garrone** and **Luca Grilli**

Sustainable development has emerged as an influential, although controversial, concept for both business and policy, and there is rising recognition that a major transformation is needed to reduce detrimental environmental and societal impacts created by our presently unsustainable practices. Striving for the development that would meet the economic, environmental and social needs of the society is the ultimate motivation of the thesis, with the focus on the environmental dimension. A group of activities that are contributing to the environmental goals are typically marked as *environmental innovation*. Environmental innovation activities refer to development of innovative products and processes that reduce (negative) environmental impacts. They are considered to be highly risky, as they require abundant financial investments, while the returns are typically collected in the long term. Hence, this type of innovation represents an extremely interesting case for research. Furthermore, the technologies that have emerged from environmental innovation activities are gathered under an umbrella term *clean technologies*. Even a completely new high-tech industrial sector has emerged, named *Cleantech*, which is encompassing

development of environmentally sustainable products, processes and services. This thesis revolves around the two topics, Cleantech as a recently defined independent industrial sector and environmental innovation as a conduct for advancing detrimental practices. The first research output is focused on the Cleantech sector, which has emerged based on the disruptive, radical technological change. According to the Schumpeterian line of reasoning, the most appropriate actors for fostering this change are entrepreneurs, as they are more flexible and agile to adjust to newly created requirements. Thus, I try to improve knowledge on antecedents and initiators of the technological change in this domain, by studying human capital of entrepreneurial ventures active in the Cleantech sector. In particular, I investigate how patterns of founding team human capital differ for this specific sector, that is, what kind of founders' human capital is present in Cleantech start-ups, and how it is combined within the teams. This might be crucial in new ventures, as human capital is argued to be a relevant determinant of their success and innovativeness. Empirical results yield that Cleantech sector does demand peculiar requirements in terms of business opportunity recognition

and entrepreneurial team formation, which is valuable for proper design of policies targeting this sector. Cleantech is found to require technically highly skilled entrepreneurs, but at the same time, still fairly commercially experienced and economically competent individuals. Furthermore, data reveals that individuals are more prone to team up with cofounders possessing complementary know-how when they are starting a new business venture in Cleantech. The second and third parts of the thesis investigate a subset of environmental innovation that is responsible for improvement of resource efficiency, and more particularly, energy efficiency. I first study determinants of energy-efficient innovation, by enlarging currently established induced innovation view. I contend that environmental externalities of energy (in) efficient practices, which are (negatively) impacting the society and its sustainable development, create a feedback loop that acts as an additional driver (next to market-based incentives) for introducing energy-efficient innovation. Stakeholder theory, a stream of literature well established in strategic management, supports the proposition. Moreover, based on the industry-level empirical analysis, firms are indeed found

to be, in average, influenced by pressures stemming from different stakeholders, mainly regulatory actors. The third part of the study combines country- and firm-level analysis, and considers the institutional characteristics of the business context within which firms need to operate. I attempt to show how energy-efficient innovation activities are contingent on these characteristics, and how this relationship is moderated by firm size. In other words, the focus is put on how small- and medium-sized firms (SMEs) are reacting differently to the institutional context with respect to large firms. Institutional theory is cross-bread with the theoretical discourse on energy-efficiency to create an anchor for the theoretical framework. The developed hypotheses are tested in a cross-country setting, and the obtained results are in support of the main set of hypotheses that institutional characteristics foster energy-efficient innovation. Moreover, different institutional dimensions are found to be working differently depending on the firm size. Compared to large firms, SMEs emerged to be more sensitive to regulatory rather than economic and social institutional characteristics. Several interpretations are offered for these somewhat controversial and thought-

provoking results. Based on these, implications for policy interventions and managers of both small and large corporations are drawn. In summary, comprised of analyses on individual-, firm-, industry- and country-level, this thesis enlightens different parts of the innovation dynamics that fosters sustainable development. Several theoretical lenses were adopted to study different topics, from competence-based, induced innovation, stakeholder to institutional theory. Analyses were performed by means of different statistical and econometric technics. By deploying this multidimensional and heterogeneous approach to the study of sustainable development issues, the thesis supplements the academic literature on the topic and supplies entrepreneurship and environmental policy makers and managers with sound empirical findings.

SUSTAINABILITY STRATEGIES IN MANUFACTURING ENTERPRISES – DEFINITION, TYPOLOGY AND DETERMINANTS FOR LONG-TERM SUCCESS

Stojan David Opresnik - Tutor and supervisor: **Prof. Marco Taisch**

The manufacturing sector contributes up to 22% of Europe's GDP, while 70% of jobs in Europe depend, either directly or indirectly, on manufacturing. Regardless of its significance, it is faced today with multiple transformations. The demand for environmentally friendly products is increasing, the technologies supporting their production and functioning are maturing, while environment related policies are becoming more severe, causing the conversion of some of the traditional bases for competitive advantage into mere market necessities. In order to avoid commoditization and to enjoy sustainable growth, manufacturers must learn how to exploit these changes. Environmental sustainability is recognized as being able to increase the long-term competitive advantage of manufacturing enterprises. However, creating a business case from sustainability (Salzmann, Ionescu-somers, & Steger, 2005) – thus planning (Berns et al., 2009) and incorporating (Cruz, Pedrozo, & Estivaleta, 2006) sustainability based operations and strategies – still too often constitutes a conundrum for managers. Also it is still unclear under what circumstances competitive advantage can be realized by the adoption of sustainability

practices (Schrettle, Hinz, Scherrer -Rathje, & Friedli, 2013). There is a lack of frameworks for both practitioners and scholars to develop insights into the development of sustainable business in manufacturing (Gunasekaran & Spalanzani, 2012a), underlining the need for more studies that develop or test theories to help understand sustainable operations management (Professor Helen Walker, 2014). The aim of this thesis is to broaden the understanding in research of environmental sustainability as an operations strategy and, on the other hand, to help managers exploit it to sustain and increase their long-term competitive advantage. The first objective, therefore, was to develop a decision support tool (i.e. procedure) for planning Sustainability Operations Strategies. A dedicated procedure linking business strategies, manufacturing strategies, sustainability strategies and environmental impact has been designed. However, in order to operationalize it, a knowledge base containing the information required to link business and environment had to be developed. For this purpose, a typology, as a methodological tool, was developed that could enable the identification, classification and description

of Sustainability Operations Strategies used by large global manufacturing enterprises. The typology was populated with 200 sustainability activities identified through a review of industrial practices. The second objective was to develop a procedure for analysing and assessing the implemented or planned Sustainability Strategies, relying on strategic management and the concept of strategic fit. Based on the knowledge acquired from the typology, seven interviews with experts and from 23 light-case studies (i.e. interview and material analysis from secondary sources), the following third and fourth objectives were achieved. The third objective was to scrutinize the possibility of achieving long-term operational success through the use of Sustainability Operations Strategies. The fourth objective was to propose a definition of Sustainability Operations Strategies, to be applied to an in-depth case study. As part of the set of results of the first objective, eleven types of Sustainability Operations Strategies used by the manufacturing industry were identified based on the populated typology. The three most pervasive strategies were in Product Design, Organization and Manufacturing. Each strategy type was described through the identification of its

relations with specific business and manufacturing strategies and environmental impacts. For example, the Product-Design Strategy is the one most widely used to support a business growth strategy – through differentiation – while supporting product quality (expressed as performance) as the main priority of a manufacturing strategy, and where the environmental impact arises mostly during the product's middle of life, thus reducing its resource consumption. The second set of results demonstrates that the decision support tool (i.e. procedure) for the planning of Sustainability Operations Strategies enables the creation of a link between business and environment. For instance, operations managers can identify the environmental impact that supports the capability to reduce a product's price, as a priority of the manufacturing strategy; in this case the most pervasive impact is the reduction of input, moreover of energy usage. The procedure in question was applied to three in-depth case studies, resulting in proposals for business development based on Sustainability Operations Strategies. The third result identified that, using the procedure in question, it should be theoretically possible to

achieve long-term operational success through Sustainability Operations Strategies. However multiple barriers and drivers have been identified that can affect such an outcome. These include the availability of competences and resource for such strategies, the level of integration of sustainability into long-term planning, the degree of common understanding of "sustainability" throughout the enterprise's functions and the capability to capture and communicate the benefits of sustainability. Thus, through the proposition of a definition of Sustainability Operations Strategy and its dedicated procedure and methodological tool to research sustainability in operations management, the research partially contributes to bridging the gap of lack of understanding of sustainability in operations management. The results have also contributed to bridging the theoretical gap of the lack of understanding as to why and under which circumstances enterprises adopt sustainability practices through which they can realise their competitive advantage. By creating a link between business (business and manufacturing strategy) and environmental sustainability, the contribution to industry is to partially fill a fundamental gap – the lack of understanding

of the business logic of sustainability. Finally, the industrial gap of the challenge of operationalization of sustainability has been bridged in part by providing a procedure for planning Sustainability Operations Strategies in manufacturing.

CREATING PUBLIC VALUE THROUGH PROCUREMENT: ORGANIZATIONAL LEVERS FOR IMPROVING PUBLIC PROCUREMENT PERFORMANCE

Andrea Stefano Patrucco - Thesis Advisor: **Professor Stefano Ronchi**

Public administration procurement is the process that starts with a survey and analysis of “public” demand and needs and continues until the stipulation and the subsequent monitoring of the contract, through the best possible supply practice. It has become a very complex function of government, handling a great proportion of public expenditures, representing a very large fraction of total economic activity.

Public procurement is continuing to evolve both conceptually and organizationally. That evolution accelerated during the 1990s as governments at all levels came under increasing pressures to “do more with less”. Indeed, all governmental entities of rich and poor countries are struggling in the face of unrelenting budget constraints; government downsizing; public demand for increased transparency in public procurement; and greater concerns about efficiency, fairness and equity. Additionally, public procurement professionals have faced a constantly changing environment typified by rapidly emerging technologies, increasing product choice, environment concerns, and the complexities of international and regional trading agreements. Further, policy makers have increasingly used public procurement as a

tool to achieve socioeconomic goals. Efficient and effective procurement is thus necessary for public sector, in order to make a rational use of resources and social spending. Procurement design directly and substantially affects countries’ performance in the short and in the long run: in the short run, most obviously by immediately determining the costs and quality of inputs in the public supply chains; in the long run, most importantly by determining suppliers’ incentives to invest in R&D and to innovate in general. The topic is not so easy to be addressed, as it can be designed as a complex system consisting of:

- Laws and regulations;
- Organizational structure;
- Skills and characteristics of procurement workforce;
- Processes;
- Tools and techniques.

Procurement design and management is a complex issue though, as contractual problems directly interact with competitive screening and risk management problems. Moreover, procurement is most often a dynamic, repeated activity, with short-term objectives often conflicting with long-term ones. Strategic procurement decisions must be taken with a focus on the future dynamics of the demand–supply relationship. Neglecting the importance

of repeated relationships with potential suppliers and the effects of procurement choices on an industry or a district dynamic could have very undesirable consequences for a large buyer, in terms of both price and quality. This dynamic distinguishing feature of procurement also greatly enlarges the role for reputational forces.

Unfortunately, there is not a one-size-fits-all measure for effective procurement design: the variety and complexity of situations in which procurement decisions are made means that appropriate purchasing procedures must take into account many aspects, and be tailored to each single situation. Nevertheless, some key forces driving effective procurement design are common to most procurement decisions, and it is on these kinds of driving forces that this handbook is focusing, providing a toolkit for how to take them into account in different situations. Strategic procurement decisions require rational and competent decision makers, especially when procuring innovative goods or services. The need for competence obviously relates to the specific ability to gauge market developments, but cannot leave aside more general skills that have to do with legal and, particularly, strategic issues.

More, from an academic perspective, it is only recently that this area started receiving attention.

Writing over a decade ago drew attention to the academic neglect of public procurement; in spite of its centrality to public service delivery and its long history in public administration, public procurement resided on the periphery of management science.

In the years since much has happened to redress this imbalance so that public procurement has moved closer to the mainstream. Its research remit continues to expand as scholars of management, public administration, finance, law, supply chain and logistics management, mathematics, and information technology apply themselves to the study of public procurement. In turn, this has opened up promising lines of inquiry on topics as diverse as eprocurement, small suppliers, and buyer professionalization. The progression of the public

procurement field is just as evident outside academia. In political and policy arenas public procurement is now linked to concerns over economic growth, social inclusion, and environmental sustainability. In particular, pressures on public finances since the 2007 global financial crisis have forced a reappraisal of the role of public procurement, with some arguing that it should be leveraged for domestic economic growth and job creation. Whatever perspective one takes, it is clear that the profile of public procurement is greater than at any time previously.

The perspective adopted in facing the challenges described above isn't the one aim to give Public Procurement a finally strategic and pervasive role for institutions; general lessons got from both theory and practice show that this evolution strictly depend on different and often out-of-control aspects (i.e. regulation, government impact, amount

of resources, history of the institution...), thus making the solution of this dilemma almost impossible. On the contrary, a significant contribution could have been introduced by developing a comprehensive research framework for public procurement, being the underlying questions:

Which are the elements that should be considered when designing the public procurement system?

How an efficient and effective management of procurement in the public sector can be promoted?

In order to answer these questions, the research project has been designed around five papers, all with the aim to shed more light on the characteristics of the Public Procurement system, assuming different perspective. The positioning of the individual papers is presented in the Table 1.

PAPER	VIEWPOINT	RESEARCH METHOD
<i>"A systematic literature review on Public Procurement: past trend, future developments"</i>	Modeling of public procurement characteristics by analyzing scholars contributions in top academic journals	Literature review, data analysis
<i>"Research perspective on Public Procurement: content analysis of 13 years of publications in the Journal of Public Procurement"</i>	Modeling of public procurement characteristics by analyzing scholars and practitioners contributions in Journal of Public Procurement	Literature review, data analysis
<i>"Theoretical and empirical exploration of Public Procurement strategy: is there a deficit?"</i>	Analysis of the concept of public procurement strategy by comparing scholars contribution and professionals perspective	Literature review, case study (interviews)
<i>"Evaluating the effectiveness of Procurement Performance Measurement Systems in Local Governments"</i>	Evaluation of the structure of public procurement PMS by document analysis and professionals perspective	Secondary source analysis, Case study (interviews),
<i>"Local Government Procurement: aligning procurement organization with desired performance"</i>	Analysis of Procurement Department organizational design choice from professionals perspective	Case study (interviews)

Table 1: Overview of the papers included in the thesis

A GUIDELINE TOWARDS DESIGNING SERIOUS GAMES IN MANUFACTURING EDUCATION

Borzoo Pourabdollahian - Supervisor: **Prof. Marco Taisch**

Nowadays, manufacturing education is struggling with challenges that it has not faced before. Moreover; preparing fresh generation of engineering graduates qualified to cope with pacing changes and unexpected situations in manufacturing environments as well as lack of interest among young talents to enrol in manufacturing engineering programs force manufacturing education to come out with new learning methods to deal with the current situation. In this regard, serious game has been welcomed as a promising learning method. Providing learning contents blurred in a series of engaging activities, which take place in a simulated environment presents a serious game as a unique solution.

Although the application of serious games in manufacturing education has been growing in recent years, there is little evidence of their effectiveness in terms of making progress in achieving different types of learning outcomes what the game is targeted for. Therefore, it becomes a challenge to optimize the effectiveness of serious games when its users in manufacturing education centres are unaware of how and to what extent a serious game could improve the achievement of desire learning outcomes. To address the problem, making a

contribution to manufacturing education systems is required in the process of game design in order to make sure that the created game is able to satisfy its users' requirements. However, their contribution sometimes does not only strengthen the game design process, but it also disturbs the whole process. Since people in manufacturing education systems are mostly unaware about the game design process; therefore, they require to be supported in terms of how to make an efficient integration between learning contents with components of the game, so that the target learning values are easily transferred to players' mind.

This thesis aims to bridge the mentioned gap through developing a guideline which supports manufacturing education systems in order to come out with clear ideas and constructive solutions while being involved in serious game design processes. To this end, initially it is required to evaluate the effectiveness of the existing serious games in manufacturing education. To this purpose, four experimental studies have been conducted to assess the impact of four different serious games on improving Cognitive and Affective learning outcome's achievement according to the latest revision of Bloom taxonomy. These games point

different topics related to manufacturing, namely Shortfall for sustainability in supply chain, LCA game for lifecycle assessment, Logistics game for logistics and operation management, and SBCE game for product development. Once the assessment studies are completed, exploratory studies are done to identify those attributes which make the games an effective learning method in manufacturing education. As a result, 13 attributes have been explored, and classified regarding their functions within the games. Thereafter, the research has focused on developing the guideline on considering the results obtained from experimental studies. In order to establish the quality of the guideline, it develops with considering those steps to be completed for developing any guideline on a general level. The guideline contains 11 recommendations classified in two classes, where each one presents a specific level of confidence in application of recommendations aggregated to that.

This thesis has made an original contribution to both knowledge and practice. For the earlier, presenting a holistic picture of status of serious games in manufacturing education, providing empirical evidence for

effectiveness of serious games in manufacturing, and exploring attributes of serious games in manufacturing are the main contributions to the knowledge extension. On the other hand, this thesis has developed a practical tool which supports designers, mainly manufacturing education systems, to design effective serious games in manufacturing education.

FROM BEST PRACTICES TO ARCHETYPES: DRAWING THE PATH OF INNOVATION

Monica Rossi - Supervisor: Assoc. Prof. Sergio Terzi

Motivation: In product development, some practices (tools, methods, techniques) are recognized to bring more beneficial results than other procedures and are defined best practices. Both in literature and industry, there is a challenging research of those kinds of practices and many efforts have already identified a conspicuous number of practices able to lead companies toward successful results.

However some issues are still open. First it is not always clear if practitioners are aware of the meaning of PD best practices. Second, it is not known the level of diffusion of those best practices within industries. Also there is an on-going discussion on whether a unique overall set of best practices is suitable to every circumstance and industry (*one size fits all*), or the use of PD best practices is context depended. Finally there is a lack of research on whether some PD best practices are grouped together and required simultaneously. These open issues motivated the rationale of my research, which aims at contributing to this on-going debate addressing the reasoning whether each circumstance requires the use of a unique overall set of PD best practices or whether there are different groups of PD best practices. Therefore the main research

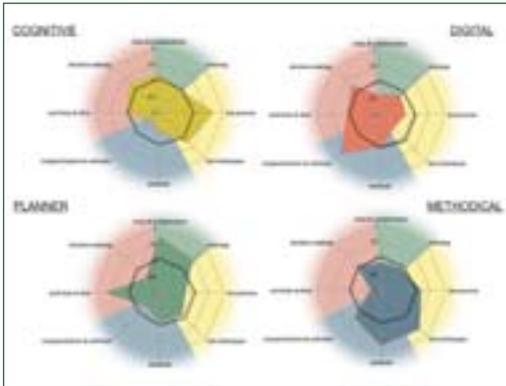
objective is to look for patterns in the use of PD best practices; this means looking for very typical examples of certain combination of PD practices adopted by companies, named *archetypes*. Archetypes serve as interpretative schemas of complex phenomena and allow better understanding of management and organizational systems.

Structure and Method:

This research is structured in 6 chapters. This first chapter introduces the area of investigation together with the motivation of the research and the expected contributions. Chapter 2 details the research objectives through the developed research questions. The methodology followed to answer these questions is also described in this chapter. The literature review that serves as a support for the whole research is described in chapter 3. The main focus is the state of the art in PD best practices, which provides the basis for the development of a PD best practices framework, as described in chapter 4. The framework serves as a preparatory basis for the data collection, as explained in this chapter. Chapter 5 describes the data analysis and the archetypes. Finally, discussion, conclusions, and further researches are delineated in Chapter 6. Since the objective of this

research is to uncover patterns behind the use of PD best practices, literature suggests the *theory-building approach* as proper research methodology. The building of theory occurs in two major stages, the descriptive and the normative phase. Since the purpose of my research is to develop a descriptive theory, it deals with the first of these two steps. The descriptive theory methodology has been accomplished through literature review and an Exploratory Research, conducted with a semi-structured questionnaire used to face-to-face interview 103 companies in Italy. Cluster analysis on the collected data led to the identification of the researched archetypes. The result is that the same variables (107 PD best practices) can be grouped in different ways (*inductive*, when basing on prevalent literature; *deductive*, when basing on collected data analysis) and both approaches generate four different archetypes:

- The inductive approach is aligned with the traditional PD literature and the so obtained four archetypes (Cognitive, Digital, Planner, Methodical) concern different companies' behaviors in term of People, Process, Tools and Knowledge Management (see. *Fig. 1*)
- The second approach, driven by data analysis, highlights



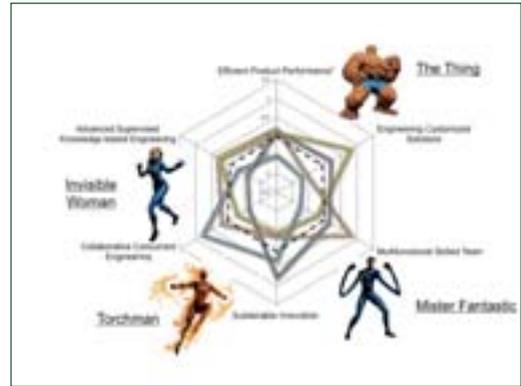
1. The Archetypes, Inductive Approach

different dynamics played by the companies and give an additional and unusual perspective. The archetypes (Mister Fantastic, The Thing, Invisible Woman, Torchman) (see Fig. 2) provide insights on elements such as sustainability, efficiency, multifunctionality, collaboration, advanced engineering, which usually are not used as categories to frame PD best practices. This second approach represents a different point of view and diverse angle from where to look at the complex dynamic of the use of practices in product development.

Theoretical implications:

This research contributes to the body of knowledge:

1. Improving and enlarge the current **understanding** on PD best practices and proposes a **PD best practices framework**;
2. Providing knowledge about the current state of **maturity** and **diffusion** of PD best practices within industries, through the **empirical research**;



2. The Archetypes, Deductive Approach

3. Proposing that it is **not true that one-size fits all** since different companies use really different PD best practices in their PD processes;
4. Introduce two different sets of **4 archetypes** each.

Practical implications:

This research has important managerial implication for industry:

1. Create awareness on the meaning of best practices;
2. Provide a benchmarking and assessment tool based on the proposed PD best practices framework, named CLIMB. It can be used as a benchmarking tool, which is recognized to stimulate companies' motivation toward continuous improvement.
3. Give perceptions on which best practices a company could use, basing on the particular archetypes it belongs to;
4. Identify gaps between prescribed PD best practices and really used practices.

This research covers the identification of suitable PD best practices to be used, considering the archetype a company belongs to. The purpose here is not to give indications on how

the mentioned PD best practices can be implemented, not even how a company can switch from an archetype to another. This is about change management and it is out of the scope of this research, which however opens the door to further research in that direction.

INTERNATIONAL EXPANSION, KNOWLEDGE SOURCING AND TECHNOLOGICAL UPGRADING. THE EXPERIENCE OF MULTINATIONAL ENTERPRISES FROM EMERGING COUNTRIES IN THE LAST DECADE

Vittoria Giada Scalera - Thesis Advisors: **Prof.ssa Lucia Piscitello** (Politecnico di Milano)

Prof.ssa Roberta Rabellotti (Università di Pavia)

The present research project is based on the awareness that in the recent years foreign direct investments (FDI) from emerging economies have significantly grown, from \$11 billion in 1990 to \$454 billion in 2013, representing around the 32% of the world stock today (UNCTAD, 2014). Although advanced economies still remain the main source of outward FDI, emerging market multinationals (EMNEs) have increasingly attracted attention since they have experienced an unusual internationalization path, often becoming global players in relatively short time (Awate et al. 2014; Ramamurti, 2009). Consistent with the *springboard theory*, EMNEs' outward FDI mainly acquisitions toward advanced markets -are triggered by pull factors, such as brands, technology, design competences, and managerial expertise, in order to acquire strategic assets and resources to compete successfully in the global market (Luo and Tung, 2007; Rui and Yip, 2008).

The foremost motivation of the acquisition of strategic assets is the development of technical and innovative capabilities. As a matter of fact, such capabilities have been traditionally identified as key determinants for firms' competitive advantage (Schumpeter, 1934). Thus, within this context, it is crucial

to build an understanding of the knowledge creation and sourcing process that boosts EMNEs' technological upgrading, identified as one of the most powerful enablers of EMNEs' ability to compete internationally.

This work focuses on EMNEs' international expansion and their strategies aimed at accessing new knowledge and valuable technological competences through collaborations with foreign actors, i.e. firms, universities and inventors. So the core research question we seek to address is: *How do EMNEs behave during their technological upgrading process through international expansion and external knowledge sourcing?*

The thesis is a collection of four papers, intended to analyze different but complementary aspects of the abovementioned research question. Specifically, in Chapter 1 we present a critical review of the recent literature about EMNEs and the characteristics of their FDI. Namely, we summarize and discuss some of the issues that have attracted most scholarly debate in the international business domain, such as EMNEs' country-and firm-specific advantages, FDI motivations and modes of entry into foreign markets. We also examine to what

extent EMNEs undertake FDI to upgrade their technological capabilities in order to reduce their technological gap with multinationals from advanced markets. In the next two chapters, we empirically analyze the internationalization strategies of EMNEs when they undertake knowledge-intensive acquisitions in advanced markets. In particular, in Chapter 2 we study the relationship between EMNEs' ownership choices and the main motivation of their international expansion. Our findings suggest that EMNEs prefer to acquire less control and keep the local partner when they invest for seeking knowledge, in order to more easily transfer competences from the target company. In Chapter 3, we focus on the importance of EMNEs' home-country specific characteristics on the ownership choice decisions, presenting a comparative analysis of Chinese and Indian MNEs. We argue that China and India inherent heterogeneity plays a crucial role in differently shaping the MNEs' ownership choice. As a result, we find that Chinese MNEs are less likely to acquire control in the target company, compared to Indian firms. Further, the greater the institutional distance between the home and the host country, the larger the difference between Chinese and Indian firms' decision. In Chapter 4,

we explore the extent to which the integration of emerging countries into the global system of innovation represents a channel for their technological upgrading. Using patent data on the innovative activity in the Chinese pharmaceutical industry, we analyze the geographic dispersion of Chinese inventor networks, as a function of the characteristics of the innovative actors. Our findings point out the critical role that foreign universities and research centers may play in the technological upgrading process of emerging countries.

PUBLIC SERVICE NETWORK FORMATION: THE CASE OF CHRONIC CARE DELIVERY

Federica Segato - Supervisor: **Prof. Cristina Masella**

Rationale - Networks have become the dominant organizational structure for public services delivery, to the point that they are now more the rule than the exception in most public sectors, healthcare included. A lot has been written about the antecedents affecting the actors' participation, and about governance-related issues. Few studies are instead dedicated to the processes through which the network evolves, especially in the first stages (i.e. formation), which is how the actors integrate among themselves to make a service operational. Nevertheless, a further comprehension of the dynamic of service network formation is crucial, since the process of formation impacts on the network structuring and functioning, and low functioning – in the healthcare specific case - means increased people disabilities, deaths and tremendous waste of resources.

Objectives - The goal of this research project is to shed light on *how a public service network becomes operational*, that is to explain its "coming into being". More specifically, the thesis aims at providing an answer to the following research questions: 1) Why do the actors (i.e. healthcare professionals) accept to become part of the network?; 2) Which phases, activities and events

make the network proceed towards its operationalization?; 3) Why do some diversities of achievement exist (if they exist) in the pathway of the network formation?

Methods and Sample -

Qualitative methodologies are the most effective and suitable to this study, since we aim at examining processes, and the limited extant knowledge about Public Service Network (i.e. PSN) formation leaves field for an exploratory and inductive research approach. More specifically, the research is framed according to Eisenhardt's (1989) process of theory building from case study research.

The empirical inquiry is based on four inter-organizational networks for chronic care delivery in Italy, whose formation was supported through a regional project. The project requires the coordination of a panel of actors (General Practitioners, case managers, nurses, specialists, technology providers), belonging to different organizations (Hospitals, Local Health Authorities, private Companies etc.), who should coordinate to provide a continuum of care to a selected population of patients affected by chronic diseases. This case is relevant for several reasons. First, its timing provided the opportunity to investigate the process of formation of

a PSN, from the first steps to the actual enrollment of the patients in the service. Second, while in regulated sectors – as the healthcare one – the dynamics are generally driven by external forces and changes are imposed through legislations and top down decisions, this experimentation was set through legislative arrangements, but the participation and commitment are up to the actors' will. Third, the project deeply modified the reimbursement model, unhinging mechanisms which are consolidated and strenuously safeguarded by the practitioners. Last, the quest for concerted forms of care delivery is generating intense debates in the Italian and international context. Providing insights on the project evolution at the network level is therefore expected to enrich the knowledge and to contribute to the international debates on this topic.

Findings – The results are based on extensive interviews with primary informants (more than 40 overall), on a survey (374 patients) and on secondary data sources (laws and decrees, newspaper articles and press releases, conferences, public debates, social networks). We accurately assessed the process of formation expected by the regional authorities when they emanated the legislation.

Then we investigated the four cases, by highlighting: the actors, goals and motivations; the phases, activities and events characterizing the four processes; the emerging strengths and weaknesses. Last, we assessed the patients' expectations and satisfaction about the service received. We discussed the differences in the processes, in terms of timing, activation, turbulence and the effect of these issues on the process outcomes.

Theoretical Implications - To assess the actors' motivations, we took the actors' external (i.e. driven by the external environment or "coerced") and internal (i.e. pertaining the individual's sphere) motivations into account, with the aim to consider both elements dealing with the actors' voluntariness and those related to institutional coercions. We found that in the networks here investigated each actor had different problems and pursued diverse goals. Despite this apparent divergence, the network appears as a common solution for their differentiated needs.

We provide initial clarifications about why some agencies participate more strongly than others: our results show that networks formed by a collection of dyadic relationships pushed by internal motivations are more likely to be collaborative and sustainable in the long run. The main contribution to the literature about the process of formation resides in the collection of the extant knowledge about inter-organizational network formation and lifecycle and in the definition of a framework which keeps together both the

elements emerging from the scant literature on this topic and those emerging from an accurate empirical research. We framed the process into four sequential phases (activation, direction setting, structuring and service delivery). Also, we provide initial support to the hypothesis that different network conceptualizations can be reconciled, as they look at the process of formation from different though complementary viewpoints.

Last, we observed that the four processes presented differences in terms of time to get things done, activation phase, and turbulence of the process. We observed that the differences (especially turbulence) in the process do not necessarily compromise the efficiency and effectiveness of the service delivered.

Managerial/Practical Implications – Although mandated networks are less likely to be successful, it is a matter of fact that individuals or organizations cannot exert control over the levers which drive the changes in public settings (e.g. resources, financing). Coherently, in healthcare, public managers and policy makers are required to activate the change and clear goals should drive them in this action.

Once the network goals are clear, the pathway to reach them should be shaped according to the context. Taking the context into consideration is demanding, especially in professionals settings, such as healthcare, where the concepts of "professional dominance" and "self-determination" and the resistance of professionals

against change, tend to alimant a sort of prejudice against practitioners. The case in object partially debunk this myth and shows that an accurate observation of the GPs' practice might have brought the policy leaders and controllers to appraise some of the existing system features instead of forcing changes in behaviors and practice. For example, they might have first work to build collaboration by bridging ties with those agencies who already have a strong reputation in the community, rather than trying to establish new ties and roles. Accordingly, in the intent to increase the effectiveness of collaboration for chronic care delivery, some authors suggest structured methods to identify naturally occurring networks of physicians working together. Last, the literature asserts that public networks should be orchestrated. We believe that this should be done up to a point. Our results in fact suggest that a negative relationship exists among the pressures exerted by external agents and the effectiveness of the process of formation. It emerges that, more than over-specifying structures and roles, greater attention should be paid upon setting clear targets and let the actors organize themselves to reach them.

A MODEL TO SUPPORT STRATEGIC CONFIGURATION OF GLOBAL SUPPLY CHAIN

Guang Song - Thesis Supervisor: **Alessandro Perego, Riccardo Mangiaracina**

Supply chain management has been studied in the past decades, because it is a powerful weapon in reducing the total supply chain costs, decreasing the operations risk, and enhancing the service level. However, there is not still a research focusing on the design of strategic supply chain configuration for the entire supply chain system (i.e. the strategic location alternatives of sourcing, manufacturing, and distribution on the global or local scale). Therefore, this research aims to develop a decision-making model in order to support users in selecting the appropriate strategic supply chain configuration or checking the coherence of an existing supply chain configuration based on the specific global supply chain problem represented by a combination of the significant drivers affecting supply chain costs and customer service level. This research employed a methodology integrating both qualitative and quantitative approaches. Eight (8) strategic supply chain configurations and 27 affecting drivers have been identified on the basis of an in-depth literature research on 124 papers published since 1982 to 2013. Forty (40) best-in-class manufacturing companies have been investigated in order to collect the information about their adopted strategic supply

chain configurations and the value of each identified driver. Five (5) contextual factors and 12 significant drivers have been found through a sequential quantitative analysis process based on correlation analysis, factor analysis, and regression analysis. As a result, three decision matrixes for each supply chain stage have been built used to make the decision on strategic supply chain configuration. Finally, the reliability of the developed decision-making model has been examined based on additional 5 firms.

Therefore, the decision-making model has been proposed and validated. A firm could adopt the decision-making model, consisted of the 12 significant drivers, data transformation scales, and decision matrix for each supply chain stage, to design an optimal strategic supply chain configuration based on a predefined 4-step sequential process.

CLEAN AND COMPETITIVE FACTORIES: A NEURO-CYBERNETIC PERSPECTIVE ON SUSTAINABLE MANUFACTURING STRATEGY

Bojan Stahl - Supervisor: **Prof. Marco Giorgino**

Manufacturing is the tip of scales in the triangle of planet, people and profit. Not only since the Brundtland Commission the concept of sustainable development has emerged in manufacturing which emphasizes on the opportunity to increase competitiveness, business growth and success by pursuing environmental soundness and social responsibility. Incorporating external drivers like poverty, energy consumption or climate change, sustainability is seen as a way of creating new business opportunities. The key is to create a viable symbiosis of a sustainable product produced in a sustainable manufacturing system supported by a sustainable supply chain and delivered to sustainable customers. The sustainable paradigm will emerge as a key strategy in designing, managing and operating products, operations and supply chains. Thinking and acting long-term, creating competitive strategic positions and outperforming competitors on a set of performances is the ultimate goal of the strategy in every manufacturing enterprise. However, companies are struggling to transfer sustainability from the strategic agenda into the manufacturing function, and theoretical advancement to describe,

explain or even support these processes is scarce. The aim of this thesis is to investigate the organizational strategy definition, deployment and capability building process. Competitive advantage is in the center of firm's success. Gaining it over competitors by offering greater value to the customer is the key for a prosperous enterprise development and a warrantor to establish long-term and viable success. Sustainability or the sustainability paradigm is seen as a new and innovative lever to establish competitive advantage. Firms being capable of translating the concept of sustainable development into their strategic agenda and transforming long-term plans into concrete strategic initiatives are moving beyond their competitors (Drake & Spinler 2013). Firms being not capable of integrating sustainability in their corporate identity and pulling it down the hierarchical meshwork are falling back and will grievously touch down. Sustainability in manufacturing is the feather that breaks the balance. Developing and deploying sustainable manufacturing strategies is a fuzzy, risky and difficult task. Various sources report of the difficulty of firms to truly implement sustainability on their operations agenda. The aim of the underlying thesis was

to investigate and explain the development and deployment process in detail.

It was found that the component people as entities of the system firm are underrepresented in operations research and movements towards behavioral operations management may be fruitful to advance the field further. Discussions and workshops with participants from industry, policy and academia revealed that while market-based necessities triggered the need for sustainability, the key aspects to fully embrace it and make it a competitive weapon are internal and organizational structure and resources.

Next, based on a case study approach we investigated the competitive aggressiveness concerning sustainability competitive priorities in relation to change management practices. Evidence was found that change management is a conditional hypothesis for creating competitive advantage. We found different archetypes of firms according to the level of change management practice and sustainable competitive aggressiveness. Furthermore, two types of gaps are hindering the implementation of successful strategic initiatives.

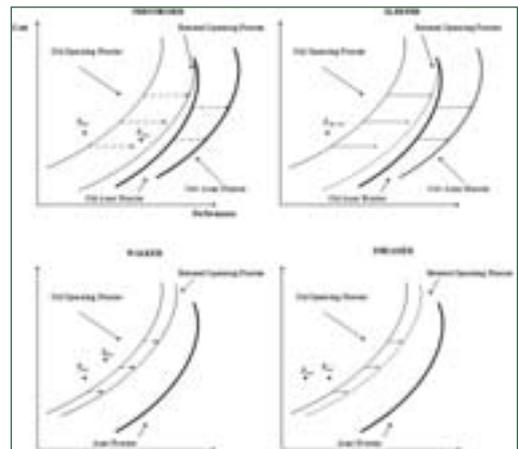
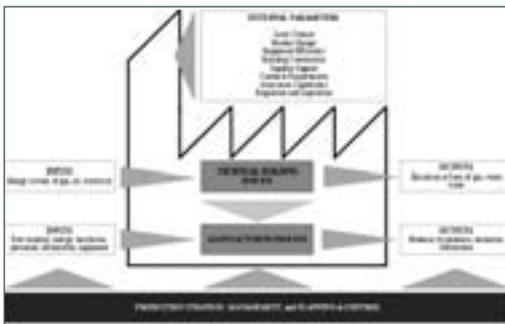
Lastly, based on the findings,

a neuro-cybernetic reference model was developed to overcome the identified implementation gaps, to foster manufacturing strategy definition and implementation and to support industrial decision-makers. The Viable Competitive Model is based on cybernetic principles and has the explanatory and diagnosing power to detail the actual process of manufacturing strategy deployment.

The doctoral thesis provides several contributions to science as well as practice. From the scientific perspective it provides several minor theoretical contributions like the confirmation or falsification of other scholar's findings. However, two major contributions stand out. First, it is the development of four archetypes of companies with differing degree of competitive aggressiveness and different values in the instances of leadership and direction as well as planning. Here, performers are seen as comparably more aggressive in their behavior and perform relatively better in both change management instances, while Sleepers show low aggression paired with low change management practices.

Two archetypes show medium aggressiveness, and are either performing well or worse in one or the other change management practices. The theoretical implications were embedded in the theory of performance frontiers. Second, the development of an ex-ante predictive reference model on Viable Competitive Systems that goes way beyond the traditional models presented in operations strategy and claims to be the first model to truly explain the manufacturing strategy deployment process. The model has strong theoretical value since it is applicable to instances regardless of size, location and focus. Furthermore, it bridges in a first try the gap between the resource- and market-based view of strategic competitiveness. The relevance for practice is astonishing. With the support of the Viable Competitive System, firms have a tool which is not only based on hard scientific facts and knowledge, but which is applicable and truly useful in industrial context. As shown in the industrial application the model supports

in mapping the is-situation of a company, identify flaws and challenging constructs and virtually implement measures to cope with those drawbacks. Hence, the VCS is considered as the first tool that truly supports manufacturing strategy deployment in practice. This thesis sets the starting point for future research on sustainable manufacturing strategy. While it contributed excessively to the advancement of the field, it opened up new questions, directions and opportunities for future research endeavors. Supervisor: Marco Taisch



AUTOMATION IN WAREHOUSES: STUDY OF THE NEW TECHNOLOGIES THROUGH THE DEVELOPMENT OF DESIGN AND ASSESSMENT MODELS

Elena Tappia - Thesis supervisor: Prof. Marco Melacini

1. Premise

Today's warehouses must be able to respond both efficiently and responsively to customer demand with continuously changing assortments and small order sizes. In this context, companies often are interested in adopting automated warehousing solutions to achieve greater operational efficiency and to cope with the today's challenge so that they can maintain competitiveness. However, companies does not always have the right competences to evaluate all the technologies proposed by material handling providers, especially those that are more recently introduced, and are therefore interested in performance analysis and design tools supporting the evaluation of such solutions. On the other hand, material handling providers are always interested in such tools for improving the performance of the provided technologies. Carried out in close cooperation with material handling providers, this research assesses the more recently introduced material-handling solutions in terms of system performance, optimal design, application areas, and environmental sustainability aspects by developing analytical models.

2. Research objectives and methodology

According to a tight relationship

with material handling providers and the gaps identified by an in-depth literature review, two innovative warehousing solutions that are of interests for companies given the list of their advantages and the lack of design tools are:

1. *shuttle-based storage systems with single deep racks (also denoted as AVS/RSs) for feeding the picking stations in "parts-to-picker" systems.* Compared to the AS/R systems, this technology brings the promise of low operational cost and inherent volume flexibility. It uses two different devices for unit load movements: vehicles that provide the horizontal movements and lifts that provide vertical movements.
2. *shuttle-based storage systems with multiple deep racks (also denoted as compact storage systems using shuttles).* In such a system, the vertical movements and the horizontal movements within the storage lanes are carried out by lifts moving unit loads across tiers and shuttles moving underneath the unit loads, respectively. Hence, this solution pairs the flexibility of shuttle-based systems with the efficiency of compact storage.

This dissertation is a collection of four papers focused on these two technologies.

The *first paper* aims at analysing the dynamic performance – i.e.

response time and throughput capacity – of AVS/R systems adopted for feeding the picking stations in "parts-to-picker" systems. The paper proposes an analytical model based on the queuing network approach. This approach is required for evaluating the impact of the waiting times for the devices performing retrieval and storage cycles on the response time. Validated through simulation, the model presents a high accuracy.

The *second paper* investigates the main design trade-offs – e.g. large number of short aisles compared to small number of long aisles – for AVS/R systems, and proposes a comprehensive framework for their optimal design – i.e. rack configuration that meet user requirements in terms of storage and throughput capacity at the minimum cost, given the required service level and physical constraints –. The *third paper* is also focused on AVS/R systems and has the following objectives: (i) to include the environmental perspective in the selection of automated warehousing solutions and (ii) to investigate the trade-off between the environmental and economic dimensions when selecting warehousing technologies – i.e. to investigate whether the selection of automated solutions changes varying the considered dimensions –.

The *fourth paper* focuses on Compact Storage Systems with Autonomous Shuttles. It aims at developing accurate analytical models based on the queuing network approach to estimate the performance measures for both single- and multi-tier systems. For single-tier systems, it also investigates the optimal depth/width ratio considering both specialised and generic shuttles. For multi-tier systems, it analyses the relationship between performance and the number of tiers considering both specialised and generic shuttles. Moreover, the paper investigates the effective improvement in load throughput time of generic shuttles, and examines how equipment needs and costs can be reduced.

3. Results

In the *first paper*, the system performance has been analysed by considering different scenarios, defined by the storage capacity values and the retrieval demand level, and different design profiles in terms of number of storage tiers, aisles and columns. Thanks to the analytical model, the impact of the rack configuration on creation of queues, and consequently on the cycle time and resource utilisation, is showed.

In the *second paper*, the evaluation of the AVS/RS cost structure shows that, first, cost minimisation may be achieved by minimizing the number of aisles, given the physical building constraints, and then by maximising aisle length to reduce the number of required vehicles. Simulation results illustrates how the lift tends to be the cause of the bottleneck

in case of configurations using high racks. Conversely, for a given storage capacity, the fleet of vehicles represents the bottleneck as the number of storage tiers is reduced. Therefore, the maximum throughput for an aisle does not necessarily correspond to the configuration with the maximum rack height.

In the *third paper*, results indicate that, differently from previous findings on the broader context of logistics, a trade-off between the environmental and economic perspectives does not always exist in warehousing.

As the AVS/RS appears to perform better than the AS/RS from an environmental perspective due to its lower energy consumption per cycle, in contexts in which the AVS/RS is more economically suitable, it is clearly the preferred system and there is no trade-off with respect to the environment. Findings also confirms that it is useful to incorporate the environmental dimension when comparing warehousing solutions as in some scenarios the technology selection shifts from one to the other when considering not only the economic but also the environmental impact.

In the *fourth paper*, the numerical results indicate that the depth/width ratio minimising expected throughput time is around 1 independent of the number of shuttles and the transaction arrival rate. Moreover, the expected throughput time varying the number of shuttles allows understanding how the flexibility of such systems – i.e. changing the size of the fleet shuttle to chase the throughput capacity required – can be managed.

For multi-tier systems, results indicate that there is no trade-off between expected throughput time and the number of storage tiers in a multi-tier system with a continuous elevator. However, in case of discrete elevator, the optimum number of tiers depends on the shuttle type. Finally, results show that the adoption of generic shuttles leads to a saving in expected throughput time but the higher cost of generic shuttles is not balanced by savings in reduced throughput time and equipment needs.

4. Further developments

Three main potential extensions to this research may be identified. First, the analytical models developed can be extended to explore other system configurations and design trade-offs that may be of interest to the warehouse designers. Second, this research starts to explore the flexibility of the examined technologies by studying how the performance changes varying the number of devices in the systems, but further developments are required. Specifically, it could be interesting to explore the flexibility value by investigating the behaviour of the system cost curve varying the difference between the required performance in the design phase and the effective requirements over time. Third, the technology selection problem can be further enriched by including the uncertainty associated with some variables that are assumed deterministic when making the decision, *in primis* the required storage and throughput capacity.

MANUFACTURING THROUGH SERVITIZATION: THEORETICAL MODEL & EMPIRICAL EVIDENCE

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Intense competition among manufacturing, make manufacturing to move into more innovative offers and shift into more profitable and sustainable business. Since 1990, companies realize the importance of moving into new system that offers mix of products and services instead of only products so called as Product-Service System. This trend in known as servitization in manufacturing and is perceived challenging. This study is based on the gap that exists on impacts of servitization over manufacturer and role of manufacturer characteristics on product and service evolution over time. We intend to establish a basis for theory development and practical learning on servitization in manufacturing. Therefore, a theoretical model is developed by support of Structure-Performance-Conduct-Performance (S-C-P) paradigm. Eco-efficiency is widely agreed for product-oriented services but there is no measurement model. Consequently, two assessment frames are suggested to enable manufacturing understand which aspects are necessary to be measured and why they have to be assessed. These assessment frameworks are developed to support economical benefit of manufacturer. The first model has system level view enabling

management to monitor service contribution (e.g. service role on customer retention). By considering manufacturer environmental goals, in second assessment model, the potential economical advantages are monitored (e.g. service resource consumption per intervention). Lastly, sets of research hypotheses based on theoretical model are tested to create grounding for future normative theory building. Results indicate that 1) Economical resources cannot describe advancement in product and service, 2) Product and service are sensitive to economical resources and research & development competences comparably, 3) Role of supplier is recognized equally relevant for both product and services, 4) Advancement in one component (e.g. service) is not resulting on higher revenue generation in another component (e.g. product revenue), 5) Economical advantages in services are more dependent and explainable by service advancement itself, 6) Service package shows a positive and service quality negative influence on service economical performance, and 7) Products with higher functionalities are having more positive influence on economical performance rather than products with better eco-efficiency features.

