Matchmaking for open innovation : perspectives on multi-sided markets

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Part I:
Introduction, background and methodology

1 Introduction

The complexity of technology, business, and innovation increases and industry sectors overlap due to a strong connection via information and communication technologies (ICT). An increasingly networked world opens spaces for external ideas that innovations diffuse across the boundaries of a firm. External ideas, knowledge, and technologies deliver a disruptive potential and create new markets for firms. Thus, networks, collaborative settings, and open innovation are key sources for successful innovation (Chesbrough, 2003; Powell, Koput, & Smith-Doerr, 1996).

Open innovation has gained increased managerial and academic attention since 2003 and follows theoretical approaches of innovation networks. It subsumes the scattered literature about technology and innovation management towards an open exchange of ideas and knowledge across the firm's boundaries in innovation networks and collaborative settings. It further suggests an exchange of innovation and technology on markets, but research has shown that markets for innovation and technology do not work properly (e.g. Arora, Fosfuri, & Gambardella, 2004). This is similar to marriage, job or housing markets where intermediaries often coordinate transactions between demand and supply side and clear market frictions. Such innovation intermediaries are also attributed as brokers, matchmakers or facilitators for open innovation in networks and on markets (e.g. Howells, 2006). Furthermore, new web-based technologies raised the expectations towards internet platforms to solve market frictions by automatically matching innovation seekers with solution providers. Little is known about the matching mechanisms along the process for open innovation, either on- or offline. Theoretical approaches on matchmaking in academia are manifold, ranging from economics, sociology or computer science.

My dissertation reports an explorative action research study on participatory cases about how open innovation partnerships emerge in practice. The research team was engaged in industrial and academic projects where new ideas, external technologies and new start-up ventures were searched and matched for open innovation projects. Therefore,

the formation of new network ties for joint business opportunities, matchmaking, is in the focus of my research. On the one hand, I contribute to the interdisciplinary field of network economics and on the other hand to open innovation as managerial paradigm. Practical implications are presented for innovation intermediaries, managers, entrepreneurs and policy makers.

The problem of matchmaking arises from the network and market structure. First, in my thesis it is shown that matchmaking for open innovation requires a multi-sided market perspective. This offers a new conceptual lens as hybrid form between organizational hierarchies and external markets for innovation – as networked market setting. The contribution is a shift from matchmaking as pure transaction-based market mechanisms towards interactive mechanisms over time, but with economic long-term impact for all market agents. The main argument is that innovation intermediaries create (temporary) matching markets between several agents, manage the matching process and thus actively contribute to collaborative innovation processes and their outcome. Matchmaking is outlined as a distinct managerial capability for market making and structured tie building in innovation networks. This offers possibilities for sustainable value propositions for innovation intermediaries which are often publicly funded. Second, I present a matching process and its corresponding coordination mechanisms for the formation of open innovation partnerships as managerial implications. Third, a critical discussion about the traditional perspective of matchmaking as market transactions ends with the conclusion that matchmaking for open innovation requires an interactive and dynamic approach. These interactions lead to a long-term shared vision with strategic and economic impact for all innovation partners involved, rather than a contractual short-term transaction in the form of technology or intellectual property transfer and licensing.

The following chapter 1.1 introduces my research motivation and the matching problem for open innovation based on problems identified in practice. In chapter 1.2, the research objective, questions, and focus are presented with an outline of contributions to theory and practice. The constructivist approach of knowledge creation in this thesis is dis-

cussed in chapter 1.3 which contains a philosophical discourse and links to resulting methodological approaches. Chapter 1.4 presents the structure of my thesis. Chapter 2 is based on the editorial of the special issue on "matchmaking for collaborative innovation" and gives insights on the interdisciplinary approaches on matchmaking in academia. My research strategy and my methodological approach is part of chapter 3 which builds on the philosophical positioning in chapter 1.3.

1.1 Motivation and problem statement

Research about innovation in clusters or in networks suggests a *collaborative* approach and an *open* exchange of ideas, knowledge, innovation, and technology across the boundaries of the firm (Chesbrough, Vanhaverbeke, & West, 2006). For managing open innovation, a wide spectrum of coordination forms exists, ranging from formal hierarchical organisations, to contractual market transactions or more informal networks (Thorelli, 1986; Williamson, 1973). Despite different forms for collaborative settings such as innovation networks, buyer and supplier relationships, strategic alliances or joint ventures, all collaboration types have in common that suitable partners have to be identified and selected.

Several successful open innovation cases exist, like the multifunctional control system iDrive from BMW which was developed within a cross-industry collaboration with the software firm Immersion whose core competences originally were in the construction sector and medical technology (Gassmann & Sutter, 2011, p.176). Another prominent example of open innovation as market transaction is the acquisition of the start-up firm Siri by Apple in 2010. The intelligent speech recognition technology offered Apple new applications for their mobile devices which opened up further collaboration opportunities and new markets e.g. for (partially) blind customers.[1] Although, studies have shown that the mortality rate of collaborations like in strategic alliances are very high (Duysters, Kok, & Vaandrager, 1999), at its core,

[1] http://www.apple.com/de/accessibility/ios/ (11/19/2014)

the outcome of a collaborative innovation project is determined by the choice of the partner.

The main problem for firms which want to collaborate or partner for innovation is finding each other. At first sight, this statement seems simple, but in reality the matching process is connected with high signalling, search and transaction costs, but also managerial coordination efforts bind valuable internal resources of an organisation. Especially, the formation of innovation partnerships with an unclear outcome and a high degree of uncertainty are difficult to manage. In the literature about managing innovation in networks (Powell et al., 1996), clusters (Porter, 1998), innovation systems (Edquist, 1997) or in living labs (Almirall & Wareham, 2008), and open innovation (Chesbrough, 2003), collaboration is claimed as the central task. If this is so, finding the right innovation partner in such open environments is a necessity for managers, engineers, researchers, and entrepreneurs for creating joint value. In this context, the underlying main question in my doctoral thesis is *'how to find a suitable partner for open innovation?'*.

Matchmaking for open innovation is a phenomenon of market failure and is not well researched (Bakicic, Almirall, & Wareham, 2010; Howells, 2006; Lopez & Vanhaverbeke, 2009). Similar to other inefficient markets, like the job, the dating, or the housing market, online and offline innovation intermediaries emerged trying to facilitate or broker between innovation demand and innovation supply (Howells, 2006; Klerkx & Leeuwis, 2008). Furthermore, innovation network formation is still a public priority supported by governments due to the failure of innovation markets caused by the matching problem. As an example, the European Union recently launched the Horizon 2020 Framework Programme for Research and Innovation in order to foster innovation in networks and through collaboration.[2]

[2] http://ec.europa.eu/programmes/horizon2020/ (10/26/2014)

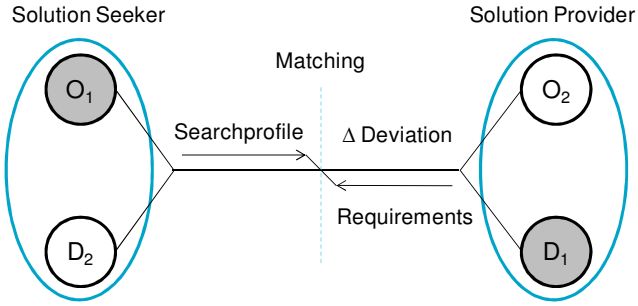

Figure 1: The matching problem for innovation partnerships: Deviation between Offer (O_x) and Demand (D_y).

In my dissertation, I therefore explore matchmaking for innovation partnerships from a process perspective using a participatory research approach. The process study furthers our understanding of how the matching process can be coordinated in terms of managerial action with strategic and economic value. Studying the matching process for open innovation is not only interesting from a practical point of view. But it also has potential for very promising contributions to theory. Research about how innovation networks evolve, how innovation demand and supply are matched on markets or other approaches of matching mechanisms and (online) matching tools for coordination are relevant scientific questions. My in-depth process analysis based on insights of the engagement in real industrial cases sets the ground for further research from various disciplines. Chapter 2 gives an overview about the interdisciplinary approaches on matchmaking which provides inspiration for further research.

1.2 Research objectives, questions and focus

This dissertation contributes to a better understanding of matchmaking for open innovation. In particular, I explore the matching process between established companies and entrepreneurial start-ups, so called *asymmetric partnerships* (Minshall, Mortara, Valli, & Probert, 2010). Based on an action research approach as explained later in chapter 3, I was actively involved in industrial technology and venture scouting projects. I documented collaboration intentions and expectations before potential partners were identified and after they were matched.

Furthermore, I observed events along the matching process and extracted patterns for collaboration formation. My work contributes to network economics as interdisciplinary field between economics, sociology and computer science. The theoretical focus of my study is on two-sided markets as theoretical background for open innovation and innovation intermediaries (Chesbrough, 2006; Roson, 2005).

In part II of this thesis, two-sided market theory is elaborated in terms of matchmaking for open innovation. Part III draws attention on the dynamics of the matching process and the corresponding interactions on a multi-sided market and part IV discusses the role of innovation intermediaries in particular.

Throughout the following chapters of my thesis, the research question RQ and its sub-questions RQ_x will be answered:

RQ: *How can a suitable innovation partner be identified?*

1) *How can the failure on innovation markets for collaboration be resolved?*
2) *How can asymmetries between innovation partners*[3] *be reduced?*
3) *What are matching mechanisms as patterns for managerial action?*

[3] In particular in partnerships between entrepreneurial start-ups and established firms.

Perspective	Academic contribution	Managerial contribution	Political implication	Practical implication
Participatory process research	Identification of patterns along the matching process for open innovation intermediation.	Development of a matching process model for open innovation.	Matching processes of public funded intermediaries can be monitored and the outcome is measurable.	Facilitating the formation of asymmetric partnerships.
Established company	Perspective of matchmaking and collaboration intentions.	Helping managers to better understand internal collaboration intentions and external entrepreneurs.	Public funded matching initiatives create value in networks for industrial partners, thus profitable income could be generated.	Learning and best practices for scouting and matching new ventures from an established firm's perspective.
Entrepreneurial new ventures	Perspective of matchmaking and collaboration intentions.	Helping entrepreneurs to better understand corporate management.	Structured matching services of public funded intermediaries create valuable access for entrepreneurs to networks.	Learning and best practices for scouting and matching corporate management from an entrepreneur's perspective.
Innovation intermediaries	Managerial role as innovation process manager, market maker and tie builder.	A better understanding about mechanisms and capabilities for open innovation intermediation.	A shift from public funded facilitation role of innovation intermediaries towards professional matching services.	Learning and best practices for scouting and matching in networks.

Table 1: Perspectives and contributions in my research project.

I contribute to the field of network economics by first conceptualizing matchmaking for open innovation as multi-sided market in part II of this thesis. With my conceptual model, I add a further empirical example of a two- or like in my case a multi-sided market to the literature besides already existing cases (Hagiu & Wright, 2011). Furthermore, my definition adds an additional perspective to innovation markets where matchmaking is interaction-based, rather than transaction-based like on multi-sided online platforms (Illing & Peitz, 2005). A process perspective on matchmaking in part III of this thesis provides detailed interactional patterns between the agents on a multi-sided market for open innovation. Matching dynamics are presented leading to "virtuous" or "vicious" circles based on social interaction. Unlike to automated transactions or auctions like on amazon or ebay, matchmaking for open innovation requires an adaptive process between goal finding, goal setting towards a shared vision and a common understanding which may result in future transactions. Interactions are discussed as matching mechanisms on multi-sided markets. Additionally, the role of innovation intermediaries is elaborated in detail. In part IV of this dissertation, a managerial perspective on matchmaking with clear capabilities is outlined. This part contributes to the literature on innovation intermediation (Howells, 2006).

Theoretical and practical contributions:

1) A conceptual networked multi-sided market model where agents are matched according to their intentions
2) An interactive matching process on a multi-sided market which was developed from and tested in industrial participatory cases leading to positive or negative network effects (virtuous or vicious circles)
3) Understanding matching dynamics as interactive process over time rather than static transactions
4) A managerial matrix for structured matchmaking approaches and managerial action

1.3 Research epistemology and methodology

Academic work aims to create new knowledge which is generated either through experimentation, mathematical and logical proof, hypothesis testing or empiricism (Katzy & Dissel, 2008). Traditionally, academic disciplines have their own epistemological perspective with specific methodologies and methods, but in our networked world scientific fields overlap and influence each other. Technical inventions and findings from engineering or computer science drastically changed social and economic behaviour. Therefore, interdisciplinary research emerged for example studying the management of technology and innovation (Lannes, 2001). Interdisciplinary research is challenging and not easy to justify against the "pure" academic disciplines. But many successful examples of interdisciplinary research do exist, which enhanced theoretical knowledge, practical use and influenced several academic fields. Matching theory and market design is a concrete example which have a high practical impact and contributed to game theory, mathematics and computer science (Roth, 2002; Roth, 2008), market microstructure and pure economics (Mortensen, 2011; Spulber, 1999) and network theory as sociological discipline (Easley & Kleinberg, 2010). Matching theory in particular as part of game theory and neo-classical economics has been explicitly approached in the quantitative research paradigm, but lacks a qualitative in depth understanding about the social processes between two or more individual agents. The *how* innovation partnerships or networks emerge over time is mentioned in Doz (1996) who claims a further understanding of process dynamics in strategic alliance formation.

Thus, for enhancing theoretical knowledge (episteme), research should be seen from a more holistic perspective. Thinking in monodisciplinary silos may cause problems in communication and joint understanding of real world phenomena between social scientists, engineers, computer scientists or economists. A core problem is the coexistence of different fundamental beliefs between the different disciplines: the rational view and the empirical view (Audi, 1999). While the rationalist draws scientific conclusions from mathematical evidence, the empiricist learns from (practical) experience and concludes more through logical sense making. Mathematicians, computer scien-

tists, and engineers argue based on absolute objective truth and quantitative proofs what is in line with the rational belief. While social and management scientists argue on empirical and more subjective findings (Katzy & Dissel, 2008). The created knowledge can be distinguished between pure objective or subjective knowledge (Burrell & Morgan, 1979). Therefore, a clear epistemological positioning is necessary for a solid interpretation and understanding of interdisciplinary research results between the audiences from different fields.

In this thesis, a naturalist or constructivist position is claimed for the creation and interpretation of the research results (Lincoln & Guba, 1985). This means that individuals create their own knowledge *(episteme, techne, phronesis)* based on their experience and their perspective and through interaction with others. Our theoretical knowledge (episteme), practical knowledge (techne), and knowledge as practical wisdom (phronesis) is something personal and becomes explicit when we articulate our knowledge to others in a way that enhances our understanding of a phenomenon (Nonaka, 1994; Ottosson & Björk, 2004).

Generally, in a constructivist world, there is no absolute truth and thus, the corresponding ontology is relative to specific constructed realities. In contrast to the objective positivistic stance, in which reality is (probably) apprehensible and findings are (probably) true. Positivists use experimental research designs in order to verify or falsify hypotheses or follow clear mathematical proofs, like engineers, economists or computer scientists do. In contrast, constructivists act in dialectical and hermeneutical environments and prefer the discourse of arguments based on existing theories and qualitative data, such as interviews, meeting minutes, observations or field notes. This research approach is useful, especially when there is not much knowledge about the topic (Patton, 2005), which is the case in matchmaking for open innovation (Howells, 2006).

Clearly, there is no true and false between both research stances, but it is important to know that depending on the perspective, a distinction between the quality criteria for scientific assessment has to be made. A positivist judges on external and internal validity of scientific data, reliability and objectivity. In contrast, trustworthiness, credibility, and

transferability are considered as important quality criteria by constructivists. Figure 2 contrasts positivism and constructivism based on the epistemological assumptions.

Basic belief	Positivism (Post-Positivism)	Constructivism
Ontology	*Naive or critical realism:* "real" reality (probably) apprehensible (only imperfectly)	*Relativism:* local and specific co-constructed realities
Epistemology	*(Modified) dualist, objectivist:* findings (probably) true	*Transactional, subjectivist:* co-created findings
Methodology	*Experimental, manipulative:* verification (falsification) of hypotheses, chiefly quantitative methods (may include qualitative methods)	*Hermeneutical, dialectical:* interpretive approach, chiefly qualitative methods (e.g. interviews combined with observations)
Criteria	*Validity:* internal, external	*Trustworthiness:* credibility, transferability
Voice	*Scientific report:* "disinterested scientist"	*Interpretive case studies:* "passionate participant"

Figure 2: An overview of scientific perspectives (similar to Lincoln, Lynham, & Guba, 2011, p. 100 f., with own supplements).

Following a clear constructivist perspective, this work derives scientific results from empirical data which were collected in a practical research setting based on the participation in industrial projects. In my case, action research methodology offers a valid framework for a contribution to both worlds: enhancing practical knowledge and solving practical problems on the one hand, and further theoretical knowledge in science on the other hand (Ottosson, 2003; Van de Ven, 2007). A core problem following such participatory approaches is the knowledge transfer between theory and practice which is caused that scientific and practical knowledge is created separately (Van de Ven & Johnson, 2006, p. 802 f.). Action research is a method for jointly creating theoretical contributions by solving practical problems which is in line with Pasteur's Quadrant for "use-inspired basic research" generating a fundamental understanding of a certain research phenomenon with the considerations of its practical use (Stokes, 1997).

Research inspired by …		Consideration of practical use?	
		no	yes
Quest for fundamental understanding?	yes	Pure basic research (Niels Bohr) → Pure theory	Use-inspired basic research (Louis Pasteur) → Theory & practice
	no	Tinkering	Pure applied research (Thomas Edison) → Pure practice

Figure 3: The Pasteur Quadrant for generalized and applied knowledge creation (according to Stokes, 1997)

Matchmaking for open innovation and in innovation networks is a little researched phenomenon. For this reason, an explorative study design is adequate using parts of the case study methodology (Eisenhardt, 1989; Yin, 2009) and action research (Herr & Anderson, 2005; Ottosson, 2003).[4] The research project is not conducted as a neutral experiment; the practical setting in a real industrial environment is rather researched while it is emerging. This means an active participation during innovation partnership formation, implementation of changes along the matching process based on action learning and theoretical reflection of field data and observations. Therefore, the participatory case studies are analysed in a longitudinal process study design for pattern identification (Miles & Huberman, 1994; Van de Ven & Poole, 1990).

My methodological research approach follows the engaged scholarship philosophy which also suggests an advancement in management sciences by actively participating in practical settings and contributing to theory by solving practical problems (Van de Ven, 2007, p. 2). For the

[4] Following a broader academic approach in terms of methodology, action research is my main methodology, although case study design and the engaged scholarship approach were also part of the methodological repertoire. Engaged scholarship philosophy from A. Van de Ven is in line with action research as a methodology. A case study approach was combined with participatory action research in the conference article Sailer, K., Holzmann, T., Katzy, B., & Weber, C. 2014. Co-evolution of goals and partnerships in collaborative innovation processes, ***XXV ISPIM Conference***. Dublin.

execution of the study, I had designed three action research studies according to Susman and Evered (1978). Alongside the innovation intermediary, I was involved in exploring patterns in the matching process, identifying problems within the process, contributing to develop solutions, and their implementation, and studying the effect of the undertaken actions. Data collection followed the cycle of action research (Kock, McQueen, & Scott, 1997). Sources for data collection were semi-structured interviews with involved managers and small entrepreneurial firms, who were each interviewed regarding their requirements and expectations before the matchmaking (ex ante) and about their evaluation of the experience after the matchmaking (ex post). Interviews were complemented by field observations, meeting participation, and document analysis all along the process. All data are archived on the server of Strascheg Center for Entrepreneurship (SCE), in my research diaries or on separate protocols and surveys.

1.4 Structure of the thesis

The following three parts of the thesis are based on four peer-reviewed papers presented at academic conferences, two peer-reviewed journal articles as extended and improved versions of selected conference papers. My thesis consists of six separate studies of which four are core publications in the chapters 4.2, 5.1, 5.2 and 6.2. The two remaining studies in chapter 4.1 and chapter 6.1 are side papers supporting the main findings from chapter 4.2 and 6.2. All publications have been partly adapted for better linkage in this thesis. The results present theoretical findings and reflections from participatory action research cases triangulated with data and findings from similar research projects in co-authored articles.[5] Practical implications for managers, entrepreneurs, policy makers and innovation intermediaries are derived in order to close the gap between theory and practice.

In *part I* of my thesis, I describe the motivation and problem statement and define my research objectives and research questions. In addition,

[5] Together with my PhD colleagues and co-authors Ebru Turgut-Dao and Christina Weber, we compared our data for external validation of our findings and wrote two joint publications. In my thesis, I only rely on the perspective on matchmaking in open innovation and innovation network contexts.

details of research epistemology and methodology are provided for a clear positioning in the scientific landscape of how knowledge is generated in my study. For setting the scene, a brief overview about existing research on matchmaking from economic, sociology and computer science is given in chapter 2 which is based on the editorial for the special issue on "matchmaking for open innovation: interaction rather than transaction". [6] Further literature from network economics about two-sided markets, multi-sided platforms, innovation intermediaries and matchmaking from interdisciplinary perspectives is summarized in each part of the thesis separately for the particular study in each chapter. In chapter 3, my participatory research approach and the methodological rigor of my study is outlined in detail.

Part II presents insights in matchmaking as economic value creation in innovation networks, especially in projects with strategic long-term orientation. The first study is based on a conference paper and provides a multi-sided market perspective derived from a single in-depth participatory case study about the matching process. It outlines first that matching takes place on an individual level between the agents in a hierarchy and a networked market. The second learning of this study is that innovation intermediation for asymmetric partnerships requires a multi-sided market with a networked logic. The second study is an improved and further developed version of the conference paper. The findings of the in-depth participatory case study are validated in a cross-case analysis. Matchmaking as multi-sided market for open innovation is introduced as a novel conceptual model for innovation markets in detail. Related research questions to part II:

RQ: *How can a suitable innovation partner be identified?*

RQ_1: *How can the failure on innovation markets for collaboration be resolved?*

RQ_3: *What are matching mechanisms as patterns for managerial action?*

[6] The special issue in Technology Analysis & Strategic Management is based on the research agenda developed by Thomas Holzmann, Klaus Sailer, Brendan Galbraith and Bernhard Katzy.

Part III opens the black box of the microstructure on a multi-sided market and provides insights about the interactions on the networked market. Similar to the transactions for market equilibrium in pure economics, the microstructure based on interactions is derived from two process studies about matchmaking. A conceptual matching matrix categorizes open innovation projects for transaction-based or interaction-based matchmaking. The studies of chapter 5 were published as conference articles and present process dynamics as network effects or feedback loops. The theoretical grounding of chapter 5.1 is based on transaction cost economics as reason for market transactions. Chapter 5.2 addresses a sociological and managerial perspective on matching dynamics and extends the existing managerial model of partnership formation. Chapter 5.3 summarizes matchmaking as market transaction and matchmaking as interaction in a conceptual matrix for managerial action based on collaboration intentions. Related research questions to part III:

RQ: *How can a suitable innovation partner be identified?*

RQ_1: *How can the failure on innovation markets for collaboration be resolved?*

RQ_2: *How can asymmetries between innovation partners[7] be reduced?*

Part IV analyses the role of innovation intermediaries and identifies matchmaking, innovation process design, and portfolio management as distinct managerial capabilities. The study in chapter 6.1, which was presented at a conference, revisits the facilitation role of intermediaries in innovation networks and provides insights towards a pro-active managerial role in networks. Chapter 6.2 is an improved and further developed study from the conference paper and highlights the strategic management position of innovation intermediaries in networks with a clear economic contribution. Related research questions to part IV:

RQ: *How can a suitable innovation partner be identified?*

[7] In particular in partnerships between entrepreneurial start-ups and established firms.

RQ_2: *How can asymmetries between innovation partners[8] be reduced?*

RQ_3: *What are matching mechanisms as patterns for managerial action?*

Part V discusses the findings from part II, III, and IV in a wider theoretical scope. Chapter 7 outlines first that innovation intermediaries deliver economic value in networks. Matchmaking for open innovation is modelled as multi-sided market. Second, matchmaking for open innovation is based on interactions with long-term impact, and transaction-based reasoning reaches the explanatory limit in this context. This finding provides a further perspective on network effects as interactions towards successful matchmaking. Third, the role of innovation intermediaries as active matchmaker is elaborated. In chapter 8 the discussed findings are linked to the research questions and are briefly summarized. The thesis concludes with theoretical and practical implications, outlines the limitations and provides paths for future research form various perspectives.

[8] In particular in partnerships between entrepreneurial start-ups and established firms.

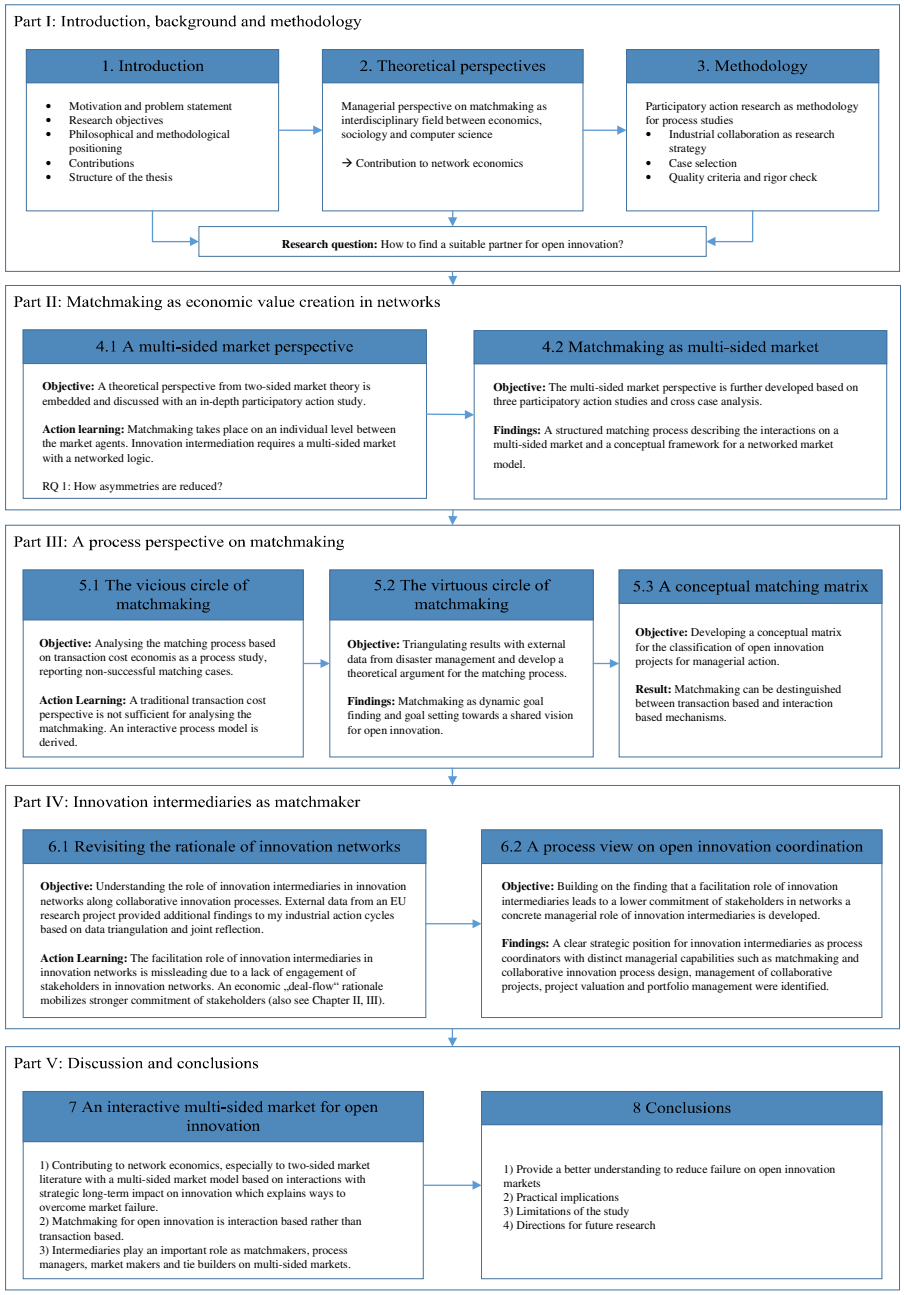

Figure 4: The structure of the thesis.