

MECHANICAL ENGINEERING | PHYSICS |  
PRESERVATION OF THE ARCHITECTURAL  
HERITAGE | SPATIAL PLANNING AND URBAN  
DEVELOPMENT | STRUCTURAL SEISMIC AND  
GEOTECHNICAL ENGINEERING | TECHNOLOGY  
AND DESIGN FOR ENVIRONMENT AND BUILDING  
| TERRITORIAL DESIGN AND GOVERNMENT |  
AEROSPACE ENGINEERING | ARCHITECTURAL AND  
URBAN DESIGN | ARCHITECTURAL COMPOSITION |  
ARCHITECTURE, URBAN DESIGN, CONSERVATION  
OF HOUSING AND LANDSCAPE | BIOENGINEERING  
| BUILDING ENGINEERING | DESIGN | DESIGN  
AND TECHNOLOGIES FOR CULTURAL HERI-  
TAGE | ELECTRICAL ENGINEERING | ENERGY  
AND NUCLEAR SCIENCE AND TECHNOLOGY  
| ENVIRONMENTAL AND INFRASTRUCTURES  
ENGINEERING | INDUSTRIAL CHEMISTRY AND  
CHEMICAL ENGINEERING | INFORMATION  
TECHNOLOGY | INTERIOR ARCHITECTURE  
AND EXHIBITION DESIGN | **MANAGEMENT,  
ECONOMICS AND INDUSTRIAL ENGINEERING**  
| MATERIALS ENGINEERING | MATHEMATICAL  
MODELS AND METHODS IN ENGINEERING



Dean:  
**Prof. Paolo Trucco**

# DOCTORAL PROGRAM IN MANAGEMENT, ECONOMICS AND INDUSTRIAL ENGINEERING

## Introduction

The Ph.D. Program in Management Engineering (DRIG) offers students advanced training and preparation to conduct research in the field of management, economics and industrial engineering. It aims at training professionals who are able to carry out high-quality research in the fields of management, economics and industrial engineering at universities or other research institutions. Ph.D. graduates from DRIG are also well equipped with distinctive skills and advanced knowledge to pursue a professional career in manufacturing and service companies, regulatory authorities and other public bodies. The program 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. The program emphasizes the benefit of studying problems in an innovative manner, combining various analytical approaches and research methodologies.

The commitment of the Department of Management, Economics and Industrial Engineering (DIG) to research and scientific cooperation with other academic institutions, major industrial companies and other organisations 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.

## Ph.D. Program Structure and Contents

The Full Time doctoral program covers three years, whereas the Executive Program lasts four years. They are entirely taught in English.

The Faculty of DRIG includes, in addition to professors of the Department of Management, Economics and Industrial Engineering, several international scholars: Neil Gandal, Tel Aviv University, Israel; Benoit Iung, Université Henri Poincaré, Nancy, France; Bertrand Quélin, HEC-Paris; 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; Hand De Bruijn and 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.

The program covers three main types of training activities.

### Main courses

- Mandatory courses in Epistemology of Research in Social Sciences and Academic Publishing.
- Methodological courses, addressing specific research methodologies and related skills relevant to research in management, economics and industrial engineering;
- Thematic courses, aiming at introducing students to the reference theoretical background and the cutting edge research in specific disciplines, such as Entrepreneurship and Entrepreneurial Finance, Innovation Economics and Management, Supply Chain Management, Organisational Theory and Design, Service Operations Management, Enterprise and Operations Risk Management, Sustainability and Social Challenges in Industrial Systems.

### Elective courses and training in specific themes

Elective training activities are customised according to the specific needs and research interests of students. The aim is to extend the scientific knowledge of students in very specific topics and to introduce them to the international research community through their active participation to international scientific conferences and PhD schools.

### Thesis

The aim of the PhD programs 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.

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. PhDs 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 at the Department. The final thesis can be submitted in the form of either a monograph or an edited compilation of papers.

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

## Scientific and Industrial Collaborations

Students are required to spend at least one semester in a foreign research institution. In addition, students are encouraged to attend doctoral schools and workshops organized by other institutions and to participate in international scientific conferences. The presentation of an original research work in an international conference is mandatory for admission to the final exam. To his end, students are granted of a personal research budget, covering a three years research period, and have access to mobility support measures aimed at promoting international collaborations between the doctoral programs in Europe and overseas.

In addition, Double Degree agreements are in place at the PhD level:

- EDIM (European Doctorate in Industrial Management, [www.edim-phd.eu](http://www.edim-phd.eu)) is an Erasmus Mundus Joint Doctoral Programme run by KTH (Sweden, Co-ordinator), POLIMI (Italy) and UPM (Spain) and is funded by the European Commission (EACEA);
- Double Degree Program with the Pontificia Universidad Católica de Valparaíso (Chile), Escuela de Ingeniería Industrial, Doctorado en Ingeniería Industrial (started in 2013).

DRIG has also developed several research collaborations with private manufacturing and service firms, regulatory bodies, and other public research institutions to fund PhD oriented research. In recent years, the following organisations supported DRIG Scholarships: Value Partners, TXT e-solutions, D'Appolonia, Consorzio MIP, Fondazione Rosselli, Eupolis, Società Banknord GE.PA.FI. SIM, Siemens, ANIMP-OICE-FONDAZIONE LUIGI DE JANUARIO,

PIRELLI & C., EUROCONTROL, C.T.G. Italcementi Group, Telecom Italia.

### Professional opportunities and the job market

Typical career opportunities opened up by the doctoral program include:

- Post doc, research fellows and young lecturers in Italian and foreign universities;
- researchers and scholars of management, economics or industrial engineering in the research departments of public and private organisations;
- highly qualified personnel in research and training institutions, with the role of providing a link between universities and the business world, or in technology transfer centres in Italy and abroad;
- professionals in leading management and strategic consulting firms able to provide deep and advanced

insight in areas of activity relating to the company itself;

- high level professional roles in national (ministries, regulatory authorities, local public institutions) and international (EIB, IMF, World Bank, European Commission, European Central Bank) public institutions;
- managerial roles in multinational companies with a strong focus on innovation;
- entrepreneurs in contexts characterised by a high level of innovation.

Support actions for placement are provided with the purpose of sharing experiences, services and information through a number of initiatives fitting the different types of career opportunities. Particular emphasis is given to career development in the Management Engineering area.

### ADVISORY BOARD

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# PREDICTING WHO STAYS OR LEAVES AFTER THE ACQUISITION: TARGET'S TOP MANAGERS TURNOVER

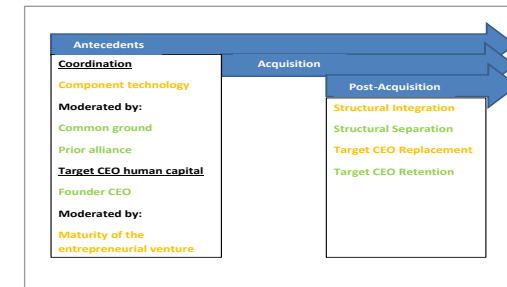
Keivan Aghasi - Supervisors: Prof. Massimo Colombo, Prof. Terrence Brown

In acquisition of high-tech and knowledge intensive firms, scholars have paid special attention to top managers' status after the deal. Literature suggests that these managers in particular CEOs if kept in post-acquisition provide coordination capacity for the acquirer to transfer the knowledge and technology from the target to the acquirer while minimizing the disruptive effect of post-acquisition integration process. In addition, the acquirer benefits from human capital embedded in target's managerial resources; especially in high-tech and knowledge intensive firms where top managers are founders or patent holders. Although the above mentioned argument have been validated by empirical studies showing that top manager's turnover reduces the post-acquisition performance for the acquirers, multiple empirical studies have reported abnormal managerial turnover shortly after the acquisition. This thesis made an attempt to explain this puzzling phenomenon by investigating on the determinants of the top manager's turnover of the target in the post-acquisition period. In particular, this thesis revolves around understanding the rationale behind the turnover of target's top manager after the acquisition. In particular, under

what circumstances the acquirer keeps the target's top managers or replaces them; in case of retention, what would be the main interest for the acquirer. This study found that none of the arguments are intrinsically dismissible, but what makes the difference on validity of the certain argument over the others is the context; the context within which acquisition occurs (the target's firm characteristics, managerial characteristics and industrial characteristics) also the context regarding the acquisition category defined by the driver behind it (motivation). This thesis paid especial attention to context to unravel the determinants behind the target's managerial turnover. Henceforth as explained earlier, the thesis focuses on knowledge intensive and high-tech industries, where knowledge is mostly tacit and embedded in human capital and any meaningful return from this type of acquisition depends on the target's employees and managers further collaboration with the acquirer in post-acquisition. In addition it is safe to assume that acquirers pursue technology and knowledge acquisition even if other motivations such as market entry and increasing market power also drive the acquisition. This thesis examines two other important theoretical arguments

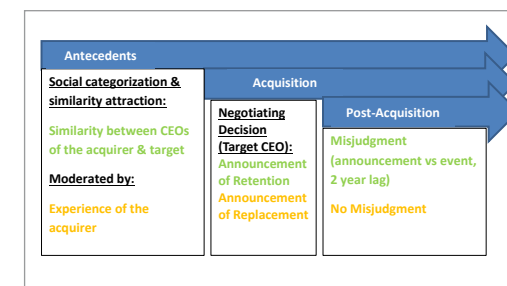
namely: post-acquisition coordination capacity and human capital. In this regard, thesis found that for the acquirers in acquisition of high-tech and knowledge intensive firms, the main integral element is providing the coordination capacity necessary to transfer the knowledge from the target to the rest of its organization. Although the target's top managers are potentially resourceful for providing some level of coordination capacity, the value of such capacity depends on the acquirer's choice of mechanism to provide the necessary level of coordination. If the acquirer decides to rely on certain mechanisms to provide higher level of coordination other than the capacity provided by the target's managerial resources, then the presence of top managers including the CEO becomes redundant after the acquisition. Indeed, their presence can potentially become detrimental to the post-acquisition implementation process because of their resistance toward the changes as some scholars suggested. Alternatively, removing their coordinating role also engenders lower status or inferiority in post-acquisition which forces them to leave after the acquisition (See Figure 1). In other words, we cannot take for granted

the value of coordination capacity in the target's managerial resources for the acquirer.



## 1. Antecedents: coordination and human capital of target CEO

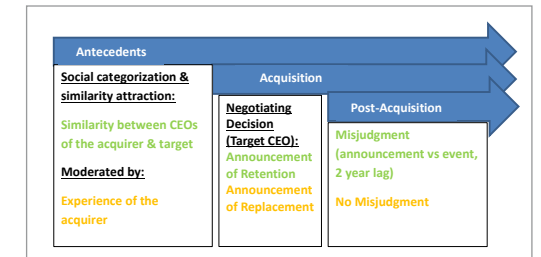
In addition, the value of human capital embedded in target managerial resources is to the extent that it does not hamper coordination. The human capital of managerial resources should fit to the acquirer's need and internal resources; otherwise generalization of value of human capital does not provide any meaningful result. A good example discussed in this paper is the case of founder-CEOs who are more likely to stay after the acquisition because of their valuable firm-specific human capital for the acquirer. However, this value diminishes by the maturity of the target. Overlooking on the multidimensional aspect of human capital and the fit can be a reason why prior studies on human capital did not find a solid evidence of human capital in determining managerial turnover (See Figure 1).



## 2. Antecedents-similarity between CEOs of the acquirer and target

Another determining factor is similarity in demographic characteristics of the two CEOs (of the acquirer and target) which causes social attraction, collaboration and cooperation which ultimately increases the chance that the target's CEO retention.

Prior researches ignored the behavioral aspects in acquisitions. Although similarity increases the chance of promise of further collaboration when the acquisition is announced, it increases the chance misjudgment because of false sense of security or deception (See Figure 2). Finally, diversity within the target's top management team (TMT) directly increases



## 3. Antecedents- team level diversity

their chance of departure after the deal. The diversity engenders social frictions, conflicts and coordination inefficiencies (See Figure 3).

## WHO HELPS YOU TO INNOVATE? THE POWER OF RADICAL CIRCLES IN VISION CREATION

**Naiara Altuna Lertxundi** - Supervisor: Ing. Claudio Dell'Era

The ultimate goal for those who innovate, and quite likely the greatest challenge they face, is the creation of a radical new vision. Indeed, when the willingness of an individual or a company goes beyond solving an existing problem the question is: how can I find a new vision (i.e., that which rethinks the rules and proposes a new interpretation of what is meaningful in a given industry)? In the “age of discontinuity” in which we live in there is a growing emphasis on the human dimension; a number of companies are putting people first, and starting with the individual relationships rather than with systems or structures. This human dimension, which implies looking at people as human beings rather than as users (of a given product), makes us get closer to their heart and helps us to (hopefully) understand what is meaningful to them. Previous studies have shown how new interpretations arise when we collaborate with external parties and this thesis has been written as an attempt to clarify which are the external sources one can leverage on when willing to propose a new vision. One of the answers: radical circles. These are restricted groups of individuals that collaborate beyond formal organizational structures and by challenging

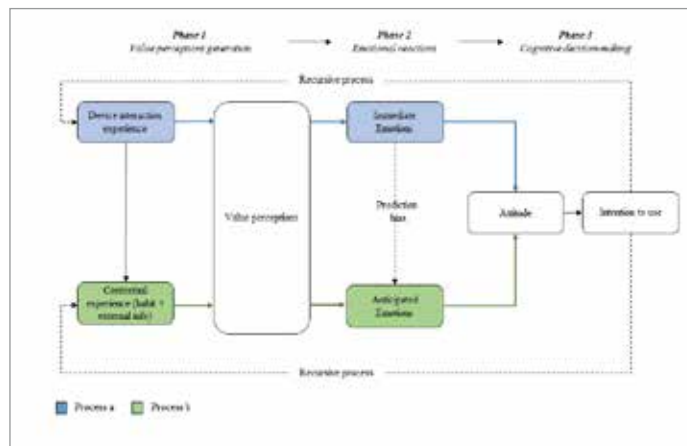
one another draft a vision in clear contrast to the dominant rules of their industries. Theory and practice related to radical circles is extended in this thesis by means of qualitative case studies. Such a research design is argued to fit with the exploratory aim of this thesis. The empirical setting is four circles of radicals (Slow Food, Memphis, Homebrew Computer Club, and the Stonemasters) and the corresponding business initiatives that were generated. The findings from the study show that circles work in intimacy first, meaning the quest is done privately. In this journey your own thoughts are exposed to, challenged and negotiated with others – the circle members, who are the most faithful audience one can get. The negotiation is based on criticism and experimentation, and eventual consensus. The gatekeeper and the charismatic leader are important referents of the circle structure, but would be unable to get anywhere without the rest of the constituents, special mention to salient members (i.e., members at the poles). Instead, the second part of their work is public, and this is when they consolidate their vision and create mass impact. The reification can be done through a number of actions: communicating, explaining, embodying,

transferring, and nurturing. In this phase, the role of the charismatic leader is still crucial, and a new role emerges, that of the operative manager, who is the person responsible of making sure the action plan is fulfilled. All in all, the nucleus of the circle will tend to stay small, and if there are any new comers these will be few. After all, the circle will quite likely dismantle and the members will begin their own voyage, individually. The contribution of the above–shared findings to the literature is three–fold. First, and foremost, it sheds some light to the “black–box” we can leverage on when attempting to innovate the meaning of things (which is after all what we do when coming up with a new vision). Second, it invites open innovation literature to expand its scope by giving some space to debates. Third, it adds on the theory of collaborative circles by providing some hints on the business impact these circles can have. The thesis, furthermore, contributes to managerial practice through a thorough illustration of practices, which may serve as inspiration for either collaborating with a radical circle or for creating your own.

# ADOPTION AND USE OF PERSONAL ELECTRONIC DEVICES: AN EMOTIONAL PERSPECTIVE

Debora Bettiga - Supervisor: Prof. Giuliano Noci

Figuring out how to incorporate consumer affective experience into technology adoption studies has been an ongoing objective in research. This work takes the challenge by exploring the role of emotions in adoption and usage of personal electronic devices, a new and fast-growing product category, still little explored, for which the psychologically engaging user experience has been acknowledged as main success factor. The research explores the influence of both immediate emotions, emerging from the interaction experience, and anticipated emotions, arising outside the experience window, on cognitive decision-making. Understanding the emotional processes enhancing or undermining adoption and usage of personal technologies can help marketers in defining the right product characteristics and meanings, the contextual experience and the communication content, able to elicit positive emotions in consumers. The thesis is articulated in three papers. The first paper proposes a conceptual framework, grounding on several theories in marketing, cognitive psychology, design and information technology fields, to explain the role of emotions in decision-making



## 1. Conceptual framework

process. Three phases of the adoption process are suggested and analyzed: (i) product value perceptions elicited during the consumer experience with the product and from external sources (ii) the affective response they elicit, namely immediate and anticipated emotions and their situational dependency and (iii) emotions influence on cognitive evaluation: attitude and, eventually, intention to adopt or use a personal electronic device. The study suggests a recursive process in which the three phases are continuously reiterated during the product life with the consumer. Figure 1 depicts the conceptual framework proposed. The second paper investigates the

immediate emotions (pleasure and arousal) elicited during the consumer-device interaction. Existing research mostly assesses emotions through self-reported questionnaires, despite these measures rely on cognitive techniques, thus reflecting conscious emotions but not unconscious feelings. In this work, conscious and unconscious emotions, their relationship and their influence on product attitude are explored. Considering both conscious and unconscious emotions entails the possibility that the consumer acts in a way that is impulsive, or even compulsive and irrational. The work employs physiological techniques (electrodermal

activity analysis) to measure unconscious arousal and self-reported measures to assess conscious arousal, pleasure and attitude. 160 subjects participated in a lab experiment with a 2 x 2 design: two contexts, direct and virtual product trial and two product typologies, hedonic and functional. Results showed that conscious and unconscious arousal are two independent components of the emotional response, reflecting different factors. Further, they have a significant and diametrical opposite influence on product attitude.

The third paper explores anticipated emotions elicited outside the consumer-product interaction. Despite anticipated emotions, the prediction about the emotional consequences of a behavior, have been confirmed as strong drivers of consumer choices, they have not been explored in product adoption field yet. This paper analyzes positive and negative anticipated emotions influence on attitude, and in its turn intention to use personal electronic devices. Further, it investigates the drivers of such emotions, namely purposive value, usability, monetary value, social enhancement, interpersonal interconnectivity, entertainment

value and self-discovery value. A survey on 270 subjects was conducted. Emotional and cognitive responses were examined for both novel and familiar devices, functional or hedonic in nature. Findings demonstrate the ability of anticipated emotions to influence consumers' attitude and intention toward personal devices adoption and use. Further, they show that value perceptions vary greatly between novel and familiar products and affect anticipated positive and negative emotions differently.

Findings of this work open the way to several studies in the field of emotions in product adoption and usage. About current emotions, this research is one of the earliest marketing studies that empirically examines unconscious emotions through physiological assessment. Future research may use fMRI, face detection or heart rate assessment to get insights on the unconscious side of emotions, able to influence the product cognitive evaluations. This work introduces anticipated emotions in the product adoption field, confirming that they are relevant drivers of product attitude. Future studies need to confirm this effect for other contexts and product typologies as well.

A deeper understanding of the consumer psychological processes will enable researchers and marketers to consider the cognitive and emotional antecedents of adoption and use likely to be dominant for the particular experience and for the particular product they are using as research stimuli or which they are marketing.

# BE LEAN TO BE RESILIENT: SETTING CAPABILITIES FOR TURBULENT TIMES

**Seyoum Eshetu Birkie** - Supervisors: Prof. Paolo Trucco, Prof. Matti Kaulio

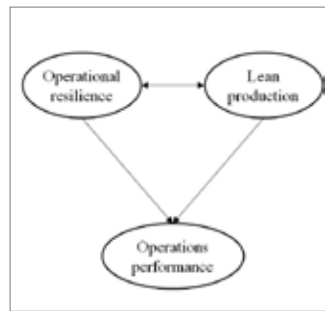
## Introduction

Businesses globally are challenged to innovate their operations strategies and practices towards tighter delivery times, better quality and cheaper prices to remain profitable in addition to managing unpredictable circumstances well in today's turbulent business environment. They often have to deal with the apparent paradox of advancing efficiency-fostering approaches such as lean production, and enhancing operational resilience against unanticipated disruptions.

## Purpose and research questions

The purpose of this study is to investigate whether and how practices in seemingly contradicting paradigms in operations management (i.e. lean and resilience) can be utilised to attain a better competitive position in the face of uncertainties. In short, resilience can be thought of as an anticipative and flexible capability to address unanticipated and uncertain circumstances and their varying consequences on business operations; lean production is a socio-technical system aimed at elimination of waste and variability to deliver better customer value. This PhD thesis is comprised of "modules" of studies designed to systematically address the three research questions (RQ).

This was necessary due to the different maturity level of the concepts (resilience and lean) brought together into the study framework shown in Figure 1. The research questions sought: (RQ1) to identify constituents of operational resilience; (RQ2) whether and how lean production enhances performance under high uncertainty; and (RQ3) to identify synergy/trade-off relationship between lean and resilience.



1. Overall framework of the thesis

## Purpose and theoretical frame

Resource-based view (RBV) argues that firms consist of bundles of productive resources and capabilities that help to achieve competitive heterogeneity with heterogeneous resources over time. The dynamic capabilities perspective advances the argument of RBV further, arguing that firms (should) possess capabilities that enable them to reconfigure,

refresh, or integrate resources to meet operational and business needs in turbulent environments. Such contingent RBV proves an appropriate theoretical frame as it takes into account uncertainties for which resource needs cannot be determined *a priori* to enable enhanced performance in turbulent environments.

## Methodology

Predominantly qualitative mixed-method approach was used for the overall research with some quantitative analysis included. The critical incident technique was used to collect data from firms that experienced supply chain disruptions. Multiple case study approach was used to investigate lean implementation strategies and implication on performance sustenance in high uncertainty context using engineer to order companies as empirical setting. Bayesian inference was used in investigation of trade-off/synergy issues among lean and resilience upon disruption with the use of data from secondary sources that are specifically encoded for the study. The methodological approaches used in the different papers making up this thesis are summarized in Table 1. With the help of this multimethod approach, the five papers jointly address the three research questions of the

thesis.

## Findings and implications

Starting with systematic literature review (Paper 1), operational resilience is characterised in terms of five core functions: sense, build, reconfigure, re-enhance, and sustain. Resilience is also operationalised using routine practices that are bundled into internal/external, proactive/reactive dimensions of capabilities that positively influence performance upon recovery from disruption (Paper 2). An investigation that lean practice bundles lead to not only improvement but also stability of performance uncertainty context is also done in the thesis (Paper 4). Engineer-to-order production is used as empirical setting for this (Paper 3). Using the insights so gathered, it is argued that business firms can better arrange their routinely undertaken practices so as to survive and excel in times of shocks or disorders. Finally, operational resilience (based on routine practices that form the core functions) was found to have stronger synergies than trade-off with lean (based

on practice bundles) in times of turbulence (Paper 5).

In line with the purpose and RQs set forth, the findings of this thesis can be summarized as; (1) extending the application of lean practices in high uncertainty business environments, (2) operationalising operational resilience in terms of specific practices that are sources of competitive advantages and improved operations performance, (3) discussing synergetic relationships which imply that resilience and lean are not necessarily alternatives but can be complementary in times of disruption and turbulent times if well managed.

This thesis extends the resource-based view to high uncertainty contexts through empirical evidence and shows that resilience (dynamic) capabilities can be built from practices that firms normally employ; the capabilities are sources of better performance and competitive advantages in turbulent business environments. The thesis contributes to the discussion on the paradox of

lean and operational resilience based approaches in the same context; lean practices bundles lend themselves to synergy with resilience capabilities, and leverage competitive gains in turbulent times. Practically, findings of this thesis suggest that companies need not abandon their lean implementation to become more resilient. In fact, it shows that lean implementation should be extended to address value chain processes beyond the shop floor for integrative removal of wastes, while being able to flexibly mitigate disruptions. The thesis additionally provides 'gauging' for lean implementing firms so as to see if they are implementing lean practices as correctly as they ought to. In a general sense, it has demonstrated that lean practice bundles implementation should not be limited to only shop-floor processes. They have to be extended to other (transactional) value chain processes so as to benefit from the integrative removal of waste from all processes while concurrently trying to embed flexibilities.

PAPER	TITLE	METHODOLOGICAL APPROACH	MAIN FINDINGS
P1	Disentangling core functions of operational resilience: A critical review of extant literature	Structured literature review	resilience discussed as a dynamic capability consisting of core functions
P2	Supply side resilience capabilities as practice bundles: A critical incident study	Qualitative and statistical analyses on critical incident data	Resilience operationalised into bundles of practices and shown to positively affect performance
P3	Understanding dynamism and complexity factors in engineer-to-order and their influence on lean implementation strategy	Case study (primary and secondary cases)	Extending lean practices into turbulent business context
P4	Sustaining performance under operational turbulence: the role of lean in engineer-to-order companies	Multiple (comparative) case study	Lean practices help sustain performance in high uncertainty context
P5	Operational resilience and lean: In search of synergies and trade-offs	Bayesian inference analysis on encoded secondary data	Lean and resilience found to have stronger synergy than trade-off in improving performance upon disruption

Table 1. Overview of papers appended to the thesis

## INITIAL PUBLIC OFFERINGS: VALUATION, LONG-TERM PERFORMANCE AND SHARES ALLOCATION

**Matteo Bonaventura** - Supervisor: Prof. Giancarlo Giudici

The thesis deals with Initial Public Offerings (IPOs).

Since researchers started investigating IPOs, three main puzzling pieces of evidence have been reported. The first is positive first day stock returns for newly listed companies. The second is the clustering of IPOs in short periods of time. The third, which is also the most puzzling, is the negative long-run performance for newly floated companies. Researchers and academicians, actually, are not even sure about the existence of long-run underperformance by IPO stocks. A first school of thought, namely the "behavioralists", argue that over-optimism drives very high valuations of newly public companies. On the other hand, the supporters of the market efficiency theory argue that the negative performance is only an econometric artifact linked to serial correlation.

Recently, other techniques have been adopted to study the poor returns of IPO companies. Namely, researchers have investigated IPO valuation, operating performance, earnings management and the relation with other corporate events (such as seasoned offerings and mergers and acquisitions) to bypass the econometric issues related to measuring long-term stock performance.

This thesis thus exploits this last strand of literature and aims at increasing the understanding on long-run performance of IPO stocks. It is made of three papers, each one tackling a different phenomenon relative to IPOs. The first paper deals with the mergers and acquisition activity done by IPO firms in the year following going public. Acquisitions are indeed related to manager imperialism and may be a consequence of the further separation between ownership and control that follows IPOs. Thus, they may serve the manager for building empires but may destroy value to the shareholders in the long-term. Furthermore, recent literature on the IPOs finds that acquiring IPO firms perform the worst in the stock market. I actually find that acquiring IPO firms, despite showing negative stock returns in the aftermarket, deliver superior long-term operating performance both in terms of earnings and operating cash flows. This result is robust controlling for IPO and acquisition characteristics. I also find that acquiring IPO firms tend to survive the least in the public market, independently from the motive of exit (either acquisition by other firms or failure). I argue that the results are driven by the window of opportunity theory, that is IPO

firms go public in periods of over-optimistic expectations that fail to be met in the long-run. This problem seems to be even more pronounced for acquiring IPO firms. The reason can be either the difficulty to estimate synergies or the difficulty of making estimates for entities having a larger size. The second paper directly investigates the optimism implied in IPO prices. Prior IPO literature finds indeed that underwriters are overly optimistic when setting target prices, but it is not clear whether they are more optimistic than equity analysts. The paper thus aims at understanding whether underwriters are more optimistic than equity analysts when making estimates, and then aims at investigating how forecast errors evolve from the book building to the first day of trading. By building a reverse engineering model of the discounted cash flow valuation method, the paper derives the short term operating forecast implied in IPO prices. Then, by comparing the expected profitability to the actual result delivered on the companies' financials, I compute the forecast error. The results show that forecast errors are similar among underwriters and equity analysts. Moreover, it finds that forecast errors are larger the more equity issues take place around the

IPO date, the faster the previous growth of the company and the higher the leverage of the firm. Furthermore, it finds that errors decrease after the book building, but they increase after the first day of trading. We interpret this result in the light of the informative role played by the book building, which however does not eliminate completely the optimistic bias present in IPO prices.

The third paper, finally, further investigates the role of the book building.

Previous literature, indeed, shows that institutional investors are rewarded for disclosing valuable information during the book building with a short term advantage, namely the IPO underpricing. Indeed, by receiving shares that appreciate in the first day of trading, they obtain a monetary advantage. On the other hand, another strand of literature investigates the shares allocation to institution in subsequent IPOs. The main results show that institutional investors are penalized in future allocations if they sell their shares after the first day of trading. Thus, to monetize their reward, institutional investors have to sell their shares in a longer time frame.

For this reason, the paper investigates the relation between shares allocation, IPO valuation

and long-term performance.

The results show that underwriters, at the prospectus, allocate more shares to retail investors when the IPO is overpriced relative to its fair value. The relative value of IPO shares to their fair value is also an important determinant of shares reallocation. Institutional investors are indeed allotted more shares in undervalued IPOs. Moreover, the demand by underwriters is also satisfied the most when IPOs are undervalued.

In order to investigate whether this relation turns into a long-term advantage, I also study the determinants of the long-run returns at one, three and five years. When I consider the final allocation among the covariates, I find no relation between the final allocation and the long-term returns. However, when I decompose final allocation in initial allocation and reallocation after the book building, I find that institutions receive larger returns when they are reallocated more shares. That is, they receive a long-run reward for producing positive information. This may also partially explain IPO overpricing as an efficient method to compensate investors for information production.

To sum up, the main results of the thesis can be summarized as

follows.

The results show that IPOs are priced over-optimistically, and this seems to be more evident for acquisitive IPO companies. Furthermore, the errors committed in pricing IPOs seem to be related to standard valuation practices to evaluate IPO companies that are common to equity analysts and underwriters. Finally, it finds that book building is effective in reducing forecast errors as it is an effective mean to produce information, and this information production activity also partially explain IPO mispricing.



# LEADERSHIP IN TRANSFORMATION: A COLLABORATIVE MANAGEMENT RESEARCH APPROACH TO BRIDGE THE RIGOR-RELEVANCE GAP

Filomena Canterino

Supervisors: Prof. Abraham B. (Rami) Shani; Prof. Raffaella Cagliano

## Aim of the study

Leading change is one of the most difficult task for leadership, but at the same time is one of the most important and characterizing responsibility leaders have to shoulder. The study of leadership and change is not new, yet the real impact of leadership on organizational transformation is not fully understood and scientific literature is inconclusive. The dissertation aims to investigate the role of leadership in organizational transformation, with a two-fold objective. First, it aims to re-examine the theoretical assumptions about the phenomenon, taking into consideration not only individual perspective on leadership but also a plural perspective. That is to say, studying not only transformational leader(s), but *leadership in transformation*, setting as the unit of the analysis not the individual leaders but the concept of leadership itself, and the role that it plays during a transformation effort. Second, the dissertation aims to address the call for the need to reflect on the traditional scientific approach used in conducting research in the behavioral and social sciences, especially in management literature. This call has been growing more and more in recent

years, with scholars criticizing the tendency to produce formulaic research, which is auto-referential and too much focused on rigor but less and less on relevance. The conceptual background of the dissertation is based on the review of two main bodies of literature. First, organizational transformation, with an illustration of the main theories and models. Second, leadership literature, with a focus on individual and plural approach of leadership and with specific emphasis on what literature says about the role that the different leadership models play during organizational transformation.

## Meta-level research questions

In specific, the meta-level research questions of the dissertation are:

- 1) What are the organizational variables that impact leadership during transformation?
- 2) To what extent individual and plural leadership play a role during organizational transformation?
- 3) How individual and plural leadership approaches relate to different drivers of on an organizational transformation?
- 4) What are the specific leadership configurations that can be found within the different phases of a transformation?
- 5) How a scientific inquiry

approach can be useful and relevant for practice when dealing with exploration of leadership in organizational transformation?

## Methodology

Coherently with the aim of this work, the methodological approach of the dissertation is the combination of action-oriented Mode 2 research - as the predominant approach to delve into the phenomenon under inquiry in a contextual setting - and Mode 1 research as a confirmatory approach to test the insights underlined with the action-oriented research methodology. In the broad family of the different action-oriented research approaches, the specific methodology chosen for studying the phenomenon under inquiry is Collaborative Management Research (CMR). The choice to adopt CMR approach among the different action research methodologies is related to the relevance of engaging management for the specific phenomenon under inquiry. In specific, four out of five articles are based on the two CMR projects in which I was involved during my PhD path. Each research project involved a company recently undergone a major transformation. Rigor, reflection and relevance have been the drivers of the

research processes. Moreover, to gain additional insights involving a broader population, a Mode 1 international survey has been performed on a sample of 586 middle managers who had been involved recently in a planned organizational change effort.

## Results and contributions of the study

Table 1 summarizes the five articles composing the dissertation in terms of aim and inquiry process. Results could be of added value for theory, methodology and practice. Concerning contribution to theory, first the studies show how leadership in organizational transformation cannot be studied as a universal phenomenon, since leadership is affected by different contextual and organizational variables such as for examples HR variables. Second, the dissertation conceptualize specific manifestations of leadership that could be relevant through the different phases of an

organizational transformation (i.e. Communicating Leadership, Envisioning Leadership and Conducting Leadership). In conceptualizing these manifestations, it contributes to the debate on how individual leadership perspective can be integrated with a plural perspective of leadership. Third, it generates new insights about how individual and plural leadership interacts with the different drivers of transformation. Concerning the contribution to method, the dissertation illustrates how adopting a Mode 2 and more specifically a CMR orientation is of added value. The exploration of complex phenomena such as leadership in organizational transformation and its interaction with organizational variables benefitted from the collaborative investigation process. Such an approach can help in overcoming the rigor-relevance gap by also having a real impact on

practitioners. Concerning the contribution to practice, the dissertation aimed to draw specific implications for practitioners. By definition, the choice of adopting a predominant Mode 2 perspective aims in fact to start from real organizational problems, instead of starting by spotting and fulfilling theoretical gaps in literature. In specific, the implications for practice – beyond the practical implications and interventions planned in the companies involved in the projects - have been the illustration of a guiding scheme and a set of specific recommendations that might help in designing and managing transformations. The CMR approach utilized in the study provided insights that guided the transformation effort. Moreover, practical examples of distribution of leadership in organizations that undertake organizational transformation are provided.

STUDY	AIM	INQUIRY PROCESS
Leading transformation in a family-owned business: Insights from an Italian company	Exploring the nature of an ongoing transformation in a specific context (i.e. family-owned business)	Case study in the frame of a long-term CMR project
Sustaining transformation via Leadership: A collaborative management study in the fashion design industry	Identifying specific manifestations of leadership in transformation as a combination of individual and plural leadership and change activities	Theory-building case study, built in the frame of a long-term CMR project
The Role of Individual and Distributed Leadership in the Implementation of Mobilizing Activities in Change Management	Testing specific hypotheses on the relationship between individual leadership, distributed leadership and change activities	Quantitative survey involving 586 international middle-managers who implemented planned organizational change projects
Transformational Leadership in Context: Insights from a Mode 2 Study	Exploring the interplay HRM practices and transformational leadership on employees' job satisfaction and affective commitment	Action-oriented Mode 2 study, mixed method: qualitative case study + quantitative survey
Collaborative Management Research as a Modality of OD Action Research: Learning from A Merger-based Study	Showing how an action-oriented CMR approach could be beneficial in transformation and how it can enable rigorous, reflective and relevant inquiry and action	Conceptual action-oriented study based on 2 and a half cycles of CMR

Table 1 - Summary of the studies

# ENTREPRENEURSHIP IN DIGITAL STARTUPS: A REFERENCE FRAMEWORK AND AN APPLICATION TO THE MOBILE INDUSTRY

**Andrea Cavallaro** - Supervisor: Prof. Andrea Rangone

## 1. Premise

Nowadays there is a quite large consensus among scholars about the positive effects of new firms' creation on the economic wealth of a Country. Entrepreneurship has been gaining increasing respect from the research community not only as a field of theoretical analysis as well as empirical application, but also as a means to achieve wealth creation and personal fulfilment. This research focuses on strategic approaches that could support entrepreneurs in developing their new ventures in the digital industry. Two main concepts have been noticed to be widespread among practitioners: Business Model Design (BMD) and Lean Startup Approach (LSA). In this thesis, the focus is on these two approaches that are still under-investigated, due to their embryonic stage of development and their fuzzy definition. This research focuses on the Mobile Telecommunications industry and this setting is very appropriate for the analysis for several reasons. First, globally, the number of mobile subscriptions jumped from 430 million at the start of the decade to more than 5 billion by the end. Second, the mobile and personal nature of wireless devices combined with the voice and data transmission capabilities of wireless networks provides a set of unique features

such as ubiquity, 24h reachability, localization, personalization dissemination and convenience. Third, such industry is going through a period of profound turbulence and discontinuity, with intriguing strategic implications ("Mobile Revolution").

## 2. Research objectives and methodology

In the light of previous considerations, the present Doctoral Thesis' objective is twofold: first, it aims at providing an original framework to support new ventures in the development process of their BMs in the dynamic context of the digital Industry; second, it aims at applying and testing the proposed framework to an empirical base extracted from the context of reference – i.e. the Mobile telecommunications industry. The thesis' findings aim at contributing to the debate of a niche of the strategic management literature, the stream that provide tools, frameworks and approaches for practitioners, in particular to entrepreneurs. Moreover, there are three interwoven empirical problems affecting the literature streams of reference of this work:

- academics are unable to relate their insights to the pressing problems of practitioners: scholars recognize that the problem lies in the difficulties

of concretizing the production of actionable knowledge while maintaining rigor and reflection;

- the accumulation of knowledge over time follows a slow and fragmented process: literature is currently struggling to keep up with a plethora of experiments conducted in dissimilar settings, which complicates the comparison among different cases, or among the same case in different times;

- the "quantitative methodological" bias that prevail in all areas of entrepreneurship research.

The identified gaps claim calls for more researches based on interpretative approach, that is why this thesis is based on a qualitative research design and following the Collaborative Management Research methodology (CMR) a multimethod research methodology approach has been chosen by applying both the Action Research and Case Study methodologies.

This dissertation presents a collection of the three scientific papers that constitute the original contribution of this thesis. The first paper "*Business Model Design & Lean Startup Approach: a liaison for a BM development process reference framework*" aims at proposing a reference framework by synthesizing together principles

from BMD and LSA streams. The second one "*How do business models arise in new ventures? A collaborative management research study on mobile telecommunications startups*" represents a concrete application of the reference framework developed in the first contribution. Lastly, the third article "*Business model change and refinement along business model lifecycle: evidences from a multiple case study on mobile telecommunications new ventures*" explores which are the business model elements – i.e. parameters or "building blocks" – subject to refinement and change during the startup development in the early stage of life.

## 3. Results

The framework developed synthesizes a set of principles and it is grounded on the relationships between LSA and BMD concepts that, starting from the LSA process adds for the first time specific notions of different strategic tools dedicated to new ventures. This thesis, moreover, extends both the field of BM and the LSA stream. In fact, the empirical contribution reveals that:

- first, it supports the view of BM as a focusing device for entrepreneurs and employees, especially when supported by a set of rules or guidelines that derive from decisions made at the proprietary level;
- second, it introduces the concept of Minimum Viable Business Model, that represents the smallest version of BM that the founding team can build and that lets the team quickly make it around the subsequent cycle based on the build/

measure/learn loop. It includes a subset of the all the early BM assumptions developed by the team;

- third, while the LSA focuses great attention on the front-end part of the BM (that includes the value proposition and delivery dimensions and the revenue model), this thesis' findings suggest that the lean process, with its tests and feedbacks from stakeholders, affects all the parameters of the BM, thus including those of the back-end – the part dealing with the value creation dimensions;
- fourth, by following the reference process, the cases under study not only confirmed previous studies arguing that trial and error innovation processes are more adequate to the front end of a BM, but it also extended it to the back-end of a BM.

The final framework should support entrepreneurs in effectively manage the process of BM development in the early stage of life of new ventures, thus aiming at reducing the startup failure rate. Following the suggested framework, companies should show aptitude in restructuring their organizations and reconfiguring their business models, which would made it possible for them to develop and succeed.

## 4. Further developments

Concisely, this thesis opens up several new research questions that could be further explored in order to provide a more concrete managerial contribution to both the academics and practitioners' worlds. These emergent concepts should be analyzed in order

to extract new knowledge and generalizable results. First of all, the framework presented needs to be tested extensively and future research will have to validate the overall structure of the model, possibly leading to theory development. Moreover, this study's results are extracted from only one sub industry of the entire digital ecosystem, i.e. the mobile telecommunications market. Further research is also needed in order to generalize findings in other empirical contexts pertaining the whole digital industry. Future developments should perform an assessment of performances reached by new ventures following this reference framework and, thereafter a comparative analysis with other processes of reference should be conducted. For instance, future studies should tackle whether new ventures adopting this approach get access to financing easier and earlier, reach the break-even point earlier, are more likely to survive, find new business opportunities, and so on and so forth. Nonetheless, future avenues could investigate in a deeper way factors hindering new ventures in the adoption of BMD and LSA principles. Moreover, opportunities for future research lie in exploring all the contextual variables affecting new ventures that follow the proposed framework. Finally, future developments need to highlight whether investors are willing to support new ventures following LSA and BMD principles rather than more traditional tools (like the business plan), and if so, when and why.

# PROPOSAL OF A TOOLSET FOR THE DESIGN OF LIFECYCLE ORIENTED SOLUTIONS IN THE MACHINERY AND EQUIPMENT SECTOR

**Daniele Cerri** - Supervisors: Prof. Marco Taisch, Prof. Sergio Terzi

Over recent years, companies that provide machineries and industrial equipment with an Engineering-to-Order approach have to face challenges coming from the modern business world. First of all, the economic globalization pushed the industrial competition at another level; in this context, developed economies' companies have to face cost pressure and competition-based pricing coming from less developed economies' ones. A mere competition on price is not sustainable for advanced countries' companies, which need to have other leverages, in order to survive and compete on the global market. Furthermore, environmental protection is become an important and stressed point by policy makers and public opinion, legislating more and more strict laws and regulations (eg. Kyoto protocol, WEEE, RoHS, Energy Performance Certificate, etc.). Finally, in the Business-to-Business market, customers' interests are changed; indeed, they want energy efficient and eco-friendly personalized solutions, with the lowest lifecycle cost and in the shortest time. Therefore, it is important to design and develop personalized and more reliable eco-friendly and energy-efficient solutions, with the lowest lifecycle costs and able to satisfy customers' requirements,

taking into account the whole lifecycle, in order to evaluate all the costs and environmental impacts generated. In particular, Engineering-to-Order companies collaborate with customers since engineering phases of the product, in order to define customers' functional requirements, up to the delivery and ramp up of the system. Furthermore, each order for ETO companies represents a large proportion of their annual turnover and is therefore of strategic importance. The most critical phases are the one that foreruns the preparation of the proposal for the customer, because they are responsible for the success or failure of the proposal. Indeed, customers evaluate different proposals coming from different suppliers. During these phases, designers and system engineers have to provide a solution that meet and satisfy customers' requirements. To award the order, key drivers in the machinery and equipment sector are: (i) lifecycle costs, (ii) lifecycle environmental impacts, (iii) technical requirements, and (iv) time for preparing the proposal. In order to support designers and system engineers in the estimation and evaluation of lifecycle costs and environmental impacts, Life Cycle Costing (LCC) and Life Cycle

Assessment (LCA) methodologies have been identified. Life Cycle Costing is a methodology able to support the evaluation and estimation of all the costs generated by the system during its life, including its cost of acquisition, operation, maintenance, conversion, and/or decommission. Life Cycle Assessment, instead, is a methodology that supports the evaluation and estimation of all the environmental impacts generated along the whole system lifecycle. As previously mentioned, Life Cycle Costing and Life Cycle Assessment can support designers and system engineers in the evaluation of costs and environmental impacts along the whole lifecycle; however, they are time-consuming methodologies that do not enable the evaluation of technical requirements. Furthermore, Life Cycle Costing and Life Cycle Assessment methodologies are not sufficient to identify the optimal lifecycle oriented solution, because they are not able to compare a high number of alternatives. The research objective is, therefore, to provide a toolset to support designers and system engineers for the preparation of the proposal, in order to identify the system that meets customer's requirements and constraints

with the lowest lifecycle costs and environmental impacts. Furthermore, the research wants to define how to insert the toolset in the de-sign process, in order to make the toolset easy to use by stakeholders. The first step is the analysis of the current literature, in order to identify how academics faced the above-mentioned LCC and LCA limitations. Two main re-search topics have been identified: one about the so-called Life Cycle Optimization and the other one about Life Cycle Simulation. Life Cycle Optimization models combine LCC and LCA methodologies with different optimization or heuristic algorithms, in order to identify the optimum / optimal lifecycle oriented solution/s. Life Cycle Simulation models, instead, combine LCC and LCA methodologies with simulation techniques, in order to verify the behavior of the possible solutions, simulating them in a computational environment. The state of the art analysis highlighted how Life Cycle Optimization is a current trend topic in the academic world, and how it can be combined with other methods, like simulation, in order to find an optimal and consistent lifecycle oriented solution. Furthermore, Life Cycle Optimization can answer to the industrial needs coming from the machinery and equipment sector. The second step is the development of a toolset able to answer to research objectives. The main logic followed during the toolset development is the creation of a user-friendly

work-place where designers and system engineers can simultaneously manage both environmental and economic indicators, evaluating technical requirements, up to develop optimal and robust lifecycle oriented solutions. The toolset has been integrated into the design process developed during the research. The process starts with the request for proposal by the customer. Customer defines requirements and constraints that the proposal has to satisfy, alone or with the help of one of the possible system's supplier. When supplier receives the request for proposal, first it defines the bill of process, which is the series of operations that the system has to complete, in order to execute as required by the customer. Then, the supplier has to define if there are possible alternatives for each component of the system. For all the components, and their alternatives, supplier has to define cost's voices, environmental impact's voices, and performance's voices. Cost and environmental impact's voices are defined following International Standards. When all the components have data and information, designers and system engineers can use the toolset. The first tool to be used is the Life Cycle Optimization tool, which enables the creation and identification of a set of optimal lifecycle oriented solutions. Life Cycle Optimization combines the different alternatives for each component, in order to create configurations that minimize lifecycle cost and environmental impacts, satisfying constraints (customer's requirements). Designers and

system engineers choose the most promising solutions. Life Cycle Simulation runs these solutions, in order to simulate and identify the solutions' behavior and robustness in a stochastic way. These tools support designers and system engineers in the creation and identification of the robust and optimal lifecycle oriented solution, which better fits with customer's requirements. At the end, the proposal is prepared and submitted to the customer, which evaluates different proposals from different suppliers. The toolset has been tested and validated in a real industrial environment, provided by an Italian company that supply industrial automation systems for the automotive sector. The validation of the toolset has been conducted in two steps: in the first one, the results coming from the application of the toolset have been validated; in the second one, feedbacks have been collected by designers and system engineers.

## ESSAYS ON WORLD TRADE AS A COMPLEX SYSTEM

**Isabella Cingolani - Supervisor: Prof. Lucia Tajoli**

The present Ph.D. Thesis is developed around the concept of Complexity. The economic system of World Trade can be considered as a Complex System as Internet and a large variety of biological and social systems. Nowadays it is not unusual to describe countries' performance using terms that evoke the idea of Complexity such as "globalization" or "economic integration". As economic agents we are indeed part of systems that hardly can be defined as simple. This work has assumed the task to show some examples of such empirical consideration.

The choice of deal with this task originates from the interest forward the so-called Emergence that can be defined as a process in which larger entities, regularities, and patterns, arise through interactions among simpler and smaller entities that themselves do not exhibit such properties. To engage this path means to take on the challenge of developing computational skills and the ability to manage large datasets. All aspects that, along with the study of the shared Science, took part to the development of the present work.

The main research problem undertaken in this Ph.D. Thesis consists in understanding how we could manage the information embedded in economic complex

systems structure. Indeed we would like to induce further attributes regarding the economic agents that are not measurable just considering their own individual original characteristics. The structure of interactions among the economic agents could add relevant information to explain or complete the knowledge we already hold using simple descriptive attributes. In this work, the Complexity of economic systems is tackled using methods representing new empirical approaches in the field of international economics. To be more specific the works here presented are aimed both to embed and develop measures that – computationally speaking- take into account the complex system of economic relations among countries to unveil their structural positions and, when possible, observe the impact of the latter on countries' trade performance. From an academic perspective, this PhD Thesis represents an attempt to introduce novel ways of doing data analysis using large dataset regarding economic relations that realize within complex economic systems. From a practical perspective, the idea is to show empirical cases where data availability on relations among economic agents brings about new insights regarding

their (economic) performance. The latter aspect could bring some benefit to policymakers for decision-making processes. All the three papers presented try to contribute to the main research question applying three self-contained methodologies. The literature on which this work is based is for a large part of methodological nature. We can distinguish two main streams of research representing distinct frameworks of methodological development sharing the general idea that the characteristics of economic agents acting in complex systems such as the international production system or the world trade system need proper methods to be measured consistently. The first body of literature we consider and refer is that which addresses the question of the international fragmentation of production. This phenomenon has been tackled from many perspectives, both theoretically and empirically. More importantly the availability of large datasets, recording the exchange relations among industries over a quite large set of countries and over time, boosted a generous data-driven research that is proposing methods and measures to describe synthetically the way countries organize and position

themselves within a more and more internationally integrated system of production. The second body of literature this Thesis is in debt with concerns instead the modelling of real systems as complex networks. A network is a reduced representation that simplify a system to an abstract structure capturing the basics of connection patterns. We must distinguish between that literature in which models are developed to explain mechanism behind large-scale phenomena occurring in complex networks as well as generalist methods and measures from that in which instead those methods and measures are used to assess the actual existence of such phenomena in real systems. Indeed of the latter, we consider mainly that literature that uses Network Analysis methodologies for the study of the World Trade Network characteristics. The paper entitled "*External Imbalances in the European Union and the International Fragmentation of Production. Is there a link?*" aims at understanding which is the relation between the macroeconomic stability of a country and the participation to the global value chains. Regarding the latter aspect, the choice of which measure could be considered as a good indicator of the countries' participation to the global value chains is not trivial. At the industry level, the international organization of production linking sectors and countries is in itself a complex system where individual industries at the country level are important also because of the links they display. Moreover the trade

imbalances used as indicator of countries' economic stability are themselves the result of trade relations and thus are strictly connected to the complex system of international trade relations. Data availability on intermediate inputs trade relations among industries residing within countries integrated with data on the intermediate inputs trade relations among industries residing in different countries enable us to study the degree of integration of countries within the international production system or, in other words, their involvement in the so-called "global value chains". For this reason, we needed to employ a methodology able to embed the complex organization of production relations to compute proper measures of participation to global production chains. The second paper entitled "*Discovering preferential patterns of sectoral trade networks*" studies the countries' selection of trade partners at the industry level. Using a scientifically recognized method for finding and evaluating (pseudo)community structures within complex systems, the paper attempts to extract information about the degree of preferentiality a country receives by the other countries as a destination of their exports or source of their imports within these preference structures. Also in this case the complexity of the system of international trade interactions is embedded to find and evaluate the preference structures. A preference structure includes only those countries that express a (not necessarily mutual) preference for at least one of the other members. The

"borders" of such structures are endogenously derived by the structural characteristics of the overall network of industry-level trade relations. The third paper entitled "*The power in complex networks: an application to the international multi-product trade network*" represents instead a proposal for measuring the power of economic agents interacting within an exchange network as it is the international trade network. Here we show that the power of an economic agent when it is defined as a function of the dependence of its exchange partners, is not always mirrored by the simple structural centrality of them. Indeed, the set of economic relations to consider to measure the power of economic agents effectively is not limited to the count of relationships maintained by agents with their partners. Indeed it is essential to look at the level of competition that exists with other agents involved in a relationship with the same partners. To perform the measurement of power for any economic agent, we needed to consider all the interactions among all the economic agents simultaneously, embedding again the complexity of the relational network within the measurement system.

# RADIO SPECTRUM VALUATION AND MARKET EFFECTS

**Nicola Garelli** - Supervisor: Prof. Massimo Gaetano Colombo

Radio spectrum is a fundamental input for modern technology and communication applications and it's the direct enabler of 2-3% of Worldwide GDP.

Due to its physical characteristics spectrum is a scarce resource and there is on one side the necessity to avoid technical interferences to the communication services, on the other side to ensure that this important good gives the highest possible contribution to the social welfare.

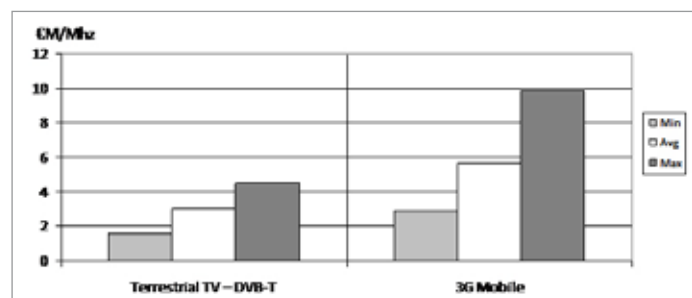
For this reason regulation policies have been central to the debate for decades, identifying a wide set of methods for allocating and assigning spectrum to private operators and public services, which can or cannot rely on market mechanisms.

A prerequisite for designing efficient assignment methods is that regulatory agencies, which typically rely on incomplete and asymmetric information, clearly identify the expected value of the spectrum, to be used to set auction bases, prices in beauty contests, incentive prices and other value references for spectrum assignment. It is also important that they understand the economic impact of spectrum allocation and assignment choices on the market.

The thesis aims at giving regulators more visibility on the spectrum value and on the impact of its availability and fees on the operators Revenue and Investments.

The research activity developed a robust techno-economic model for assessing the spectrum value in each international Country for a wide range of services. The model derived the value of the spectrum for DVB-T/DVB-T2 within the Digital Dividend bandwidth in Italy, placing it in the range 1.6 – 4.4 M€ / MHz, meaning 12-35 MHz per channel.

Calculations were also developed to obtain the opportunity cost of the spectrum assigned to 3G services, to compare it with the results of DVB-T/DVB-T2 and to understand which allocation would create the highest welfare. The model obtained a value for 3G in the range 5-9.9 M€ / Mhz

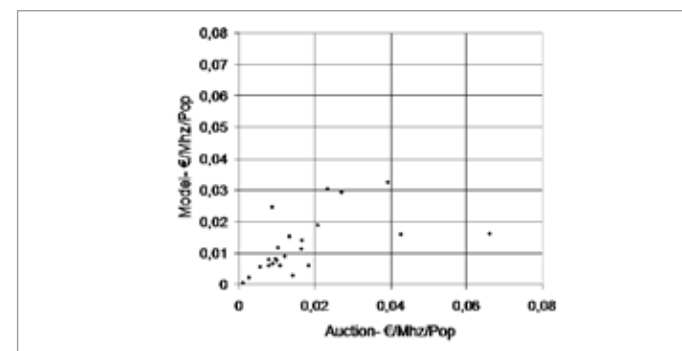


1. Value of the spectrum in Italy – DVB-T vs 3G mobile

(Average 7.4), in line with the average of those emerged in spectrum auctions at the time of the evaluation.

Because DVB-T/DVB-T2 value is lower than what can be obtained allocating the same spectrum to mobile services, it indicates that, when not considering “soft” benefits deriving from the service such as population education and pluralism support, there might be economic reasons for further restructuring the spectrum dedicated to TV broadcasting.

Given its objectivity and the possibility of applying the same methodology to different areas and scenarios, the model may also be used to perform homogeneous international comparisons of the value of specific portions of the spectrum, in particular obtaining the value of the spectrum allocated to the 4G service.



## 2. Comparison amongst spectrum values from different auctions with the values estimated in the model

The model, tested with the results of 4G auctions in 24 Countries, shows good prediction capabilities and represents a good base for regulators needing to set their auction bases or to define alternative pricing methods at the time many 3G licenses had to be renewed and there was the opportunity to increase the spectrum available for Mobile,

using part of the Digital Dividend.

The research also built an original dataset including mobile spectrum auction variables –prices, spectrum quantity, license duration- and fixed and mobile telecom market indicators –revenue, investments, competition- for the period 2004-2015. The dataset includes 24 Countries and even though

selected regressions suggest the existence of a correlation between spectrum fees and Mobile revenue realized by the operators, when it is introduced an estimate able to take into consideration the presence of regressors which might not be strictly exogenous the analysis provides evidence that spectrum license fees are sunk costs for the mobile operators, since they appear not to impact operators' future Revenue and Investments.

This result shows that regulatory agencies and Governments adopted correct policies and spectrum valuations to maximize the national welfare, though few bids appear to be excessively high.

Variable	with Difference model		with System model	
	GMM-1 - one-step	GMM-2 - two-steps	GMM-3- one-step	GMM-4- two-steps
<b>Real GDP</b>	.5458635 (.1719912) ***	.338888 (.6147281)	.0613539 (.0867967) **	-2.679782 (1.792081)
<b>Population</b>	1.166191 (.7041742) *	7.514798 (8.668919)	.0506974 (.0249368) ***	.5274762 (.4755268)
<b>Urban population</b>	1.196986 (.4534354) ***	3.891169 (10.40531)	.1901877 (.2762765)	(omitted)
<b>Market protection</b>	.0566335 (.0434217)	.0778257 (.2528583)	.0476497 (.0562956)	.0727214 (.6916974)
<b>Fixed revenue</b>	.0760823 (.0519546)	-.0022485 (.2077045)	-.238905 (.2860455)	1.063079 (.6013271) *
<b>License Fees</b>	.0286199 (.0145665)	-.0096335 (.0720316)	-.0036584 (.0192099)	.002135 (.0826241)
<b>Country dummies</b>	Yes	Yes	Yes	Yes
<b>Time dummies</b>	Yes	Yes	Yes	Yes
<b>Arellano-Bond test for AR(1)</b>	z = -1.85 Pr > z = 0.065	z = -0.66 Pr > z = 0.508	z = -0.96 Pr > z = 0.335	z = -1.13 Pr > z = 0.257
<b>Arellano-Bond test for AR(2)</b>	z = 0.40 Pr > z = 0.686	z = 0.71 Pr > z = 0.477	z = -0.14 Pr > z = 0.888	z = -0.24 Pr > z = 0.807
<b>Wald Chi2</b>	5242.38	2869.59	20610.80	9283.54

Standard errors are in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1. Mobile revenue correlation analysis - Generalized method of moments (GMM) estimation with Difference model

# MANAGING AND OPTIMISING WORKING CAPITAL AT THE SUPPLY CHAIN LEVEL

Luca M. Gelsomino - Supervisor: Prof. Alessandro Perego

## Premise

The recent economic downturn forced companies to face a series of financial and economic difficulties due to a reduction in the granting of loans and the increase in the cost of borrowing. Those financial problems cause corporates to reduce trade credit and create liquidity shortages that propagate throughout the supply chain. In response to these problems, the last years saw a burst of attention towards managing and optimising working capital at the supply chain level. One of the most important approaches in this sense is called Supply Chain Finance (SCF). More specifically, three main factors triggered the development and attention towards SCF: (i) the increase in perceived corporate risk, with a subsequent contraction of bank lending, (ii) the propagation of liquidity shortages and other financial problems throughout the supply chain, and (iii) the maturity of ICT for innovative Working Capital Management practices.

## Research Objective and Design

This thesis is organised as a collection of three articles. Each article addresses a specific objective: (i) to provide a clear understanding of SCF,

highlighting available definitions, existing perspectives and directions for future research, (ii) to provide a clear understanding of the SCF adoption process and of the objectives leading to the adoption of different SCF solutions and (iii) to provide a methodology for measuring the financial performance of a supply chain, in order to strengthen managerial decisions in implementing SCF solutions through a holistic supply chain perspective. The underlying research design lays within the Osservatorio on Supply Chain Finance, a Research project of the School of Management of Politecnico di Milano focused on generate and share knowledge on SCF and contribute to the development of the Italian market. The Osservatorio is part of the SCF Community, an international organism collecting universities working on the topic of SCF. These two bodies ensured a strong interaction with practitioners and services providers, both nationally and internationally. This Ph.D. program employs a mix of quantitative and qualitative methodologies: (i) a literature review, to clarify the topic, its definition and gaps in current research, (ii) a case study approach, to highlight

relevant characteristics of the SCF adoption process and (iii) analytical model development, to define the Supply Chain profiling model that allows to control working capital at the supply chain level.

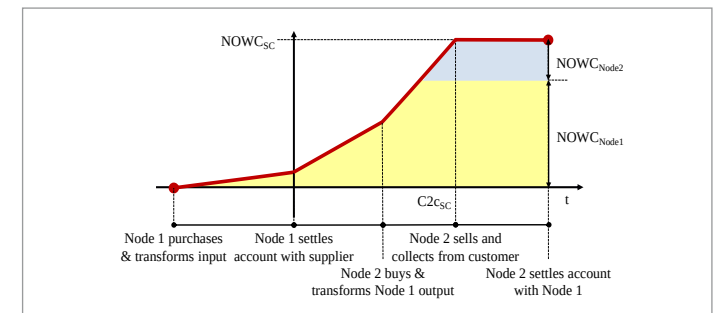
## Results

The first paper is a systematic literature review on the topic of SCF. It highlights the existence of the *finance oriented* and the *supply chain oriented* perspectives on the topic. The former is focused on financial aspects and considers the SCF approach as a set of financial solutions. The latter emphasises the role of collaboration amongst supply chain members and extends the boundaries of SCF to inventories, supply chain processes, and even collaborative solutions for fixed asset financing. The differences between the two perspectives result in conflicting frameworks and definitions, and consequently it is still very difficult to derive a clear picture of SCF from the existing literature. To facilitate the harmonious development of the topic, the review identifies four main gaps to be addressed by future research: (i) define a general theory of SCF that address and generalise the building blocks of this approach (e.g. schemes and solutions,

issues, enablers). (ii) increase empirical-based holistic analyses on the application of SCF (iii) extend the focus of the assessment models of SCF solutions to include more complex supply chain set-ups. (iv) develop tools for choosing SCF solutions for different Supply Chains and objectives.

The second article, a multiple case study based on 14 applications among Italian companies, investigates the objectives leading – and contextual factors affecting – the adoption of SCF solutions. Main results include: (i) the identification of the different objectives leading to the adoption of the different SCF models. (ii) the analysis of the impact of contextual factors, in particular the level of inter- and intra-firm collaboration, the level of digitalization of the trade process, and the bargaining power and financial strength of the leading firm, on the adoption of the different SCF solutions. (iii) the formulation of a reference framework that can support the effective adoption of different SCF models.

The first two articles highlighted both the need for a supply chain approach to SCF solutions and – more generally – to working capital control. Consequently, the third article proposes a model for the concurrent, supply chain-wide, assessment of C2c, Net Operating Working Capital (NOWC) and Financial Cost. The model returns a ‘supply chain financial profile’, which allows to monitor and control working capital at the supply chain



1. The ‘supply chain profiling’ model output

level, identify criticalities in the management of financial flows along the chain, benchmarking the supply chain short-term financial performance and assess the multi-tier NOWC and Financial Cost reductions deriving from different SCF strategies. An example of the model output (NOWC only) is reported in Figure 1. The article proposes two empirical applications: one corporate involved in the OSCF, and a benchmark of the short-term financial performance of the Pharmaceutical industry in Italy.

## Conclusions and direction for future Research

This research provides several theoretical contributions. First of all, it provides offers a step forward toward the development of a general theory of SCF. It also contributes to the empirical body of knowledge on SCF providing a case study analysis based on 14 Italian applications. Moreover, it advances theory in the multi-tier working capital management, providing a model grounded in the previous works, yet innovative and of value for practitioners. Finally, it contributes to the development

of joint research in the field of Supply Chain Management and Finance. Further Research is still due. The most prominent and interesting research directions include proceed further towards a complete theory of SCF, the creation of an SCF cost toolbox to support practitioners in more aware choices, the integration of supply chain information in credit scoring models to support financial institution that offer SCF solutions and, finally, the development of a definitive model to select the ‘best’ SCF strategy for a supply chain.

# FINANCIAL INTERMEDIATION: A TRANSACTION TWO-SIDED MARKET MODEL APPROACH

Carlo Gozzelino - Supervisors: Prof. Luigi Buzzacchi, Prof. Fabio Bertoni

In recent years, several players in the financial intermediation industry moved from a vertically integrated landscape, i.e. advising and selling their own products, to an open architecture one, i.e. intermediating a constantly increasing share of products provided by third parties. In parallel, and as a consequence, a raising attention has been placed from regulatory point of view on the relationships between intermediaries and product providers to protect the final clients from potential conflicts of interest and information asymmetry. While mentioned regulation focuses on one side at a time, to rule commercial agreements (or inducements) and to give full transparency of products and pricings to the investors, this research develops a more comprehensive interpretation of the vertical disintegration as a move towards a two-sided market. With this interpretation, the prices set by the platform on both sides, investors and product providers, are the legitimate consequence of the externalities between the two faced sets of agents and represent the platform's strategy to remunerate its intermediation services.

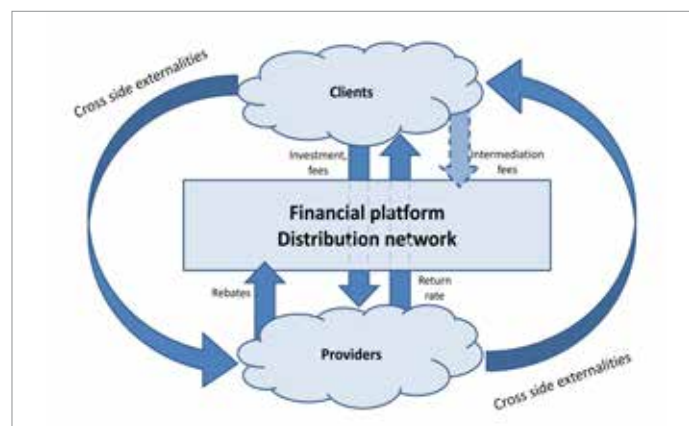
Since the early 2000s, two-sided markets have been of

growing interest in academic literature as they differ from traditional market settings by having cross-side network effects and same-side network effects characterizing the transactions. Due to such externalities, pricing strategies can be based on subsidizing the participation of one side (i.e. considered key for the platform to attract the other side) while recovering the loss on the other side.

While several applications of two-sided market framework are available in academic literature with regards to other products and industries (traditional examples are credit cards, shopping malls and newspapers), this research develops a new two-sided market framework to explain financial intermediation

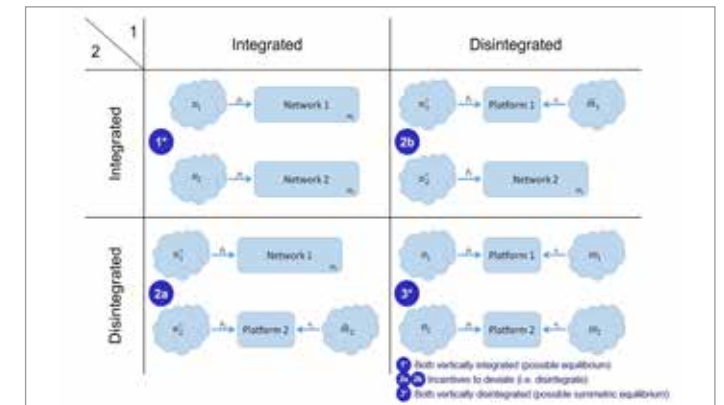
industry trends. It interprets the vertical disintegration as an exploitation of the market power coming from the distribution of financial products, thus a behavior change from merchant to platform, to show that prices are reflecting the cross side externalities between the two sides of the market faced by the financial intermediary rather than pure private negotiations between the single actors.

To this extent, a model is developed to show how competitors behave when vertically integrated and how the peculiarities of a two-sided market – especially the market power of being a distribution network – act as an incentive to disintegrate. Additionally, it is shown that when all players act



1. Two-sided market framework applied to financial intermediation

as a platform, the dynamics of a two-sided markets can allow at least a Nash equilibrium to exist, in which platform of different sizes enjoy positive profit while applying non-zero, legitimate fees to both sides in exchange of the distribution services offered. Finally, empirical evidences from Italian market are given to sustain – and to challenge – this interpretation.



2. Developed game matrix

# ANALYSING THE COMPLEXITY OF THE MODEL-BASED DECISION MAKING PROCESSES WITHIN THE INDUSTRIAL MANAGEMENT CONTEXT

**Raul Pulido Martinez**

Supervisors: Prof. Álvaro García Sánchez, Prof. Alessandro Brun

## Purpose

The decision-making process plays a key role in organizations. Every decision-making process produces a final choice that may or may not prompt action. Recurrently, decision makers find themselves in the dichotomous question of following a traditional sequence decision-making process where the output of a decision is used as the input of the next stage of the decision, or following a joint decision-making approach where several decisions are taken simultaneously. The implication of the decision-making process will impact different players of the organization. The choice of the decision-making approach becomes difficult to find, even with the current literature and practitioners' knowledge.

The pursuit of better ways for making decisions has been a common goal for academics and practitioners. Management scientists use different techniques and approaches to improve different types of decisions. The purpose of this decision is to use the available resources as well as possible (data and techniques) to achieve the objectives of the organization. The developing and applying of models and concepts may be helpful to solve managerial

problems faced every day in different companies.

As a result of this research different decision models are presented to contribute to the body of knowledge of management science. The first models are focused on the manufacturing industry and the second part of the models on the health care industry. Despite these models being case specific, they serve the purpose of exemplifying that different approaches to the problems and could provide interesting results. Unfortunately, there is no universal recipe that could be applied to all the problems. Furthermore, the same model could deliver good results with certain data and bad results for other data. A framework to analyse the data before selecting the model to be used is presented and tested in the models developed to exemplify the ideas.

## Methodology

As the first step of the research a systematic literature review on the joint decision is presented, as are the different opinions and suggestions of different scholars. For the next stage of the thesis, the decision-making process of more than 50 companies was analysed in companies from

different sectors in the production planning area at the Job Shop level. The data was obtained using surveys and face-to-face interviews.

The following part of the research was held in two application fields that are highly relevant for our society; manufacturing and health care.

The first step was to study the interactions and develop a mathematical model for the replenishment of the car assembly where the problem of "Vehicle routing problem and Inventory" were combined. The next step was to add the scheduling or car production decision and use some metaheuristics such as ant colony and genetic algorithms to measure if the behaviour is kept up with different case size problems. A similar approach is presented in a production of semiconductors and aviation parts, where a hoist has to change from one station to another to deal with the work, and a jobs schedule has to be done. However, for this problem simulation was used for experimentation. In parallel, the scheduling of operating rooms was studied. Surgeries were allocated to surgeons and the scheduling of operating rooms was analysed.

The first part of the research was done in a Teaching hospital, and for the second part the interaction of uncertainty was added. Once the previous problem had been analysed a general framework to characterize the instance was built. In the final chapter a general conclusion is presented.

## Contribution

The contribution of this thesis could be divided into different parts. The first contribution is to investigate the benefit and implications of a joint decision. The main benefit is the possible savings thanks to the better utilization of key resources. Unfortunately, this creates important implications and organizational challenges, generating costs that have to be fulfilled with the savings of the joint approach. A careful benefit-cost analysis should be performed and the savings needed to justify the implementation of the new decision-making process evaluated.

For the managerial theory, we research into the decision-making process starting with a literature review of the different theories, and analyse the misalignment between the beliefs of integration and the real integration. It is important to highlight the need to add an extra phase to the definition of the scope to decide if a traditional sequential approach is better or a joint solution approach is possible, since a shift in the scope of the problems creates new possibilities that could achieve a better global solution. We recommend spending

more time on the first phase of the decision-making process, evaluating the alternatives and defining the scope since this has a huge impact on the decision. Then the utilization of either solving method will not affect the solution so much since many of the different techniques offer a similar solution.

The following contribution is the development of different decision models to contribute to the decision-based model body of knowledge. To develop the algorithm model we presented a MILP model to deal with the vehicle routing problem plus the inventory problem and another version to also deal with the car scheduling problem. We accompanied this model with its heuristic version. We created two simulation models; one for the aeronautical manufacturing plant and another for the operating room scheduling at teaching hospitals. For the teaching hospital, we also presented a MILP, model. For the operating room scheduling we presented a different heuristic model and a MILP model to deal with the deterministic and stochastic version of the problem. For the stochastic version of the problem a hybrid method was also developed. These hybrid algorithms are a combination of exact and heuristic methods. In addition to the contribution of the solving methods, the final contribution is the framework that is proposed to pre-evaluate the problem before thinking of the techniques to solve it. However, there is no straightforward answer as to whether it is better

to have joint or sequential solutions. Following the proposed framework with the evaluation of factors such as the flexibility of the answer, the number of actors, and the tightness of the data, give us important hints as to the most suitable direction to take to tackle the problem.

## Research limitations and avenues for future research

In the first part of the work it was really complicated to calculate the possible savings of different projects, since in many papers these quantities are not reported or the impact is based on non-quantifiable benefits. The other issue is the confidentiality of many projects where the data cannot be presented. For the operation research problem there was a lack of historical data to perform a parallel analysis in the teaching hospital.

In order to keep testing the decision framework it is necessary to keep applying more case studies in order to generalize the results and make them more evident and less ambiguous. The health care field offers great opportunities since despite the recent awareness of the need to improve the decision-making process there are many opportunities to improve. Another big difference with the automotive industry is that the last improvements are not spread among all the actors. Therefore, in the future this research will focus more on the collaboration between academia and the health care sector.



# THE UNEXPECTED IMPLICATIONS OF OPENING UP INNOVATION

## A MULTI-PERSPECTIVE STUDY OF THE ROLE OF OPEN INNOVATION PRACTICES IN MATURE INDUSTRIES

**Andrés Ramírez Portilla**

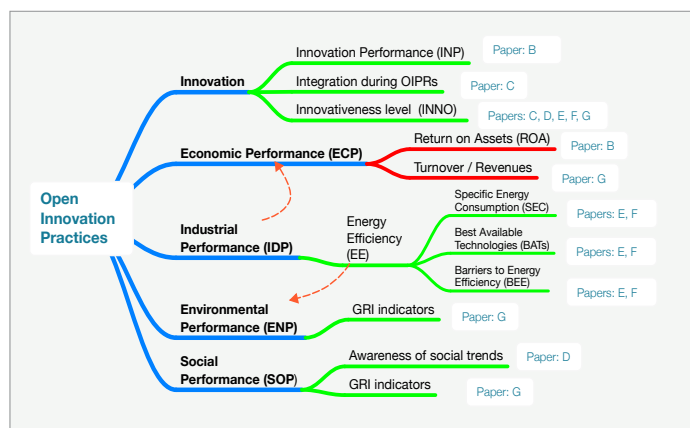
Supervisors: Prof. Enrico Cagno, Prof. Terrence Brown

The way firms innovate has notably changed in recent years. A clear example is the manufacturing sector, which has been experiencing a new revolution in production and innovation. Linked to this industrial shift, manufacturing firms have been adopting more open and collaborative practices to innovate. This phenomenon, known as Open Innovation (OI), is helping firms to acquire and explore knowledge from external sources (inbound process) and to exploit knowledge via the commercialisation of ideas and technology (outbound process). Even though numerous researchers have studied the adoption of OI and its relation to numerous strategic and organisational results, very few studies have focused on investigating the positive influence of diverse OI approaches and practices on multiple dimensions of firm performance from different angles. These drawbacks hinder the diffusion of Open Innovation practices (OIPs) and raise the question of whether it is convenient for any firm in any industry to adopt or not to adopt OI. Thus, this thesis helps to fill this gap by examining the extent to which OIPs are adopted by firms and other actors in unexplored mature manufacturing

industries and by understanding the unidentified roles that these practices play in relation to different dimensions of firm and industrial performance.

This thesis brings together different methodologies and data to investigate OIPs with a novel multi-perspective approach. Hence, OIPs are framed within the industrial context of manufacturing firms in Italy and Sweden, several actors in the food industry, small and medium-sized enterprises (SMEs) from the Italian foundry industry, and also within worldwide SMEs designing and producing supercars. More specifically, using data from 247 European manufacturing firms collected

through a tailored OI survey, this thesis supports the relevance of internal context characteristics such as firm size and provides evidence of the relation between configurations of OI models and innovation performance. Through two case studies in the food industry, this thesis demonstrates novel forms of OIPs that can be characterised and adopted by different innovation actors within and around this mature industry. Likewise, drawing from 30 rigorous case studies of small and medium-sized foundries, this research for the first time illuminates the relation between the aggregations of some innovation practices (specifically internal R&D and inbound OI) with a contemporarily relevant



1. Mapping the 'driving' influence of OIPs on diverse performance dimensions

dimension of environmental and industrial performance such as energy efficiency. Although foregrounding the practical implications of adopting OIPs, this project also investigates and attempts to contrast some of the theoretical perspectives used when researching OI in mature manufacturing industries. This thesis concludes with an integrative study of the main aspects of the research project to demonstrate the advantages of using a multi-perspective approach to study OI. This last study, originally inspired from two case studies of small carmakers, involved collecting data from 48 small and medium-sized manufacturers of supercars with a survey designed to evaluate OI influence on several types of firm performance. Collectively, the results from this thesis confirm the validity of OI in new research contexts and reveal a combined influence of specific innovation practices on innovativeness, but also on the dimensions of industrial, environmental, and social performance as seen in Figure 1.

Although the several implications in this thesis due to the multi-perspective approach used the more unexpected and interesting ones related to the role of OIPs are the next ones.

- Context matters to a great extent in OI research and practice. In fact, not only the adoption of OI is highly dependent on the context but the context can also influence the way in which OIPs can be characterised as well as the

outcomes resulting from their implementation, adoption, and regular practice.

- Although OI can be explained through several and even conflicting theoretical perspectives, using a practice-based view can allow us to understand different forms in which OI can be characterised and practiced within and around industrial settings where OIPs might seem not valid or relevant at first sight.
  - OIPs can be characterised in varied forms such as models, mechanisms, approaches, initiatives, and methods, amongst others. This variety of practices can complement other variety dimensions to provide a more comprehensive understanding of the different options and key choices related to adopting OI.
  - While adopting OI can certainly have a positive effect on higher levels of innovativeness, it may not guarantee better economic performance. However, practicing OI can also have a significant influence on other relevant indicators and dimensions also related to firm and industrial performance.
  - The adoption of certain OIPs can have a direct and positive relationship with higher levels of energy efficiency indicators. While this link is especially important in energy-intensive industries, it is also relevant for other contexts since it shows a clear connection between OIPs and environmental indicators.
  - Because in energy-intensive industries such as foundries, being energy efficient
- has a considerable and direct relationship with the performance of all the firms in the industry, it could be said that adopting OIPs can be a feasible approach to influence positively the industrial performance of certain sectors.
- Whereas it can be expected that SMEs adopting OI in terms of practices and models could have higher levels of innovativeness (but not necessarily economic performance), it is also possible to anticipate a positive effect on sustainability indicators related to environmental and social performance.
  - Just as with technology or creativity, the adoption of OI practices and similar approaches is also likely to have a 'dark' side. Moreover, the potential issues and drawbacks related to this side are also contingent on the context of an organisation. Thus, it is advised that firms plan sensibly the adoption of OIPs.
  - To conclude, this thesis contributes to theory and practice by empirically showing that even though OI and the results of practicing it are highly context dependent, adopting OI practices can definitely have a positive influence in the overall performance of firms in mature manufacturing industries, including SMEs and other small actors.

# THE ROLE OF TOTAL COST OF OWNERSHIP WITHIN THE ASSET MANAGEMENT FRAMEWORK

Irene Roda - Supervisor: Prof. Marco Garetti

This PhD research investigates the role of Total Cost of Ownership (TCO) as a tool for supporting decision-making process in production companies within the Asset Management (AM) process. The use of a TCO model is increasingly acknowledged as a fundamental element for supporting AM implementation within industry. Furthermore, the publication of the ISO body of standards on Asset Management (ISO 5500X) in 2014 opened new horizons for clarifying its role in the management of industrial assets. However, no single TCO model has been defined yet that has been widely adopted in the industrial practice. This research aims at investigating the main applicability issues of TCO in the industrial context and its potential contribution for enabling AM integration in production systems. The research question is: *Does the adoption of a TCO model contribute to AM integration within production systems?*

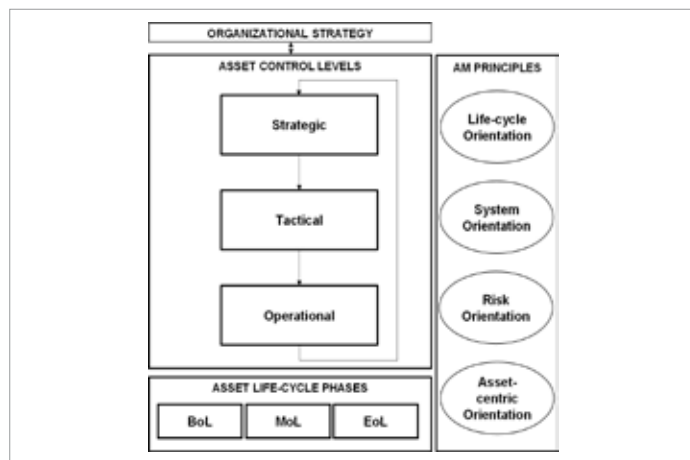
The following sub-research questions are defined to address the main research question.

**RQ1:** *Which are the main elements and guiding principles needed for AM integration in production systems?*

**RQ2:** *Is there a relationship between TCO use and the level of integration of AM in production companies?*

**RQ3:** *How to define a methodology for building up a TCO model that can support asset-related decision making in a production company?* The first research stage aims at answering to RQ1 and RQ2. Firstly, a framework is defined (Figure 1) providing the guidelines for approaching asset-related decision-making to support integrating AM within production companies. In the framework, four guiding principles – i.e., life-cycle orientation, system orientation, risk orientation and asset-centric orientation – are defined as the foundation for approaching proper decision-making supporting integration of AM. The framework was developed based on an extensive literature review and on brainstorming activities

with industrial exponents. The synthetization of the framework is the basis for next research steps. Secondly, based on the defined framework, this dissertation aims at answering to RQ2 investigating TCO potentials for AM integration in production systems. This is done through a multiple case study analysis by involving nine leading production companies belonging to different industrial sectors. The case study development allows achieving two main findings. The first one is the identification of the existence of causal relationships between the level of integration of AM and the adoption of a TCO model in the targeted production companies. The second one is the identification of potentialities and applicability conditions for



1. AM integration framework

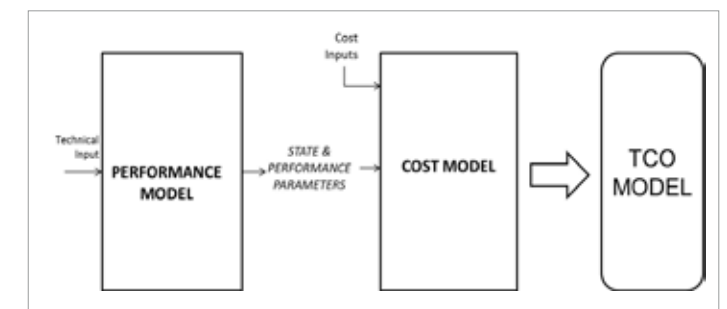
the adoption of a TCO model in production companies, including the identification of the main perceived barriers. The second stage of the research addresses RQ3; an innovative methodology for building up a performance-driven TCO model is defined. The intent is to overcome the existing gap between theory and practice by designing a methodology that allows building up a TCO model that can be applicable in industry and results in a reliable asset-related decision-making support tool. The definition of the methodology is based on the main findings that emerged from the case study analysis on TCO applicability potentials and barriers. In particular, the main requirements that are addressed by the methodology are the following:

- the adoption of a holistic perspective when defining the Cost Breakdown Structure of the TCO model;
- the quantification of hidden costs related to systemic performance losses that can occur during the life cycle of an asset by the integration of unpredictability in endogenous factors in the TCO model;
- the consideration of interdependencies among the components of an asset that might create additional costs.

The proposed methodology is based on the idea that only by the integration of a performance model and a cost model it is possible to develop a consistent TCO model to support asset-related decision-making by addressing the identified

requirements above (Figure 2). The technical performance model allows the estimation of the performances of the asset over its lifecycle. The cost model allows evaluating the cost items of a pre-defined CBS by using as input both cost parameters and the outputs coming from the technical performance analysis. The integration of the two models allows calculating the TCO of the asset under study. For these reasons, the resulting TCO model is defined as “performance-driven TCO model”. In the defined methodology, the use of the RBD (Reliability Block Diagram) technique and next-event Monte Carlo simulation is proposed for the implementation of the technical performance evaluations. In the thesis, an application process of the whole methodology for building up and use a TCO model is proposed.

The TCO model, built through the designed methodology, is finally tested in one of the leading companies in Italy in the chemical sector. The application project, allowed experimenting the TCO model built through the defined methodology on a real industrial



2. Performance-driven TCO model building methodology

plant, and collecting additional data on the role of TCO toward AM integration based on the application experience. The overall conclusion of this investigation is that the adoption of a TCO model contributes to AM integration within production systems, if it is defined according to the main identified requirements. The intention of this thesis is to provide a piece of work that perpetrates the fulfilment of the current gap between theory and practice and that enriches the path towards the definition of clear guidelines and tools for AM integration within production systems. The presented work is the result of a three years research process marked by several publications that have been presented at conferences to ensure robust contribution to knowledge. The objective was to provide a piece of research that not only proposes an innovative contribution to knowledge but also a useful indication for industrial practitioners.

# UNCERTAINTY AND THE DIFFUSION OF RENEWABLE TECHNOLOGIES IN THE ELECTRICITY SECTOR

**Teresa Romano** - Supervisor: Prof. Elena Fumagalli

As of today, climate change and energy security represent considerable concerns for most countries, in Europe and worldwide. This has led governments to pay more and more attention to renewable energy.

The EU, for example, has explicitly included a renewable energy target in its climate policy goals: 20% of all primary energy in the EU is to be produced from renewable sources by 2020. In January 2014, the European Commission put forward a set of energy and climate goals for 2030 with the aim of encouraging private investment in low-carbon technologies. One of the key targets proposed is for the share of renewable energy to reach at least 27 % by 2030. By supporting research, as well as developing and commercialising innovative green technologies, Member States are expected not only to contribute to a sustainable growth but also to achieve macroeconomics benefits, such as the creation of new jobs, improved energy security and a reduction in social costs related to pollution from fossil fuels.

Given such ambitious goals, early adoption of new, cleaner technologies has become crucial. However, as energy generated from renewable energy sources (RES) remains more expensive

than conventional energy (rendering the related investment unprofitable under free market conditions), government intervention has been, and is still particularly important to spur investments. This applies also to the electricity sector, that is, the main global source of energy-related CO<sub>2</sub> emissions (42% of the energy sector in 2013) and the main focus of the present work. In broad terms, this research aims at providing a better understanding of the role that policy and uncertainty play in the adoption and diffusion of new technologies, with a specific focus on RES technologies for power generation.

The first objective of this work is to recap and reorganise what we empirically know regarding how policy incentives affect RES technology diffusion (as compared to market incentives, as compared to one another, etc.) at both aggregate (country) and individual level, and to explore what are the effects of uncertainty on investments in the realm of RES technologies, in order to check whether the standard inhibitory effects hold in this context as well. In this respect, in light of the current events in European policy, we are particularly interested in assessing what is the current state of knowledge related to when

uncertainty is on policy. Do we know how to properly capture uncertainty with existing models? Do we have an appropriate definition of policy uncertainty? The answers to these questions should indicate future research paths and implications for policy design, as we move forward to a framework where significant changes are expected. Secondly, as RES adoption consolidates over time, we question how investors decide to substitute existing, environmentally friendly equipment with more technologically advanced apparatus in the same location and by the same investor - a process known as repowering of (renewable) power plants. This is an important aspect, as adoption of innovative technologies (i.e., more cost efficient technologies) largely impacts long-term costs of climate policy and is thus one of the main reasons for government intervention in favour of renewable energy. Also, the adoption of innovative technologies is already an empirical fact in a number of European countries. For instance, investments in repowering have become more and more important in the wind energy sector, in countries like Germany and

Denmark. Surprisingly, as far as RES technology policy instruments are concerned, their effect on diffusion of more advanced renewable technologies has been largely neglected.

Moreover, also in the repowering context, investors' decisions are made difficult by the presence of multiple sources of uncertainties, like the ones on investment costs and on future revenues (whose path also closely depends on the kind of policy instrument implemented). Hence, another goal of this research is to develop ad hoc modelling tools to be used in this context.

Finally, we address policy uncertainty directly. Specifically, by taking an original, system-wide perspective, we ask what are the consequences of policy uncertainty, in terms of the rate of diffusion of RES technologies. In doing so, we also search for a more appropriate definition of policy uncertainty, that is, one that can capture continuous changes in the policy - in the literature policy uncertainty is captured by one-time, sudden changes in the drift and/or volatility of a stochastic process, describing carbon prices or subsidy payments. The aim is to arrive at a better understanding of the sources of this kind of uncertainty (on the institutional setting in general, and on RES technology policy specifically). The search for a better definition of policy uncertainty intended as a complex phenomenon naturally brings with it the need for new modeling tools. Developing such tools is another important goal of this thesis, which consists of three parts.

In the first part, a critical literature review analyses the relationship between technology diffusion, policy, and uncertainty. The role of technology policy and, therefore, of policy uncertainty emerges as significant in determining the timing of adoption of a RES technology.

In the second part of this work, the decentralized investment decision of a risk-neutral firm which has to choose whether or not to adopt a RES technology for power generation is studied. This paper compares support mechanisms for renewable energy with respect to their ex-ante effectiveness in promoting the adoption of innovative technologies. We analyse two stylized policy instruments in the context of wind repowering: quotas and feed-in tariffs (FITs). Quota systems, like the British Renewable Obligation Certificates (ROCs), are based on mandatory targets. FITs, like the German Erneuerbare-Energien-Gesetz (EEG) tariffs, guarantee a certain, fixed price for "green" electricity. This paper focuses on one aspect of the difference between the two instruments: the allocation of uncertainty. While under ROCs both electricity price and capital cost risks are borne by the wind farm owner, under FITs only capital cost risks remain with the owner. In a stochastic dynamic programming setting assuming a deterministic, exogenous technological progress and calibrated on German data, it is found that, independently of the employed technology, the propensity to repower a wind plant is higher under the policy scenario that ensures certain

revenues, while the uncertainty on investment costs plays a minor role.

European renewable energy policies have been going through a period of revisions, often unanticipated, which are likely to influence timing and level of investments in RES technologies. This issue is addressed in the third part of this work, aiming at studying the effect of policy uncertainty on the decision to adopt a wind power technology. Using data on wind plants installations in Italy (1999-2014), we observe that all policy modifications (not only a single change in the type of policy) are relevant in this respect. To capture their effect, we take a novel modeling approach which focuses on the study of the technology diffusion pattern. Our results indicate that adoption events are highly clustered over time. This signals that investors rapidly respond to changes in policy characteristics, by anticipating or delaying adoption, in order to benefit from the support scheme they perceive as more favorable. Additionally, we show that market environment also plays a relevant role in a way consistent with an S-shaped long-run diffusion pattern. The same happens with learning effects, although their influence weakens with the investment size.

## INTER-MUNICIPAL COOPERATION: MORE THAN MEETS THE EYE?

**Claudio Russo** - Supervisor: Prof. Giuliano Noci

The purpose of this thesis is contributing to a scientific and practitioner knowledge base about Inter-Municipal Cooperation, starting from different literature branches. The aim is providing a holistic perspective about this topic, going into detail about the creation of a cooperation form, starting from design to implementation to monitoring of performances. This work is outlined in three chapters, each one structured as a paper, giving a significant contribution to each steps above mentioned. The first paper, titled "Inter-Municipal Cooperation: the prologue of a fairy tale with an uncertain plot", is aimed at providing an interpretation framework, with a managerial perspective, about Inter-Municipal Cooperation phenomenon and dimensions having an impact on it that is able to overcome sector-based characterizations by previous researchers, combining scientific outcomes gathering from Shared Service Centre and Public Network branches. The approach is based on Literature Review on a set of 165 papers, examined by following steps of in-depth analysis. Analysed literature has highlighted a strong complement between Shared Service Centre

and Public Network branches. Starting from here, five analysis dimensions have been identified to approach the Inter-Municipal Cooperation phenomenon according to a logical guiding thread of reciprocal influence. The first step of coding variables arising from the literature review focused on management aspects and has yielded two dimensions: Organization & ICT and Performance. A second variable systematization has identified further dimensions, not very managerial, but having an influence on them: Strategy, Governance and Politics. An analysis framework of the phenomenon has been proposed furnishing wide support to adapt to and acquire preliminary knowledge about the theme and guarantee easier in depth inquiry. Next studies could be carried out and explored beyond the analysed literature. The original contribution is focused on the synergistic analysis between two literature branches gives a wide interpretation about the phenomenon. Identification of a bundle of operative steps and elements take into account design and operative start-up that steers Inter-Municipal Cooperation. The second paper, titled "Opening the Pandora's box of

Inter-Municipal Cooperation. Managerial and political practices" is aimed at providing an empirical inquiring into managerial and political elements, and their reciprocal influences, occurring in start-up and operative phases of Inter-Municipal Cooperation forms resorting to a broad approach including perspectives coming from Shared Service Centre and Public Network branches. It has been used a Case Study approach identifying three units of analysis, in two different Countries, to investigate/describe the Inter-Municipal Cooperation phenomenon and preliminarily validate the theoretical framework. The outcomes have been presented according to the managerial perspectives of this phenomenon: Organization & ICT and Performance, and then according to those impacting the Inter-Municipal Cooperation managerial world: Strategy, Governance and Politics. The research makes possible a concrete key to interpretation of this phenomenon, identifying those elements characterizing start-up and operating speed phases. This work provides detail about elements characterizing Inter-Municipal Cooperation in an international context. This represents an operative

instrument for those involved in these processes including policy makers and contributes the basic knowledge necessary to develop further research. Concluding, considering the increasing recourse to Inter-Municipal Cooperation, this paper represents a first step of exploration about decisional and management processes of the Inter-Municipal Cooperation phenomenon, developing a basic knowledge that overcomes previous analysis and becomes an operative instrument able to support processes and policies implementation of Inter-Municipal Cooperation. In addition, the phenomenon has been approached from a broad perspective gleaning into different literature branches usually examined separately. The third paper, titled "Inter-Municipal Cooperation: is it a way of improving efficiency? The case of social services in Italy" is aimed at studying the impact of taking part in Inter-Municipal Cooperation form on Municipality expenditure efficiency and in identifying the variables that influence it. The efficiency analysis has been carried out through a non-parametric method called DEA (Data Envelopment Analysis),

applied to the social service portfolio and referred to all the Italian Municipalities taking part in a cooperation form over 11 years. The study about the impact of external variables to efficiency has been made through a truncated regression. The results highlight that there is a relevant effect on Municipal expenditure efficiency until amounts more than 25%, in moving to a cooperation form. Looking at the whole system level, positive and negative effects tend to balance out, with some differences between analysed services in terms of efficiency variation values and ratios between efficient and inefficient Municipalities. It is possible to identify different external factors that can influence the efficiency variation of a Municipality moving to a cooperation form, and they have been classified as geographical, demographical, administrative and economical dimensions. The results provide recommendations both to policy makers and practitioners in Municipalities and upper institutional levels, for the start-up and the configuration of Inter-Municipal Cooperation, and identify the determinants impacting efficiency. The research focuses only on the Italian context, so it has not

highlighted the relationship between efficiency and national regulations. The focus of efficiency analysis has been on a single services portfolio and on Municipal expenditures, therefore the Inter-Municipal Cooperation perspective and the effects of a possible global efficiency variation are not considered in the research results. Concluding, this is the first study aimed at quantitatively evaluating the impact of expenditure efficiency of Inter-Municipal Cooperation with an explicit reference to service portfolio supplied by a Municipality.

# ASSESSING AND FOSTERING INDUSTRIAL ENERGY MANAGEMENT THROUGH ENERGY MANAGEMENT PRACTICE'S DEFINITION AND CLASSIFICATION

Aida Salimnezhadgharehzaedini - Supervisor: Prof. Enrico Cagno

The work reported here is the summary of PhD thesis of Aida Salimnezhadgharehzaedini. The work consists of a collection of five papers focused on energy management (EnM) programs and practices and also determinant factors in which supporting the decision making process which leads to the implementation of EnM programs in small, medium and large sized energy-intensive companies from different sectors. This introductory section has two objectives:

- It clarifies the theoretical and empirical background of the research project, and it presents the main problem addressed. These topics are discussed in the first part of this introductory section: "Background".
- It clarifies the overall objective of the research and it summarizes the aims, methods and findings of the five included papers, explaining the way in which the papers are aligned with respect to the overall objective of the research. These topics are discussed in the second part of this introductory section: "The research project".

This introductory section is followed by the five papers, which are the main results of the current thesis.

## 1. Background

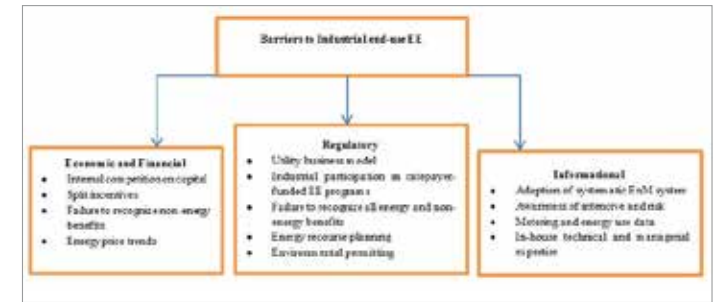
### 1.1. The importance of Energy Efficiency and Energy Management in industry

Potentials for energy efficiency (EE) activities, energy management (EnM) are huge due to the numerous inefficient energy-intensive and non-intensive industrial companies. A general estimation of the investment opportunity by International Finance Corporation (2011) exceeds 100 billion US dollars. Due to the strategic importance of EE, national policies are also favouring EnM programs within industrial companies (IFC 2011). Despite the huge potential and favouring policies, the phenomenon that economically profitable EE investments are not being realized is called "energy-efficiency paradox" (Zhang 2003). It is also known as "energy efficiency gap" expressing the difference between the potential cost-effective EE investments and the actual investment level implemented (Brown, 2001; Levine et al., 1995; Golove and Eto, 1996; Jaffe and Stavins, 1994; Sanstad and Howarth, 1994. Goldman et al., 2005). Why is that always the case?. The existence of "energy efficiency paradox" or "energy efficiency gap" is exposed to discussion in terms of market failures and market barriers (Jaffe

and Stavins, 1994; Goldman et al., 2005; Rohdin et al., 2007). There is considerable potential for improving industrial EE both from technical and managerial point of view. Nevertheless, it has been addressed the numerous 'barriers' inhibit the adoption of such improvements, such as lack of information, shortage of trained and expertise personnel and limited access to capital. In particular, the adoption of such improvement programs may be associated with various 'hidden costs' that are difficult to capture within existing energy-economic models. But while there is a general debate on energy efficiency 'gap', both the policy options and continuous improvement within an organization to overcome this gap need to be identified and acted upon. Moreover, considerable debate over the most effective approach is highlighted. The most frequently announced barriers to end-use EE has been shown in figure 1. Nowadays, companies have to consider the efficient and smart use of energy and resources in manufacturing besides traditional performances to sustain their competitiveness in their respective industry. Thus, it became a must for manufacturing firms to put more efforts on in-depth

analysis of energy and resource performance through their manufacturing processes and facilities. A comprehensive process design and plant optimization with a specific focus on EE is of paramount importance for this purpose. Currently, Potentials to improve EE are far from being exploited as mentioned by many scholars.

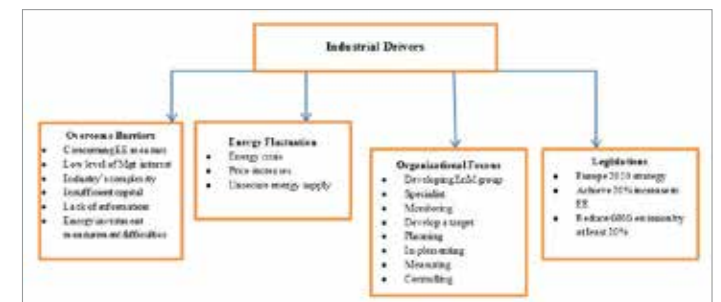
The concept of a barrier to EE is both confused and contested. Although the term is widely used, there is little consensus on how barriers should be understood, how important they are in different contexts, and how (if at all) they should be addressed. Since industrial energy use accounts for roughly one third of global energy demand and that share is growing steadily, managing energy consumption is vital for manufacturers. However, nowadays companies have become more aware about the potentials of waste of energy and associated cost savings. Systematic energy management (EnM) is identified by practitioners and academics as one of the most effective approach to improve and sustain EE in industries. The reason can be explained through EnM systematic and program to equip companies with practices and procedures to continuously realize and capture the possible improvements and new opportunities. The most announced drivers to implement EnM within an organization can be categorized as follows in figure 2. Although, there are lots of evidence in the academic literature which approve the huge potential of EnM to improve the EE level



### 1. Barriers to industrial end-use EE

of the company, still there is no cohesive definition about EnM and also, there is a huge gap about *how* exactly EnM could make the improvements within the companies. Moreover, studies concerning energy services in the industry have not been extensively exploited. There is no study on classification of energy management practices (EnMPs). Notably, energy policy measures for improved EE in industry is in need of clarifications in these regards, as policies involving EnM components forms the backbone of successful industrial energy policies, e.g. Voluntary Agreements (Rezessy and Bertoldi 2011; Price 2005; Cagno et al., 2015a). EnMPs are to be seen as more managerial actions, while others defined it as more technical and operational practices. The lack of single

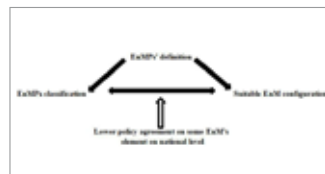
accepted definition for EnMPs causes imprecise understanding about EnMPs. As another result, no characterization which could characterize EnMPs' based on their target exists in the body of EnM literature. These gaps also cause failure in choosing proper EnM configuration through single industry's characteristics. In other word, the lack of a precise definition about EnMPs causes both technical and managerial failure towards improving companies' EE. If major improvements in EE are the target for a single industry, many different policy instruments and pre-steps can and must be taken. As for effective EnM it is pillar to work continuously, for better result it is necessary to establish policies which could support EnM programs properly



### 2. Industrial driver to adopt EnM

and continuously. Even though an EnM system as such cannot be seen as national policy, EnM standards often comprise the backbone of Voluntary Agreements. According to Jelic' et al. (2010) the comparison of national EnM standards illustrates that there is a lower agreement on some elements. Management commitment, strategic planning, purchasing and design are all those listed with low agreement level. Policy makers, engineers and scholars are in a position to think about not only what to install to improve EnM programs, but also how to implement these measures. Thus to converge an unanimously accepted strategy, close contact between practitioners, policy makers and scholars is the mainstay. Simultaneously, it causes not only to avoid any possible confusion in existing program when policy makers and scholars get in touch with the realness of the industry through the practitioners, but also to establish policies which support EnM program properly. Thus, regardless of any discipline which laws are relevant to, they constantly need to be revised by policy makers to innovate and inject new, necessary, and value added items to the existing program. In Figure 3 a presentation on how these four elements affect each other's failure and/or success is shown. Different definitions of a single concept not only cause inaccurate understanding about it, but also cause improper proceedings to obtain the desired results. The perspectives of management only or merely technical to the

EnM concept has caused both mentioned problems in industries. However, EnMPs could be defined as *total continuous or frequent managerial and technical actions in a company which aim primarily to reduce energy costs or secure energy supply and secondary to reduce pollution* (Sa et al., 2015a). Some authors believe that there is overlap between EnMPs and EE measures. But apart from the existence of some overlaps it is possible to differentiate EnMPs from EE measure (Trianni et al., 2013). It is useful to list all EnMPs and group them based on where and how they improve the EE. Characterization of EnMP through the EnM definition can be a light to better understanding of what EnM is.



### 3. EnMPs Gap Analysis (Sa et al., 2015b)

Based on EnM literature, there are indications that EnMPs positively link to a top management support and ambitious, productivity, and firm's climate friendly R&D (Cagno et al., 2015b). Therefore, according to the mentioned problems, this research intends to contribute to the companies and academia a better understanding on how to successfully integrate EnM into the manufacturing process.

## 2. Research Project

### 2.1 Background

Paradox or energy efficiency gap was first defined by Hirst and Brown (1990) meaning that profitable investments into improved EE is not realized in companies because of the barriers to EE (Decanio 1993 and 1998; Eichhammer, 2004; Cagno and Trianni 2013; Trianni et al., 2013; Brunke et al., 2014). A number of papers examined barriers to EE in the industry, some of the high-ranked for whole sizes being technical risks, lack of options to improve energy management practices (EnMPs) (Brunke et al., 2014) limited access to capital, lack of time or low priority given to EE by the top management, poor information quality and/or lack of information (Brunke et al., 2014) or high transaction costs (DeCanio and Watkins, 1998). Several studies have identified a low status of Energy Management (EnM) in industrial companies to be a barrier to EE (Rohdin et al., 2007; Thollander and Ottosson 2010). Implementing EnM can be a way to improve EE and to reduce the related CO2 emissions (Christoffersen et al., 2003; Kannan and Boie 2003) and overcome barriers to EE. To improve EE in the industry through EnM programs, long term energy strategies, committed and skilled energy managers are both important factors in spurring improved EE in industrial firms. As several factors promote the efficient use of energy, barriers also exist. Energy management (EnM) addressed in several scientific papers as a robust and efficient means to overcome such barriers. The term EnM has been used differently in the

academic literature, and still there is no adhesive definition (Schulze et al., 2015). What many definitions of EnM have in common is that they primarily concentrate on implementation of energy efficient technologies and replacing inefficient equipment. However, EnM also includes practices such as care, operation and maintenance of technology, to maintain an effective functioning. Continuous work and improvement practices are the first requirements for that (Gordic et al., 2010). The most recent theoretical and empirical researches about drivers and barriers respectively can be found in Cagno et al., 2013; Brunke et al., 2014 and Trianni and Cagno 2015. As regards the foundry sector the most recent comprehensive research about barriers can be found in Trianni et al., (2013) and for drivers look at Thollander et al., (2013). Meanwhile, previous policy researchers identified and classified a number of barriers to and drivers for EE in industries (DeCanio, 1993; de Groot, 2001; Sandberg and Soderstrom, 2003; Thollander and Ottosson 2008). Two of these barriers, namely organizational and behavioral barriers relate to the energy management practices (EnMPs) within the company. Because in general, the details of how an EnM program could make continuous improvement within the company have remained largely unexplored (Christoffersen et al., 2006; Kannan and Boie, 2003; Thollander et al., 2010). Organizational barriers relate to the unclear division of tasks and the lack of financial resources, time and skilled

personnel (Sardianou, 2008). Personnel values and mindset is included in behavioral barriers (Lindgren Soroye and Nilsson, 2010; Stern, 1992). The EE improvements through EnMPs in companies is addressed as an important but also challenging issue by policy researchers. A compounding of different policy measures has been introduced to influence industry, both directly and indirectly, including a mixture of voluntary and non-voluntary standards. This challenge, also, is due to a lack of clear understanding about EnMPs and also how these should be placed by organizations in order to improve EE. Guidelines and different standards on EnM emphasize the importance of monitoring, evaluating and enhancing energy performance at process and system levels. However, for better results managers need to assess their program to track the strength and weakness of the current energy plan. The reasons for this relate to the need of verifying and evaluating companies' energy strategy and the current situation of the adopted practices together with assessing companies' policy, organizing, training, performance measurement, communication and investment maturity level. Moreover, implementing EnM is also difficult because of many misconceptions (e.g. Only big companies can do it, only plants with new equipment can do it, large capital budgets are required, we have no enough time and staff, we already do everything we can, and everybody manages energy) and the barriers which depends

on the geographic location and industry's character itself (such as energy intensity and size). Therefore, EnM programs with its huge potential for improved EE is still far from what it should be exploited in practice based on the adopted highest success levels (Sa et al., 2015). Those potentials have been untapped not only because of the mentioned barriers, but also because of lack of alignment between energy programs and company's total strategy or company's macroeconomic policy and also because of lack of transparency which accordingly increases the nature of risk. Within the last twenty years, by increasing energy prices and global energy crisis, EnM considerably developed as an industrial energy system support function. The former studies addressed its strategic and efficient role in improved energy system. Meanwhile, the number of empirical and theoretical studies increased about drivers for and barrier to the EE project implementation. However, EnM is not properly decided upon and/or not fully adopted, with all its potential, to help companies for improving their EE performance level. In macro perspective, there are two different perspectives in EE literature about investment decision making". A number of former researchers believe EE investments would decide upon if the financial analysis conforms the investment for a particular program (which is in line with finance theory). However, others emphasis on organizational energy culture, power relationship, managers mindset and characteristics of the investment

REFERENCES	DESCRIPTION OF STRATEGIC INVESTMENT
Butler et al., 1991; Lu and Heard 1995; Schoemaker 1993	Decisions as vital importance.
Carr and Tomkins 1996	Decisions which have a significant effect on the organization as a whole.
Butler et al., 1991; Carr and Tomkins 1996; Cauwenbergh et al., 1996	Decisions which have a significant potential for improving corporate performance.
Cossette 2004	Strategic means important and not secondary issue.
Child 1972	Decisions which regarding the goals, domains, technologies and structure of a firm.
Dereumaux and Romelaer 2001	Decisions regarding a firm's development through products-market- technologies triplets

**Table1. Strategic investment descriptions**

itself. Strategic decision making literature did not provide a clear and applicable answer about what makes an investment strategic. However, some researchers in this field are described strategic decisions as follow: The definition provided by strategic process research are not comprehensive enough to understand the strategic character of investment decisions because the aspect of the scope and content of investments did not take into the account properly. Adopting a practice based on how it is aligned with an organization's strategy would not lead us to clear and proper selection and it would leave us in a vague situation. The reason for that is either the firm's strategy is not often identifiable or it does not exist (Cooremans 2011). Cooremans (2011) and Sa et al., (2015) in their paper emphasized on enhancing the understandings about the scope and/or the target of each practice or investment and make it more strategic and align with organization's total strategy. Moreover, it is important to analyze how a particular program enables a firm to strength its strategic position (Cooremans 2011). Therefore, in this way energy related issues would not seen as a secondary issue (which they normally seen) but a strategic issue. Literature determines top management's support as a key and very important drivers to adopt any proposed EnM program. Payback time is another driver which gives priority or rejection for any proposed program. Thollander and Ottosson (2010) in an empirical investigation within the Swedish pulp and paper and foundry sector showed that companies apply a criterion of three years or less for EE's pay off. This result in an investigation which conducted in the developing countries across nine manufacturing sub sectors fell into 0.9 to 2.9 years (Alcorta et al., 2014). Pay off criterion differs through countries and time when we look at the what Gruber and Brand showed in 1991. In an empirical study in Germany

with sample size of 500 of SMEs companies the average required payback criteria were about four years (Gruber and Brand, 1991). Since top management support in a variety of studies addressed as a fundamental and necessary affecting factor to implement a program, the need for investigation about managerial perspective is highlighted. Many believe that as long as a program is profitable the possibility of adopting a program would increase. However, it is not the case in every situation. Many EE practices which theoretically are profitable are not adopted in practice (Aflaki et al., 2013). Often it is due to lack of executing and valuing the project properly and improper definition (Schulze et al., 2015; Sa et al., 2015). Though it is sometimes due to uncertainty and its associated risk, lack of transparency and weaker understandable calculation (Sandberg and Soderstrom, 2003). Top management is positioned in a strategic level of a company and they make decisions about what is in line with company's total strategy. In other word, they are dealing with the core business. Energy is considered as a non-core business, non-strategic, but a secondary and peripheral issue (Sorrell et al., 2000). Moreover, since energy related costs in comparing with the company's total cost receives a small portion, thus energy related practices receive relatively small attention (Cooremans 2015). Another important point which resulted in low levels of EnMPs adoption and/or decision making is due to the high level of EE

investment risks in compare with the other projects. Neoclassical energy economists (like: Newell 2004; Soest and Bulte 2001) believe that the EE gap is not real because their energy-saving programs technically are energy efficient but no economically (due to hidden costs and return overestimations). Although being risky is the nature of making any decisions (due to uncertainty), but the level of the risk increases if it is more strategic. EE investment literature discussed very little in this regard. Apart from financial risk which raises from these investments, Sorrel et al., (2000) listed core business risk or technical risk linked to adoption of new technologies as a third important barrier to adoption and/or positive decision making regard to EE investments. Several strategic risks threaten a company when a decision is made (have a look on Cooremans 2011). However, the uncertainty of EE investment outcome leads to negative investment decision making in most of the time.

## 2.2. Objective of the thesis

Believing energy to be finite and nature as a place to live not only for the present generation, but for future generations increasingly leads us to use energy smarter and more efficiently. Industry, meanwhile, especially energy-intensive industries, as a major energy user receives relatively more attention. While according to an International Energy Agency report in 2007, industry in all sectors had made successful improvements, but still the Hirst and Brown's claim in 1990 about the existence of the gap between

the actual level of energy efficiency (EE) potential are remaining strong (International Energy Agency, 2012). According to IEA (2014), if current trends continue in the years to come, two-third of the economic potential to improve EE will remain untapped until 2035 (IEA, 2014). Though several researchers addressed barriers to implement EE measures, namely energy efficient technology's complexity (Fleiter et al., 2012), and implementing EE measures are a challenge because of industry's complexity (industry's characteristic) (Schulze et al., 2015). Therefore, this challenge makes it difficult to generalize any success stories or programs. Researchers addressed energy management (EnM) as a tool for overcoming EE barriers. Energy management means to optimize one of the most complex and important managerial and technical creations that we know: the energy system. However, how an EnM could do more in detail such improvements are scarce. The reason for this can be addressed to several gaps regarding: lack of proper understanding about EnMPs, lack of information about scope and target of practices which results in poor EnM configuration and moreover, lack of understanding about effective driving factors which leads the positive investment decision making through top management. These knowledge gaps are the starting point of the thesis. The thesis aims at increasing the effectiveness of the decision making process leading to the implementation of EnM in the

manufacturing sector. Thus, the research questions can be stated as follows:

- 1) **How Energy management practices can be defined?**
- 2) **How energy management practices can be classified according to their scope and target?**
- 3) **How to assess industrial energy management program?**
- 4) **How to foster energy management program's implementation?**

## 2.3 Outline of the thesis

In order to have a clear idea about EnM literature a review of the literature has been performed, with a focus on the studies dealing with the EnM definition and its related programs and practices. The questions presented here as first and second research questions highlighted as a gap in the body of EnM literature. Therefore, paper 1, entitled "Industrial Energy Management Gap Analysis" has been carried out to analyze the importance level and correlation of identifying gaps to contribute better understanding about and implementation of EnM. The research related to research question 1 and research question 2 is presented on paper 2, entitled "Classification of Industrial Energy Management Practices A case study of a Swedish foundry". To provide a comprehensive definition for EnMPs and classification for EnM program the use of knowledge from both scientific literature and practitioners in the field of manufacturing has been carried out.

To develop an assessment model for the EnM program within manufacturing companies (Research question 3) and moreover to assess the most important promoting factors for improved energy efficiency a multiple case study of 10 Swedish foundry has been carried out. Research related to research question 3 is presented on paper 3, entitled "Assessing Industrial Energy Management Program – A Multiple case study of Swedish foundries".

To address the relevant contextual factors which hindering (barriers) or fostering (drivers) the positive investment decision making, regarding EnM program implementation in manufacturing industry, (Research question 4), two parallel research processes have been followed for barriers and drivers. First, it has been necessary to develop a taxonomy of the drivers for and barriers to

positive decision making within the organization. The research has been performed by means of an iterative process, and by incorporating the scientific literature and the practitioners' knowledge. Moreover, in this regard, the results of paper 2 and paper 3 have been used to assess the exiting EnM programs in practice. Having developed a taxonomy of barriers and drivers for positive investment decision making in the process of EnM implementation, the relevant barriers and drivers have been identified by means of doing a multiple case study in all sizes and different sectors within 15 Swedish energy intensive manufacturing companies. The results are presented in the paper 4, entitled "Assessing the Driving Factors for Energy Management Program Adoption".

Although EnM improvements through policy makers is not

within the scope of current research, paper 5 entitled "Introducing Passive House Concept to Industries" aims to inject a new idea into the EnM guidelines. Also, it attempts to introduce self-sufficient industries through passive house concept with special focus on industrial facility design (see Table 2).

Paper 1	Sa A, Thollander P, Cagno E (2015) Industrial Energy Management Gap Analysis. <i>Innov Ener Res</i> 4: 122. doi:10.4172/ier.1000122 Published in <i>Innovative Energy &amp; Research Journal</i> 2015.
Paper 2	Sa, A., Paramonova, S., Thollander, P., & Cagno, E. (2015). Classification of Industrial Energy Management Practices: A case study of a Swedish Foundry. <i>Energy Procedia</i> , 75, 2581-2588. Preliminary version has been presented at ICAE 2015 conference. Second, extended version has been published in <i>Energy Procedia</i> 2015. Full version to be submitted to <i>Applied Energy Journal</i> .
Paper 3	Sa, A., Thollander, P., & Cagno, E. (2015). Assessing Industrial Energy Management Program – A Multiple case study of Swedish foundries. Preliminary version has been presented in the Global Cleaner Production Conference 2015. Spain. The full version has been submitted to the <i>Cleaner Production Journal</i> .
Paper 4	Sa, A., Thollander, P., & Cagno, E. (2015). Assessing the Driving Factors for Energy Management Program Adoption. Has been submitted to the <i>Renewable &amp; Sustainable Energy Review's Journal</i> .
Paper 5	SA, A., THOLLANDER, P., & CAGNO, E. Introducing Passive House Concept to Industries. Preliminary version has been presented in WSEAS conference 2015 and

**Table1. List of papers**



## ESSAYS ON ENTREPRENEURIAL FINANCE: THE ROLE OF CORPORATE VENTURE CAPITAL, INDEPENDENT VENTURE CAPITAL, AND CROWDFUNDING

**Mohammadmehdi Shafizadeh Khoolenjani** - Supervisor: Prof. Massimo Colombo

Lack of access to external financing for new firms increases their failure likelihood and impedes their growth. Given the strategic importance of financing for new firms, I follow two major themes in my thesis, which consists of a collection of five standalone, yet related, papers. The first theme is about how institutional environment plays an important role in the extent of value-adding activity of independent venture capitals (IVC), and the selection of corporate venture capitals (CVC) by entrepreneurs. More specifically, I investigate institutional conditions that facilitate access of new

firms to external financing from specialized investors such as CVCs (Paper 2 and 3). Relatedly, I discuss whether unfriendly policy environment undermines the value-adding services offered by IVCs to their portfolio firms (Paper 1). Second, in light of emergence of new forms of financing by crowd (so called "crowdfunding"), I study the implications of these alternatives modes of financing for new firms. More specifically, I ask whether reward-based crowdfunding complements or substitutes traditional financing of VC and business angels (Paper 4). Finally, I study the behavioral

patterns of equity crowdfunders, appreciating that crowdfunders are investors with limited proficiency in managing the adverse selection risks and moral hazard problems of investing in new firms, and limited resources and incentives to perform extensive due diligence compared to professional investors like VCs (Paper 5). Overall, my attempt is to shed light on how institutional environment and considerations of alternative sources of financing inform entrepreneurs' decisions in seeking external financing.

# STUDY ON INFORMATION TRANSITION TO FACILITATE SUSTAINABLE CONSUMPTION: MULTI-STAKEHOLDERS' VIEWPOINTS

Jing Shao - Supervisors: Prof. Marco Taisch, Prof. Miguel Ortega Mier

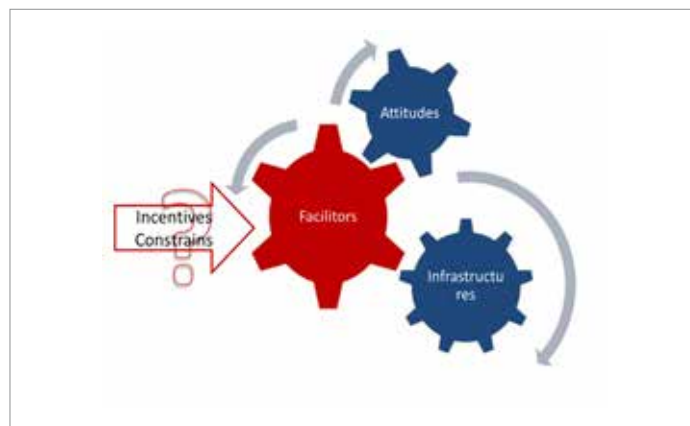
From both practical and theoretical studies, it is necessary to strengthen information transition and provide a facilitator to bridge the gap between consumers' attitude and behavior. It could help translate consumers' beliefs and values about sustainability into their demands and promote green purchasing behavior. This study focused on the in-depth understanding of how to provide a facilitator within Attitude-Facilitator-Infrastructure (AFI) framework in order to provide incentives for promoting sustainable consumption.

The first part of result in this study visualized the prioritization and interrelationships among barriers that exist between environmentally friendly products and their consumers by applying the grey-DEMATEL technique to three cases in the European automobile industry. The analysis results showed that dispelling the concern consumers have regarding their expectations and perceptions of environmentally friendly products becomes the most important task. To solve this issue, adequate sustainability-related information should be made publicly available by governments or organizations for consumers when purchasing, and it becomes a prerequisite for enabling consumers to purchase environmentally friendly products.

From the review of current sustainability assessment approaches, the result shows most indicators are less effective for supporting communication with consumers due to their underestimation of consumer information needs. Furthermore, the study suggests that necessary attributes could be extracted from current assessment methodologies, after which the full involvement and empowerment of public stakeholders, especially consumers, should be considered. This part of study suggests that the focus scope and assessment methods of the present approaches need to be modified to meet stakeholders' needs.

Continuously, 28 attributes were extracted from the current indicators and captured key

factors for success transferring from consumers' motivation and behavior, and plays the role of facilitator in AFI framework. Furthermore, in order to gain comprehensive insights from different stakeholders, such as academic experts, industry experts, and consumers, several studies were conducted based on viewpoints from multiple stakeholders. Firstly, an expert evaluation exercise (EEE) was used to evaluate the importance and applicability of the attributes. Unnecessary attributes and the ones that could not be measured properly at plant level are eliminated. The first prototype with 22 attributes was decided and they could fully meet the consumer-focused criteria. It comprises the social and environmental



1. Key elements for mainstreaming sustainable consumption

impact information and conducts evaluation at the product level. The proposed list of attribute could be applied to fundamental study for further investigations configured to specific industries and developed in relation to local/regional/national public policies, plans, and programs, including existing sustainability monitoring initiatives. It could also be integrated into management and policy procedures with the goal of developing more sustainable cities. The viewpoints from various stakeholders were provided in the study, in the context of automobile industry. A survey of 682 consumers was conducted and the method of SEM was applied to analyze the data. Besides gaining the importance value of attributes, it is evident that environmental impact related sustainability assessment attributes are the most important determinants for consumers currently. Interestingly, I found the social impact of related sustainability assessment attributes currently have not positive impact on promoting green purchasing of consumers.

As the last part of study, it presented configuration model of the automobile industry in the context of Italian companies. This study is based on the interviews with three industry experts from three European automobile companies in Italy in 2015. The aim is to conduct Analytic Hierarchy Process (AHP) analysis on the set of attributes and gain the weight of each attribute. The prominence of each attribute was gained from the industry experts directly. By applying their weights integrally, the general attribute

list is transformed towards a configuration of the automobile industry. This study is the most important step for obtaining weights from experts in the process of developing the proposed set of attributes. The proposed configuration model is expected to contribute to the studies in the field of developing an information transition approach for sustainable consumption and production. The effectiveness of the proposed attributes will be evaluated in case studies in further research. The theoretical contribution of this study could be summarized as following: based on cognitive consumer behavior model, this study developed a set of necessary attributes that could adequately meet the consumer-focused criteria, and play the role of facilitator in AFI framework. The proposed set of attributes could fully reach the consumer-focused criteria raised previously. It comprises social and environmental impact information and conducts an evaluation at the product level. This study provides empirical insights on importance and weights of numbers of necessary attributes from multi-perspective and highlights the different viewpoints that might exist among various stakeholders. In the context of European automobile industry, this study firstly visualized the prioritization and interrelationships among barriers that exist between environmentally friendly products and their consumers by applying the grey-DEMATEL technique. The results provided the major contributions of this study include: (1) a clear identification of the

barriers consumers are facing regarding environmentally friendly products; and (2) real-world data gathering that explored some of the interrelationships amongst these barriers. After the general list of attributes development, the configuration model based on European automobile industry was developed.

This study contributes to the research fields of developing an information transition approach from cleaner production to sustainable consumption, as well as marketing instrument development. The proposed attributes could serve as a fundamental study for developing related governmental/regional public policies, including existing sustainability monitoring initiatives. It could also be integrated into management and administration procedures with the goal of developing more sustainable cities. Furthermore, it is also very beneficial and constructive for practitioners to provide consumers with product-level sustainability information. Such environmentally and socially-conscious information will provide an effective way for consumers to facilitate product comparisons and choose products with more transparent information, resulting in increased market share and profit for practitioners. Consequently, it will provide a long-term competitive advantage due to increased differentiation.

# UTILIZING THE INTERNET OF THINGS TO PROMOTE ENERGY AWARENESS AND EFFICIENCY AT DISCRETE PRODUCTION PROCESSES: PRACTICES AND METHODOLOGY

**Fadi Shrouf** - Supervisors: Prof. Giovanni Miragliotta, Prof. Joaquin Ordieres

In today's manufacturing scenario, rising energy prices, increasing ecological awareness, and changing consumer behaviors are driving decision makers to prioritize green manufacturing. The Internet of Things (IoT) paradigm promises to increase the visibility and awareness on energy consumption, thanks to smart sensors and smart meters at the machine and production line level. Consequently, real-time energy consumption data from the manufacturing processes can be easily collected and then analyzed to improve energy-aware decision-making. This thesis aims to investigate how to utilize the adoption of the Internet of Things at shop floor level to increase energy-awareness and the energy efficiency of discrete production processes. In order to achieve the main research goal, the research has been divided into four sub-objectives, and was accomplished during four main research phases (i.e., four studies and related papers).

In the first phase (i.e. first study and paper), by relying on a comprehensive literature review and on experts' insights, the thesis defines energy-efficient production management practices that are enhanced

and enabled by IoT technology. The first study also explains the benefits that can be obtained by adopting such management practices. Furthermore, it presents a framework to support the integration of gathered energy data into a company's information technology tools and platforms, which is done with the ultimate goal of highlighting how operational and tactical decision-making processes could leverage such data in order to improve energy efficiency.

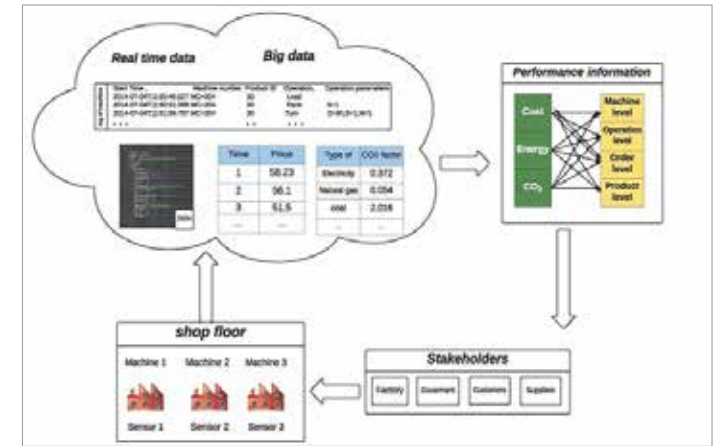
Then, considering the variable energy prices in one day, along with the availability of detailed machine status energy data, the second phase (i.e. second study and paper) proposes a mathematical model to minimize energy consumption costs for single machine production scheduling during production processes. This model works by making decisions at the machine level to determine the launch times for job processing, idle times, and machine shut down. This model enables the operations manager to implement the least expensive production schedule during a production shift. In the third phase (i.e. third study and paper), the research provides a methodology to help managers implement the

IoT at the production system level; it includes an analysis of current energy management and production systems at the factory, and recommends procedures for implementing the IoT to collect and analyze energy data. The methodology has been validated by a pilot study, where energy KPIs have been used to evaluate the increase in energy efficiency at machine level. In order to analysis the collected real-time data, big data tools have been used

In the fourth phase (i.e. fourth study and paper), the goal is to introduce a way to achieve multi-level awareness of the energy consumed during production processes. The proposed method enables discrete factories to specify energy consumption, CO<sub>2</sub> emissions, and the cost of the energy consumed at operation, production and order levels, while considering energy sources and fluctuations in energy prices. Figure 1 shows a framework for a multi-level awareness of the energy consumed during production processes.

The results show that energy-efficient production management practices and decisions can be enhanced and enabled by the IoT. With the outcomes of the thesis, energy managers can approach the IoT adoption

in a benefit-driven way, by addressing energy management practices that are close to the maturity level of their factory and their own targets. The thesis also shows that significant reductions in energy costs can be achieved by avoiding high-energy price periods in a day. Furthermore, the thesis helps to determine the correct level of monitoring energy consumption (i.e., machine level), the interval time and the recommended energy data analysis, which are all important factors involved in finding opportunities to improve energy efficiency. Eventually, integrating real-time energy data with production data (when available) will enable factories to specify the amount and cost of energy consumed, as well as the CO<sub>2</sub> emitted, while producing a product, thus providing valuable information to decision makers at the factory level as well as to consumers and regulators.



**1. A framework of a multi-level awareness of the energy consumed during production process**

# PERFORMANCE MANAGEMENT SYSTEMS IN THE AGE OF SOCIAL MEDIA

**Yulia Sidorova** - Supervisor: Prof. Michela Arnaboldi

The diffusion of social media is incomparable to any other media: *"it took 13 years for television to reach 50 million users, while [...] Twitter only 9 months. Today, there are 2.4 billion online users"* (McCaughy et al., 2014: 576). Many companies all over the world and across different sectors have seized this mounting interest in social media information (HBR, 2012). *"It's no longer a choice of whether or not you are on social. You've got to be there."* said Callison, Global Marketing and Corporate Affairs Compliance Executive of Bank of America in her interview to Forbes (November, 2015). Researchers in management have also stepped in this lively discussion on implications of social media on reporting, performance measurements and dissemination procedures (Balakrishnan et al, 2014; Lee et al., 2015). Miller and Skinner (2015: 222) highlighted that *"changes in information technology, the media and securities markets interact to affect the ways information about firms is produced, disseminated, and processed"*. This dissertation explores how social media are changing performance management systems. Performance Management Systems (PMS) are of the formal mechanisms, used by organizations, and informal

controls helping to achieve key objectives and goals set by managers at every level (Ferreira & Otley, 2009: 264; Malmi & Brown, 2008). Social media are "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of user-generated content" (Kaplan and Haenlein, 2009). Social media have become part of companies' *business activities* (Richardson, 2009; Jin, 2012; Roblek et al., 2013; Chikandiwa et al., 2013; Guinan et al., 2014) in dual way: technology to be managed (Vuori & Okkonen, 2012; Lorenzo-Romero et al., 2014) and source of information (Romero, 2011, Bajaj & Russell, 2010, Sashittal et al., 2012; Einwiller & Steilen, 2014; Swani et al., 2014). The prior works started to touch the surface of large phenomena that social media applications generate a large corpus of data that companies can exploit to measure and manage their performance through feed-back, planning and decision making. In this context this thesis aims to contribute to interdisciplinary management research and answer the urge call for understanding of how companies approach social media (Jeacle and Carter,

2014; Miller et al., 2014). More in specific, the research question of this study is how *social media information* is changing PMS. In order to investigate this topic the thesis was sub-divided it into four consecutive studies:

- 1) The first study provides an interdisciplinary literature review focusing on social media performance measurement to capture changes related to PMS.
- 2) The second study proposes a holistic framework for PMS exploiting social media for the accountants and managers of the companies. This framework accounts for the changes in measurement methods based on empirical evidence from eight case studies.
- 3) The third study is focused on application of the sociotechnical framework on four telecommunication companies to explore social media information calculative practices and their connection with the organizational and technical dimensions.
- 4) The fourth study investigates the value of social media information for PMS and its end user based on thorough single case study with one of the most proactive users of social media information.

The four studies collected in this thesis are contributing to answer the overall research question *how information derived from social media are changing performance management*. Prior literature (Balakrishnan et al, 2014; Lee et al., 2015; Miller and Skinner, 2015) investigated how social media information transforms some of the PMS components in a fragmented way, addressing issues such as reporting, dissemination procedures or return on the investment measurement. Notwithstanding an overarching analysis of the impact of social media information on PMS is missing, which is instead important to understand the overall frame going through data collection, analysis, use, leading to the creation of knowledge from social media information and its employment to support managers. The results of the thesis contributes to the PMS literature and provide an in-depth understanding on how technological, organizational and accounting components are interviewed with social media information. It responds to the call of Nguyen et al (2014) in knowledge acquisition process from social media information and value creation for the management activities across

organizations. This study broaden performance management and accounting theories by proposing new frame emerging from literature and empirical evidence, taking into consideration the velocity, volume, and variety characteristics of social media information (Gandomi and Haider, 2015). The theoretical contribution of this research mainly addresses management and accounting literature, adding to lively discussion on performance measurement systems and employment of social media data for managerial activities, supporting decision-making, planning and feed-back. In the era of big data managers are exposed to the large corpora of various information (words, pictures, videos or even symbols) with high speed. This study aims in filling in gap identified by Suddaby et al. (2015:66) that highlighted the "absence of ethics and norms in the language of professional expertise" for social media information. This is why it is important to understand the thorough process of SMI employment to support managers. This became a critical issue not only for a single manager or company, but also for public administration and governments

(Picazo-Vela et al., 2012; Jeacle and Carter, 2014; Miller et al., 2014; Gandomi and Haider, 2015) searching for effective and reliable way to understand and adopt social media data. Furthermore, this thesis underlines the threats of social media information and critical issues, privacy and information reliability. From practitioners perspective the four consecutive studies provide thorough and detailed overview of social media information employment within PMS practices, including roadmaps, taxonomy of methods and measurement metrics that represent useful set of tools for management accountants, departments directly working with social media or managers using social media information.