Ambidextrous Organizational and Individual Competencies in Open Innovation: The Dawn of a new Research Agenda

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Abstract: This paper describes a conceptual approach to individual and organizational competencies needed for Open Innovation (OI) using a new ambidexterity model. It starts from the assumption that the entire innovation process is rarely open by all means, as the OI concept may suggest. It rather takes into consideration that in practice especially for early phases of the innovation process the organization and their innovation actors are opening up for new ways of joint ideation, collaboration etc. to gain a maximum of explorative performance and effectiveness. Though, when it comes to committing considerable resources to development and implementation activities, the innovation process usually closes step by step as efficiency criteria gain ground for a maximum of knowledge exploitation. The ambidexterity model of competences for OI refers to these tensions and provides a new framework to understand the needs of industry and Higher Education Institutes (HEI) to develop appropriate exploration and exploitation competencies for OI.

Keywords: OI; Exploration; Exploitation; Ambidexterity; Organizational Antecedents; Individual Competencies; Organizational Competencies

1. Introduction

This paper brings together research in Open Innovation (OI) with research in organizational and contextual ambidexterity. Since Henry Chesbrough introduced the term Open Innovation a decade ago (2003), a huge body of conceptual and empirical work has been conducted in this area to understand e.g. the drivers, mechanisms, tools, organizational antecedents and success criteria of opening up the innovation process. Already a decade before laying the ground for the OI paradigm, the scientific discussion about balancing explorative and exploitative activities in firms started, having its origin in the seminal work of James G. March (1991). He pointed out capabilities of how to manage the tensions between exploration and the exploitation of resources in the innovation process and in organizational learning. However, up to now, the links between OI and ambidexterity are not researched in depth, though there is at least casuistic evidence on a strong mutual interaction between these two research agendas, e.g. widening the relevant management dimensions of OI (see. Stoetzel and Wiener, 2013), identifying different styles of culture and leadership as important organizational antecedents of OI (Brem and Viardot, 2013).

In this paper an ambidexterity model of OI is presented based on earlier work of the

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authors on organizational antecedents, contextual ambidexterity and individual competencies for exploration and exploitation (cf. Hafkesbrink et al., 2013) and as well on organizational competencies for OI (cf. Hafkesbrink and Schroll, 2010a). Special emphasis is laid on two distinct aspects of this symbiosis: (1) organizational antecedents and competencies for exploration and exploitation and (2) individual competencies for exploration and exploitation in the OI process. The aim is to provide a heuristic framework for developing a curriculum on OI Competencies for HEI, reflecting the needs of industry to drive effective and efficient innovation processes.

On this background this paper is organized as follows: in the following chapter two a short overview is presented on the current discourse on OI and on the ambidexterity debate. Chapter three provides the conceptual linkage between the OI and the ambidexterity model. Organizational competencies are described for the core tasks of exploration and exploitation in the OI process. On this background chapter four presents an in-depth set of hypotheses for organizational antecedents as well as organizational and individual competencies for OI based on a literature review and an ambidexterity model for OI. Finally chapter five presents a short summary as well as an outline of a new research agenda on ambidextrous competencies for OI.

2. Open Innovation and Ambidexterity

2.1 Open Innovation

OI usually is defined as the targeted opening of the innovation process to include external knowledge such as of customers, suppliers and research institutes etc. into the innovation process (outside-in) with the aim to successfully implement new products or services on the market and/or to exploit own knowledge via collaboration with third parties (inside-out), e.g. by way of licensing (cf. Hafkesbrink and Schroll 2010a). Here an important contribution to this new way of thinking innovation processes was made by Henry Chesbrough. He stressed that, in short, OI focuses on how to combine different competencies or technological capabilities, whether they are inside or outside the firm, and apply them to commercial ends (cf. Chesbrough 2003 and 2004; Lazzarotti and Manzin, 2009).

Such opening processes first require a change in thinking and in strategy: wasn't it – hitherto – confidentiality being the credo of all innovation activities, e.g. by hiding product development as long as possible from the competitors to achieve time savings in the market launch? Thus, such opening processes also require a specific "constitution" of the organization: what does "opening of organizational boundaries" in everyday life mean – does it mean clear communication from the inside out on whatever competition-related topic? The transition from closed to OI is shown in fig. 1:

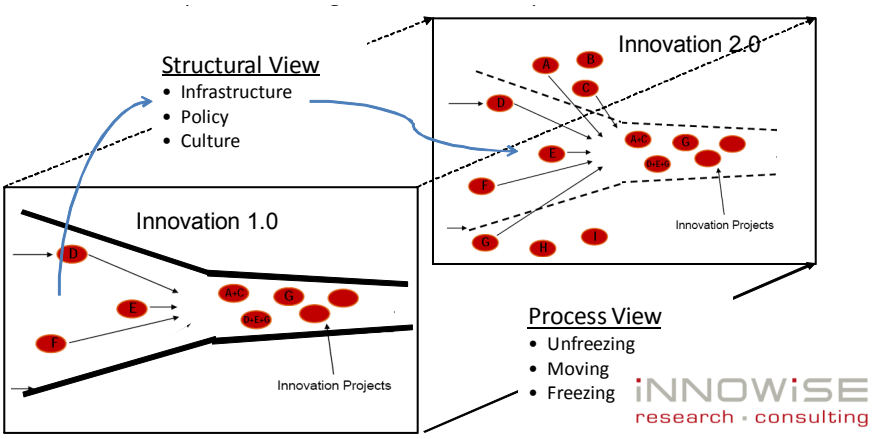

Fig. 1. Transition from Closed to OI (Source: Hafkesbrink and Scholl 2010)

To step from "Innovation 1.0" as the archetype of a closed innovation model towards "Innovation 2.0" as the new OI model, a paradigm shift in certain constitutive elements of the organization is needed (structural view). This embraces unfreezing existing infrastructure-, policy- and culture elements of the organization, moving to new institutional arrangements, by, for example, configurating trials, working in a new way, developing trust and commitment and subsequently refreezing them so as to enable new organizational competences and stability to emerge in the next stages of organizational development (cf. Lewin 1948).

Findings of numerous empirical and theoretical studies now show (at a glance cf. Hafkesbrink and Schroll, 2010a) that, for opening up the innovation process, especially in the phases of idea generation and design, there is a need for more exploratory forms of organizational design to provide a maximum of flexibility and knowledge absorption in the innovation process. This in particular includes cultural openness, dynamic adaptability of the structures and processes, IT-support, networking skills, collaboration capability beyond organizational boundaries and the ability to identify new knowledge and technologies (see fig. 2).

In contrast, for later phases of the innovation process rather exploitative forms of organizational design are needed, which ensure an efficient exploitation of new knowledge. Thus, product development and production are more dependent on reliable and stable organizational structures that are used to retain obligations and routines. In this respect, less the appropriation, but rather the transformation and exploitation of knowledge are central organizational performance factors.

According to figure 2, empirical evidence in the literature reveals that organizations which can manage both modes of organizational design, are able to adapt more effectively and efficiently to changing environments (Güttel and Konlechner, 2007; Tushman et al. 2002). Obviously, this so called 'ambidexterity' produces relevant trade-offs between those phases of an innovation process where flexible adaptation to new ideas, designs, moods etc. ("De-compressive Openness") is necessary with those phases of the innovation process that need straight-forward management ("Compression Mode") (cf. Eisenhardt and Tabrizzi, 1995). Figure 2 suggests that there is a strict line separating explorative from exploitative modes, organic from mechanistic structures, stable from flexible phases, heuristics from routines etc. Of course in reality, we may experience a specific composition of these ambidextrous modes depending on the single innovation case, sector, environmental dynamics,

community communication channels, learning requirements etc.

Characteristics of Ambidextrous Organizations		
Implementation Mode	explorative	exploitative
Structural Mode	organic	mechanistic
Adaptation Condition	flexible	stable
Rules	heuristical	routinized
Decision Making	implicit leadership	explicit leadership
Communication	lateral	vertical
Governance	advice and learning	desicions by superiors
Control and Authority	network and trust	hierarchy

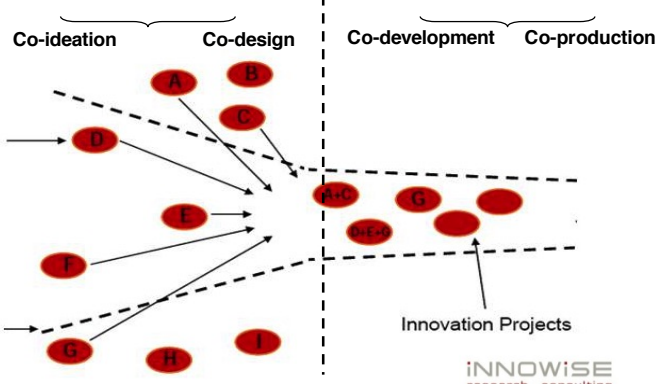

Fig. 2. Characteristics of ambidextrous organizations in the OI Process (Source: Hafkesbrink et.al., 2011)

This sheds light on different facets of organizational learning in the context of OI:

First, it seems obvious that in the context of OI the organization must learn both incremental and radical (Perkins et al., 2007, p. 306). Even in the opening up process it has to rely on existing structures that determine e.g. the borderlines and self-organization capabilities of the organization, on cultures that rule e.g. open-mindedness, reputation and trust and the knowledge friendliness of the organization. But OI also requires radical learning in terms of changing the rules of the game: intellectual property rights, non-disclosure principles, historically evolved hierarchies etc. may be in need for change radically if an organization would like to benefit from open knowledge collaboration.

Second, it appears quite clear that in OI organizations also have to learn both on an individual/cognitive and a social/cultural level (Perkins et al. ibid). There are important links between the learning of organization members when solving problems and learning on the superior organizational level, understood as the capacity of an organization to transform its underlying structures, cultural values, and objectives in response to, or in anticipation of, changing environmental demands (cf. Argyris and Schon, 1996). “Hence, a learning organization depends on openness to new ideas and change at both the individual and organizational level” (Perkins et al. 2007, p. 307).

2.2 Ambidexterity

Ambidexterity is usually defined as the ability to develop and utilize new resources

and competences (resources exploration) and at the same time make efficient use of already available resources (resources exploitation). A very general definition is given by Bledow et.al. (2009): *"We define ambidexterity as the ability of a complex and adaptive system to manage and meet conflicting demands by engaging in fundamentally different activities. On the most general level ambidexterity implies successfully managing the dichotomy of explorative variability creation and exploitative variability reduction"* (Bledow et al., 2009, p. 31).

The term 'ambidexterity' was introduced by Duncan (1976) into innovation and organizational research to describe the ability of a firm to build dual organizational structures, on the one hand for the creation of innovation and on the other hand, for the implementation of innovation (so-called 'Dual Structures for Innovation'). Organizational ambidexterity in this context means the ability of an organization to create a sustainable organizational capacity through balancing resources exploration and resources exploitation (cf. March 1991, Tushman and O'Reilly, 1996). In this context organizations have to make choices considering the principal scarcity of resources: "Organizations make explicit and implicit choices between the two" (March 1991, p. 71), which at first glance assumes a trade-off between these two modes of resource use (ibid., p. 72 f.). However, recent research shows that there also may be synergies between resource exploration and exploitation instead of trade-offs: „On the other hand, exploitation and exploration are considered to be mutually enhancing, so that it is possible for firms to attain high levels of both" (Gupta et al., 2006; cf. Jansen et al., 2006). Both modes of the relationship between exploration and exploitation under the 'scarcity of resources paradigm' are depicted in the following figure:

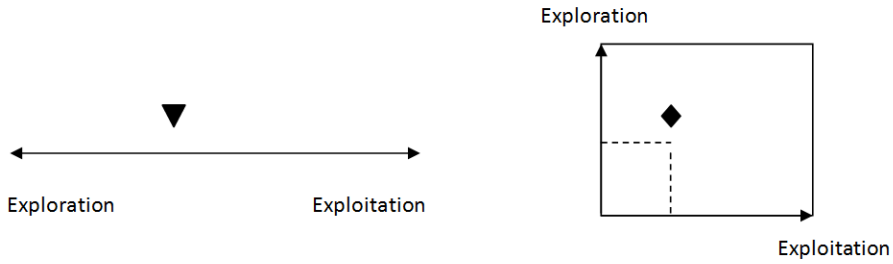

Fig. 3. Relationship between exploration and exploitation

The left part of figure 3 describes two ends of a continuum and involves the assumption of a trade- off between resource exploration and exploitation. Limited by scarce resources only a certain level of activity of either exploration or exploitation can be achieved, thus there exists a trade-off between the two activities ('Conflict School', i.e. dichotomous approach that stresses the fundamental contradictions between exploration and exploitation). The illustration on the right part of figure 3 states that exploration and exploitation may relate orthogonal to each other (so-called 'Complement School', starting from the assumption that exploration and exploitation tolerate each other (see Hobus and Busch, 2011, p. 189 ff.).

The terms 'exploration' and 'exploitation' are connoted with a plurality of features. On a very general level, exploration refers to 'the discovery of new possibilities' and exploitation to the 'valorization of existing potentials' (cf. Stephan and Kerber, 2010, pp. V). "While exploration processes aim on the search for new knowledge, for unknown technologies or diversifying into uncertain new product markets, exploitation means the recovery or refining of existing enterprise resources, for example through deepening of knowledge, incremental innovations or differentiation of the product range" (ibid. translation by the author).

Mirroring the tensions between exploration and exploitation, also innovation research reveals that innovation processes can be characterized principally by a variety of stresses (cf. Lewis et al., 2002), paradoxes (cf. Miron et al., 2004), contradictions (cf. King et al., 1992) and dilemmas (cf. Stoetzel and Wiener, 2013; Benner and Tushman, 2003; Bledow et.al., 2009, p. 4). Thus, from the perspective of innovation research, the terms 'exploration' and "exploitation' play the following central role: 'exploratory innovations' require new knowledge and leave familiar knowledge domains (cf. Benner and Tushmann, 2003, p. 243). „Exploratory innovations are radical innovations and are designed to meet the needs of emerging customers or markets" (Benner and Tushman, 2003, p. 243, see also Danneels, 2002). ‚Exploitative innovations', however, are incremental innovations to meet the needs of existing customers. They broaden existing knowledge, improve existing designs, expand existing products and services and improve the efficiency of the distribution (cf. Abernathy and Clark, 1985; Benner and Tushman, 2002; Tushman and Smith, 2002; Levinthal and March, 1993). In this context Tushman and O'Reilly (1996) define ambidexterity as the „ability to simultaneously pursue both incremental and discontinuous innovation" (Tushman and O'Reilly, 1996, p. 24).

3. Linking Open Innovation and the Ambidexterity Model

Figure 2 already gives a hint to how OI is linked to ambidexterity. Going more into detail, interrelationships are more complex and need to be described more in-depth. Thus figure 4 provides an outline of the elements, the subsistent relationships, the survey marks and operational items of the ambidexterity model (cf. Hafkesbrink et al., 2013). The model is based on a contingency-based approach to organizational adaptation (cf. Burns and Stalker, 1961; Lawrence and Lorsch, 1967, Miller and Friesen, 1983), assuming that ambidexterity and its organizational and individual enabling depends on context factors like environmental dynamics and complexity (cf. Auh and Menguc 2005), and that the main driver for switching between exploration and exploitation as alternative modes of learning is environmental change. At the same time, the model is based on a multi-level analysis: ambidexterity may not only arise at an organizational level but also at an individual, team or inter-organizational level (cf. Kaupilla, 2010; Simsek, 2009, p. 605; Hobus and Busch, 2011, p. 192). Furthermore, multiple interdependencies are anchored within the model, focusing on (a) reciprocities between organizational design and individual competencies development, leading to a loop between individual and organizational learning, and (b) amplifying and/or compensation effects between organizational design dimensions and performance criteria (cf. Simsek, 2009, p. 607). Finally, the model raises the question as to how single organizational design dimensions and individual competencies contribute to single exploration and exploitation performance criteria:

The basic hypothesis of our model is that ambidexterity for OI develops as the result of:

- a specific configuration of organizational antecedents which are specialization, coordination, formalization, (de-)centralization, leadership styles and organizational culture (cf. Jansen et.al., 2006; Gibson and Birkinshaw, 2004);
- a specific configuration of professional, methodical, social and personal competencies to support exploration and exploitation activities within the organization (cf. Hafkesbrink and Schroll 2010a).

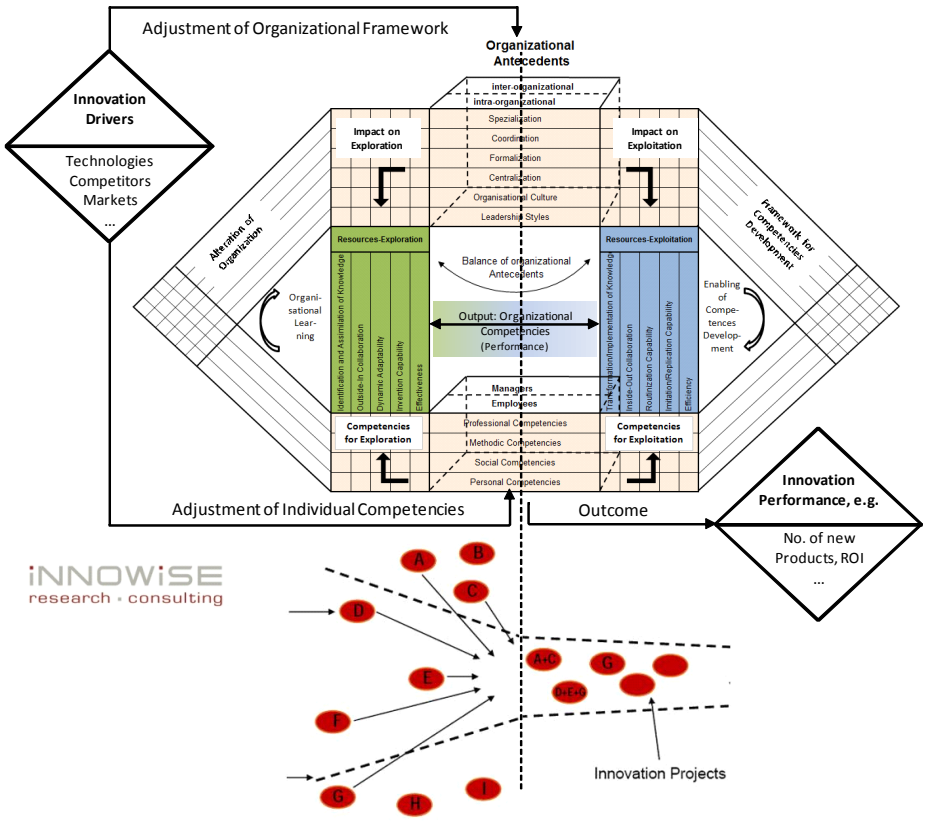

Fig. 4. Ambidexterity Model of OI

The following interdependencies are considered to be important for the ambidexterity model (see fig. 4):

- the model assumes that firms adjust their organization to new requirements, e.g. to OI, from the firms environment (independent variable, contingency variable) by altering the organizational antecedents (response variables I) mentioned above within organizational change processes;
- the model also implies that individual competencies of managers and employees are adjusted to these new requirements by altering professional, methodical, social and personal competencies (response variables II) within personal development and training processes;
- alterations in the organizational framework may also impact individual competences development, i.e. it may enable or impede individual competencies acquisition (moderation effect between response variables I and II);
- individual learning cumulates along the team level up to the organizational level introducing organizational learning;
- alterations of organizational antecedents and individual competencies directly impact the performance of exploration and exploitation (dependant variable);

- organizational competencies (dependant variable) are composed of exploration- and exploitation performance criteria; these are (1) for exploration: identification/assimilation of knowledge, outside-in collaboration capability, dynamic adaptability, inventive capability, and effectiveness; and (2) for exploitation: transfer/valorization of knowledge, inside-out collaboration capability, routinization capability, imitation/replication capability, and efficiency;
- overall innovation capability (e.g. measured by the number of successful products or ROI) is the outcome variable (dependant variable) of the model;
- finally the ambidexterity model assumes that resources exploration is applicable to the early phases, resources exploitation applicable to the later phases of the OI process.

Considering of what has been argued so far and looking on organizational competencies it becomes quite obvious how the ambidexterity model is linked to the OI process (extract from fig. 4):

Dimension	Exploration	Exploitation
Knowledge management/ -absorption	Identification/ assimilation of knowledge	Transfer/ valorization of knowledge
Collaboration with external partners	Outside-In collaboration capability	Inside-Out collaboration capability
Stability/ organizational learning	Dynamic adaptability	Routinization
Innovation process	Inventive capability	Imitation/ replication capability
Performance	Effectiveness	Efficiency

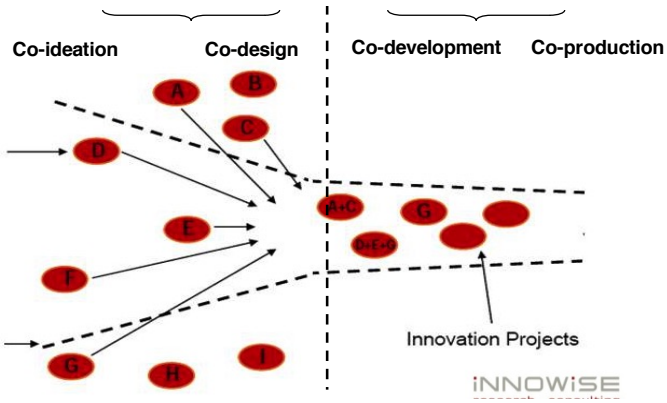

Fig. 5. Linking Organizational Competencies for Exploration and Exploitation to the OI process

4. Organizational Antecedents, Organizational and Individual Competences for Open Innovation

In the following chapter we will first describe the ***organizational competencies*** for OI

more in-depth, following the main dimensions of exploration and exploitation, displayed in the above fig. 5. Then we will turn to the ***organizational antecedents*** that moderate these organizational competences in one way or the other. Finally we will draw on ***individual competencies*** for OI, since the innovation process is always driven by humans and their personal, social, methodical and professional competencies.

4.1 Organizational Competences and Antecedents for Open Innovation

Organizational Competencies for the Exploration of Resources.

Ability to identify and assimilate knowledge: For OI exploration, it is decisive to establish capabilities for the identification of technological and market-based options that are relevant to the company (cf. Mortara et al., 2009), and the ability to evaluate and to build compatibility with the company's existing expertise (cf. Schroll, 2009; Schreyögg and Kliesch, 2002; Boscherini et al. 2009; Cohen and Levinthal, 1990; Mortara et al., 2009). In the literature, this part of the acquisition of knowledge is referred to as 'potential absorptive capacity'. "Potential absorptive capacity, [...] includes knowledge acquisition and assimilation, captures efforts expended in identifying and acquiring new external knowledge and in assimilating knowledge obtained from external sources" (Zahra and George, 2002, p. 189). It may make a difference whether the source of knowledge is of academic or industrial nature (cf. Vega-Jurado et al., 2008), thus 'scientific absorptive capacity' and 'industrial absorptive capacity' are distinguished: "The former is a firm's ability to absorb scientific/technological knowledge from universities, technology institutes, and public and private research centers; the latter is its ability to assimilate and exploit knowledge from actors in the industry chain. The factors that determine the development of these types of absorptive capacities is different although in certain sectors they may be complementary" (see p. 11). The ability for the identification and acquisition of knowledge can be measured by how successful the organization identifies and acquires relevant knowledge from external sources (i.e. knowledge for the purpose of new problem solutions in the company).

Ability for Outside-in Collaboration: Outside-in collaboration is about the ability to build solid communication and working relationships with the appropriate external sources of knowledge and expertise in order to support the identification and acquisition of knowledge (cf. Hafkesbrink and Schroll 2010a). In addition to the known groups of partners in the innovation process such as suppliers and consultants, the OI debate has directed attention to crowdsourcing communities, i.e. working with customers to generate ideas for new products and services (ibid.) or with other communities of practice, of affinity, of knowledge (cf. Evers and Hafkesbrink 2010; Hafkesbrink and Schroll 2010b). The sustainability of these communication and working relationships can be operationalized by the sum of the tightly and loosely coupled connections (cf. Granovetter 1983; Andriopoulos and Lewis 2009, p. 704) to the corresponding market partners. It is a question of both building formal structures of relationships, for example in the context of strategic alliances, as well as informal social relationship structures that provide access to 'tacit knowledge' (cf. Hess and Rothaermel, 2008).

Dynamic adaptability: The term Dynamic Adaptability ('Dynamic Capabilities') refers to so-called 'double-loop (or second-order) learning', i.e. changes in values, structures and processes in the organization, with the result of profound organizational changes as a precondition to OI (cf. Helfat et al., 2007). "(The) Key to understanding dynamic capabilities, therefore, is the organization's ability to alter its resource base in a repeatable and reliable fashion, as guided by the organization's strategic intent" (Hess and Rothaermel, 2008, p. 1 f). Dynamic adaptability can be operationalized by various indicators to assess if the organizational structure, the

organizational culture and the management/strategy system are able to establish a 'fit' between changing environmental conditions and internal contingency factors on the one hand (e.g., size, age of the organization) and organizational structures and processes on the other hand.

Inventive capability: In the context of exploration activities, the initial utilization of new knowledge in the form of idea generation and development activities for the creation of something new plays a central role. The creative ability which leads to inventions or in general to new potential problem solving (cf. Middendorf, 1981) can be referred to as 'inventive capability'. This inventive capability comprises examining and experimenting as well as the so-called 'mental transgressions' in connection with the approach to new knowledge. "Boundary transgression refers to mental moves that cross the boundaries of past practice and convention, tying together academic disciplines in unexpected ways, redefining not only means but often the problem itself, and challenging entrenched beliefs about the limits of the possible" (MIT 2004, p. 9). The inventive capability can be operationalized by indicators such as the 'number of beneficial ideas', 'number or functionality of prototypes', the 'feasibility of a concept' etc. The inventive capability may be enriched by using well known OI tools for creativity enhancement, idea orchestration etc.

Effectiveness: The term effectiveness follows the paradigm of goal orientation (cf. Scholz, 1992), i.e. organizations are 'effective' in the context of a predefined goal (e.g. satisfaction of stakeholders): "Organizational effectiveness is an external standard of how well an organization is meeting the demands of the various groups and organizations that are concerned with its activities" (Pfeffer and Salancik, 1978, p. 11). As a measure of success for the exploration of resources, effectiveness describes colloquially the ability "to do the right things", as opposed to the efficiency of resource exploitation ("doing things right"). The effectiveness of resource exploration can be operationalized by different indicators such as 'achieving objectives in resource acquisition', 'the quality of problem solving', 'motivation and stimulation of creativity, morality, entrepreneurial freedom, participation and influence' (cf. Scholz, 1992).

Now, after we have learned about relevant organizational competencies for the exploration phase of OI, i.e. Ability to identify and assimilate knowledge, Ability for Outside-in Collaboration, Dynamic adaptability, Inventive capability and Effectiveness, we will now turn to their counterparts in the exploitation phase of OI (see again fig. 5).

Organizational Competencies for the Exploitation of Resources.

Ability for transfer/valorization of knowledge: The subsequent steps following knowledge identification and assimilation are the integration of (existing) knowledge for the continuous improvement of business processes (cf. Lazzarotti/Manzin 2009, Mortara et.al. 2009, Schreyögg and Kliesch, 2002), and the ability to utilize knowledge in the market (cf. Boscherini et al., 2009). In the literature this part of the knowledge utilization is also described as 'realized absorptive capacity', "which includes knowledge transformation and exploitation, encompasses deriving new insights and consequences from the combination of existing and newly acquired knowledge, and incorporating transformed knowledge into operations" (Zahra and George, 2002, p. 190). The ability to transform and utilize knowledge in the enterprise can be operationalized, for example, by observing the extent to which existing knowledge (including knowledge, which reached the company via a knowledge acquisition process or exploration process) is actually incorporated in new products, services or its underlying technologies, or was used to improve existing products, services and technologies (e.g. the number of own patents as a basis for the company's product portfolio).

Ability for Inside-Out Collaboration: Inside-out collaboration is about a company utilizing its knowledge externally, that is not used for its own market-based purposes (cf. Kutvonen, 2009; Kutvonen and Torkkeli, 2008; Hafkesbrink and Schroll, 2010a; Escher 2005; Gassmann and Enkel, 2004; Lichtenthaler, 2007), and establishing communication and working relationships with corresponding market partners. This kind of 'downstream or outbound utilization' is usually production and marketing-oriented and addressed to as the 'exploitation of explicit knowledge' (cf. Hess and Rothaermel, 2008). The ability for inside-out collaboration can be operationalized by, for example, the number of licenses sold, or the number and quality of exploitation alliances with third parties.

Routinization capability: In evolutionary economics routines are outlined as "repetitive patterns of activity" (Nelson and Winter, 1982, p. 97). Routines are ascribed a complexity reducing effect and, as a result, a decline in transaction costs leading to more efficiency. The actors in an organization take pressure off themselves by using routines instead of having ongoing search and decision problems. Routines are so-called 'first-order' capabilities in organizations (cf. Collis, 1994) that represent the operational core of the organization (e.g. production processes, marketing, sales). For innovation processes routines are – in the right measure – not counterproductive per se, they just must not grow disproportionally otherwise they will handicap the search for the new, and decrease the ability to manage the unexpected (cf. Bessant et al., 2010, p. 4). Thus, Comacchio/Bonesso (2011) present empirical findings on the routinization of the absorptive capacity of organizations showing that also for exploratory phases of innovation as part of the identification and assimilation of new knowledge certain routinized action sequences are beneficial (e.g. formalized trend monitoring activities), in order to survey new discoveries with implications for the company and to keep records for others to understand. Routinization capability is often described as a dynamic first-order skill ('First-Order Dynamic Capability'; cf. Zollo and Winter, 2002) that aims to improve the core processes of the organization (incrementally). Routinization capabilities can thus be referred to as an organizational competence for incrementally changing operational routines (cf. Konlechner and Güttel, 2010). They prepare the way for organizational learning and improve efficiency and effectiveness by accumulating the general adaptability of the organization (cf. Marino, 2011). Routinization capability can be operationalized, for example, by the ability to apply methods of process and project management and by their impacts on organizational reflexivity (cf. Moldaschl, 2010).

Imitation/replication capability: Imitation and replication are important processes for the utilization, or renewed utilization, of knowledge in organizations. Imitation aims for the acquisition of external knowledge; replication on the other hand, aims for the re-use of the organization's own internal knowledge (cf. Konlechner and Güttel, 2010, p. 32). The starting assumption is that routines that are used successfully in certain organizational units and that are implemented in other organizational units with a similar or identical context are equally successful (cf. Kaluza and Blecker, 2005; Winter, 1995). "Replication is about leveraging knowledge and is successful when ‚broadly equivalent' outcomes are realized by 'similar means'" (Baden-Fuller and Winter, 2005, p. 8 quoted by Konlechner and Güttel, 2010, p. 32). Replication strategies became known especially through franchise models (the so-called McDonald's approach). Organizational imitation and replication capabilities can be operationalized with the help of indicators like "quality of knowledge codification" and "quality of knowledge transfer", i.e. by an assessment of how existing (external or internal) directly applicable knowledge will be usable codified and documented for third parties e.g. through the use of templates (cf. Nelson and Winter, 1982), and how this knowledge gets to the user.

Efficiency: the term efficiency describes the operational performance of an organi-

zation as a ratio of output and input (cf. Hafkesbrink, 1986, p. 45 f.) ("doing things right"). For the organizational dimensions of the ambidexterity model different sub-efficiencies can be determined, e.g. for specialization, the 'economies of scale' (specialization advantage); for coordination, the 'achieved performance in synchronization of a process based on the division of labor in relation to the transaction costs of coordination'; for formalization, the 'benefits compared to the cost of written rules'; for decentralization, the 'comparison of decisions (quantity and quality) and spent transaction costs', etc.

4.2 Organizational Antecedents for Ambidexterity in Open Innovation.

Now, as organizational competencies for resources exploration and exploitation have been described, we will now turn to their organizational antecedents. There is a large body of literature on these organizational antecedents often describing ambivalent results of the moderating effects on resources exploration and exploitation, comprised in fig. 6:

+/-	+/-	+	+/-	+/-	low	**Specialization**	high	-	+	+	+	+
+/-	+/-	+	+	+	self-determination	**Coordination**	institutiona-lized	+	+/-	+	+	+
+	-	-	-	-	low	**Formalization**	high	+	+/-	+	+	+
+	+	+/-	+	+/-	low	**Centralization**	high	+	+	+	+	+
+	+	+	+	+	open, reliable	**Organizational Culture**	closed	-	-	+	+	-
+	+	+	+	+	transforma-tional	**Leadership Style**	transactional	+/-	+/-	+	+/-	+/-
Ressources-Exploration					**Input: organizational ressources**			**Ressources-Exploitation**				
Identification and Assimilation of Knowledge	Outside-In Collaboration	Dynamic Adaptability	Invention Capability	Effectiveness	Balance of organizational framework conditions			Transformation/Implementation of Knowledge	Inside-Out Collaboration	Routinization Capability	Imitation/Replication Capability	Efficiency

Fig. 6. Moderating effects of organizational antecedents on resource exploration and exploitation

We do not go into any detail of this matrix because it is beyond the scope of this paper (for more detailed results see Hafkesbrink et al., 2013). As a kind of summary the following brief headwords may be sufficient:

The likelihood of exploration decreases with the organization's knowledge specialization, while it increases the returns to exploitation and thus induces a commitment to it (cf. Dimov and Martin de Holan, 2005).

Coordination instruments aimed at self-determination do not support all phases of exploration equally. To identify knowledge and to support management in

collaboration with third parties in (open) innovation processes, technocratic coordination instruments are well suited. On the other hand, institutionalized forms of co-ordination are more conducive for exploitation activities (cf. Zahra and George, 2002; Szulanski and Jensen, 2006, 2008; Konlechner and Güttel, 2010).

According to Jansen et al. (2006), formalization does not decrease a business unit's exploratory innovation, but positively influences exploitation. The reason that formalization negatively correlates with exploration may be that the search for other than already-known solutions may be inhibited (cf. Weick, 1979).

For the impacts of centralization on exploration, there is evidence that a high centralization negatively moderates the explorative performance of an organization unit, and vice versa organizations high in power distance will generate high exploitative innovation (cf. Tsai, 2002). Furthermore, bottom-up knowledge and horizontal inflows of a manager will be positively related to the extent to which this individual engages in exploration activities, while top-down knowledge inflows of a manager will be positively related to the extent to which he or she engages in exploitation activities (cf. Jansen et al., 2006; Bledow et al., 2009; Mom et al., 2007).

In general, a transparent and open organization culture supports processes of resource exploration, while closed corporate cultures are especially conducive to routinization and replication (cf. McCarthy and Gordon, 2011; Jaworski and Kohli, 1993; Atuahene-Gima 2003; McFadyen and Cannella, 2004; Subramaniam and Youndt, 2005).

The debate on leadership styles mostly centers around the dichotomy of transformational and transactional leadership. Thus transactional leadership behavior is supposed to have a negative relationship with exploratory innovation, but a positive relationship with exploitation processes. Transformational leadership will be highly related to exploratory innovation when the organization's environment is perceived as dynamic; conversely transformational leadership will be minimally related to exploratory innovation when the organization's environment is perceived as stable, and vice versa. Here transactional leadership is applied (cf. He and Wong, 2004; Simsek 2009; Panday and Sharma, 2009; Jansen et al., 2009; Sosik et al., 1997).

For the OI discussion, a transformation of these findings to concrete organizational design measures is necessary that enables opening up the organization and the mindset of the people within the organization. The following table comprises a selection of these organizational design measures and their instrumental origins (as a combination of distinctive organizational antecedents):

Table 1. Exemplary organizational design measures and their instrumental origins (organizational antecedents) to cope with the challenges of OI

	Organizational Antecedents						
Organizational Design Measures towards Open Innovation	**Spezialization**	**Coordination**	**Formalization**	**Centralization**	**Organisation Culture**	**Leadership Style**	**Source**
Cross-funktional Teams	X	X			X		Lovelace/Shapiro/Weingart
Fluide project structures as knowledge		X					Hobus/Busch 2011, S. 191
Diversity to enhance different					X	X	Bledow et.al. 2009, S. 14
Development of slack resources						X	Stein/Klein 2010, S. 59-79
induced disorders, to break-up routines						X	Brunner et.al. 2009
Garbage Cans			X				Cohen/March/Olsen 1972
Job Enrichment and Job Rotation	X		X		X		Adler/Goldoftas/Levine 1999
Decentralized Structures				X			Tushman/O'Reilly
Shared Visions					X	X	Bartlett/Ghoshal 1989
Learnoriented organization culture			X		X		Birkinshaw/Gibson 2004
Dual Structures	X	X					Ducan 1976; Simsek 2009
Semi-/Quasi-Strucktures to promote		X			X		Jelinek/Schoonhoven 1993
Coexistence of Authority and Democracy, Disciplin and Empowerment,		X			X		Lewis 2000
Bridging ties to cross structural holes creating the potential for innovation.	X	X					Tiwana 2008

Thus, looking again on fig. 4, we now shared our view on the organizational antecedents for ambidexterity, especially how they are moderating distinct exploration and exploitation competencies in the OI process. We learned that there are - no wonder – different impacts of organizational design measures on the ambidextrous performance in exploration and exploitation of resources.

Now we are going to enter more or less virgin soil as we ask the question: what is the significance of individual competencies in OI and how are individual competencies to be differentiated in the OI process with respect to resources exploration and resources exploitation?

4.3 Individual Competencies for Ambidexterity in OI

The link between individual competence development and resources exploration or exploitation is still widely neglected. In the Anglo-American literature some research contributions can be found on the subject of "individual ambidextrous competences" in the background of the discussion about "contextual ambidexterity" (cf. Gibson and Birkinshaw, 2004). These contributions follow the recognition that ambidexterity is at least based on decisions and behavioral arrangements of executives and employees: "Although ambidexterity is a characteristic of a business unit as a whole, it manifests itself in the specific actions of individuals throughout the organization" (ibid, p. 211).

In the debate on individual competencies two fundamentally different work situations have to be distinguished (cf. Erpenbeck and von Rosenstiel, 2003). (1) On the

exploration side, it is about divergent self-organized processes with creative, partially or totally open goal attainment situations that often require a deviation from known patterns of action (cf. Wang and Rafiq, 2009). Here skills are required that help to enhance variety and effectiveness ("doing the right things"). (2) On the exploitation side, it is about convergent requirement-driven processes, i.e. to meet external requirements in much more familiar, experience-based situations, where it makes sense to build skills that reduce variety and support efficiency orientation.

The core challenges in exploration and exploitation to cope with in OI are displayed in the figure 7. In that sense individual competencies to cope with ambidextrous challenges of resources exploration and exploitation need to develop both:

- combinative and focussing skills in the area of professional competencies
- complexity management and variety reduction skills in the area of methodic competencies
- cooperation and hierarchical skills in the area of social competencies
- self-reflective and authority skills in the area of personal competencies:

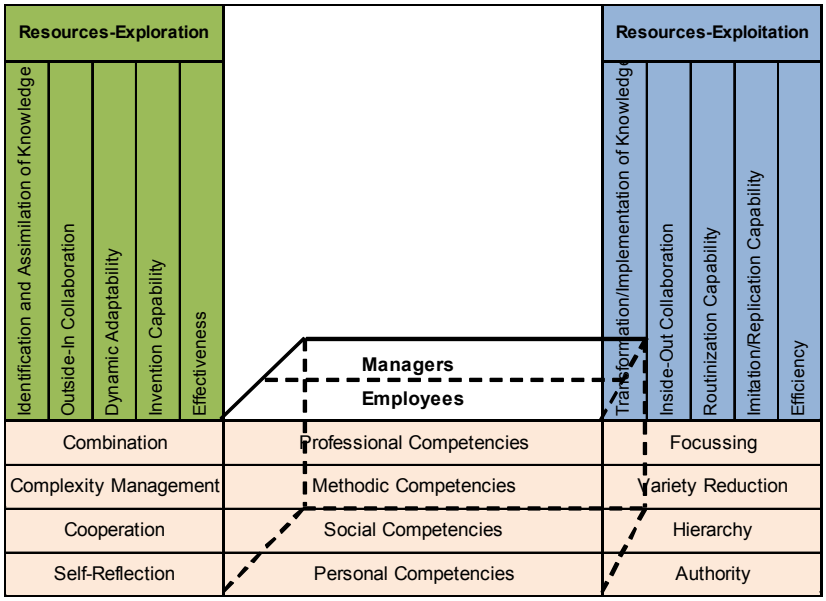

Fig. 7. Principal challenges of individual competencies to cope with in Exploration and Exploitation

In the following sections, we will differentiate these individual competencies by using the dimensions of ***professional, methodical, social and personal competencies*** (cf. Hafkesbrink and Schroll 2010a) in order to establish a heuristically more enriched system of hypotheses and to gain new insights into the relationship between individual competencies and exploration/exploitation in OI.

Relevance of Professional Competencies in Exploration and Exploitation.

Professional competencies are those skills that help to cope with typical occupational tasks and requirements based on a self-organized process, i.e. to

creatively solve problems with specialist knowledge and to be able to classify and meaningfully evaluate knowledge that is relevant for task fulfillment. Professional competencies, and their appropriation, are subject to increasing pressure for change, due to dynamic developments of technology, and the general shift from a manufacturing towards a services and knowledge society.

Professional competencies are key features in the innovation process, thus also in OI. In resources exploration, it is important to identify and translate new specialist knowledge for the organization innovation process. There the focus is primarily on the access to new knowledge, either in the form of trend reports and market studies (explicit knowledge) or in the form of so-called 'tacit knowledge' (cf. Hess/Rothaermel 2008), bound to e.g. university research personnel. On the other hand in resources exploitation it is about incrementally enriching existing knowledge with experience along a chosen technology path, with the aim to optimize the expertise based on the existing (business) processes.

On this background it seems reasonable that broad expertise is beneficial to the exploration process, as diverse knowledge for different domains and tasks is available (cf. Schudy, 2010, p. 13). In contrast, specialized knowledge is more conducive for exploitation processes because specialists dispose of a very deep knowledge in their own field and can use it effectively to apply knowledge in more or less known situations (ibid).

Professional competencies for knowledge exploration: New knowledge must be interlinked with existing knowledge. Nonaka and Takeushi (1995) refer to this as "combination". This combination works well, if the new knowledge is close to the already available knowledge. Diversified background knowledge is important because this improves the chance to relate new information to already existing knowledge. At the individual level competencies of how to combine new with existing knowledge are discussed, and are defined as methodical skills, e.g. 'gate-keeping' or 'boundary-spanning' (cf. Ansett 2004), which is especially relevant for OI. The tasks are knowledge identification (carrier, sources etc.), the translation of knowledge into a language that is understood in the organization, and the transformation and dissemination of knowledge in the organization for the purpose of exploitation etc. (cf. Cohen and Levinthal, 1990; Van den Bosch et al., 1999; Kogut and Zander, 1992; Eisenhardt and Martin, 2000; Klose, 2008; Meeus et al., 2011).

Professional competencies for knowledge exploitation: A high degree of knowledge specialization may hinder intra-organizational transformation and the diffusion of newly acquired knowledge to improve existing processes, because it causes myopia and inertia as well as a 'Not-Invented-Here' syndrome (lock-in).

Professional competencies for Outside-In/Inside-Out collaboration: Specialized expertise can effectively support processes of outside-in and inside-out collaboration particularly when it comes to cooperation with external market partners of the same professional domain. In cooperation with complementary market partners, too much specialization may hinder cooperation due to communication problems.

Professional competencies for the management of change and routinization processes: highly specialized expertise may prevent dynamic adjustment processes because cognitive lock-in processes may appear with the effect of learning inertia, learning trajectories, and the risk of core rigidities (cf. Holtmann, 2008; Leonard-Barton, 1992). Specialized expertise, on the other hand, promotes the routinization of processes and contributes generally to productivity and quality improvement.

Professional competencies for Invention/Implementation: Broad-based expertise and trans-disciplinary thinking can promote radical innovation better than specialization and mono-disciplinary thinking. Specialized expertise, on the other

hand, facilitates imitation, replication and the implementation of existing solutions.

Professional competencies for Effectiveness and Efficiency orientation: Professional T-shaped skills, i.e. the combination of specialized and general knowledge (cf. Karjalainen and Salimäki, 2008), improve the effectiveness of knowledge identification and assimilation, as the possibility of combining new and existing knowledge increases. Specialization in knowledge acquisition should also increase efficiency in knowledge acquisition (cf. Hsu, 2009).

Relevance of Methodical Competencies in Exploration and Exploitation.

Methodical competencies are defined as skills to identify, procure, process, store and use professional knowledge. They serve as a bridge in the innovation process: on the exploration side, methodical skills have to bridge the process of knowledge identification and knowledge acquisition in relation to external partners. In the transition from exploration to exploitation methodical skills have to support the assimilation and transformation of knowledge within the organization, i.e. the translation of existing external knowledge to internally understandable knowledge (cf. ter Wal and Salter, 2011; Lane and Lubatkin, 1998).

Methodical competencies for knowledge exploration are those which are awarded to gatekeeper and boundary spanners, i.e. to those innovation actors that dominate the identification, assimilation and the transfer of new knowledge into the organization (cf. Hess and Rothaermel, 2008; Rost et al., 2006). Such technological gatekeepers often act as professional promoters, i.e. they promote interorganizational exchange of object-specific expertise and make use of expertise as arguments against opponents. Thus methodical skills for knowledge exploration should enable attention to be focused on trends that increase inspiration in the innovation process, e.g. with methods such as "cross-innovation" capabilities (cf. Steinle et al., 2009), trend monitoring (cf. Hafkesbrink et al., 2010), and networking with diverse communities of knowledge (cf. Evers and Hafkesbrink, 2010).

Methodical competencies also have to enable internal assimilation of new knowledge, e.g. by applying methods of 'idea banking', the evaluation of feedback from after-sales services, through idea visualization techniques, by methods of diachronic and synchronic communication, the facilitation of 'Team Enabling Spaces', etc. (cf. Commacchio and Bonesso, 2011). Thus methodical skills such as abstraction (e.g. abstracting from individual case studies), analysis and planning (e.g. to be able to interpret trends), decision-making and judgment (e.g. to evaluate the significance of a trend for the company), the mastery of research techniques (e.g. to produce variety), strategic thinking and acting (for the evaluation of action sequences) and well-structured thinking (about the systematization of knowledge acquisition) are at the center of knowledge exploration.

Methodical competencies for knowledge exploitation must support the usage of knowledge with respect to customers and external exploitation partners. They must be able to bring the knowledge internally to the right place, to apply knowledge in products, services, or processes in the organization itself and to ensure secure protection against loss of knowledge. Hence, it is about the methodical support of horizontal or vertical intra-organizational knowledge flows (cf. Xiong, 2011), for both tacit and explicit knowledge. In intra-organizational knowledge transformation the following play an important role: diplomatic skills (e.g. switching between R & D and production and sales); capabilities to integrate opinions and media/presentation skills (to 'sell' new ideas within the organization); facilitation skills (e.g. to lead cross-functional groups) and problem solving, project management and reorganization skills play an important role.

Methodical competencies for Outside-In/Inside-Out Management must be able to support cooperation with technology and market partners upstream (i.e. towards

suppliers of knowledge, technologies, etc.) and downstream (i.e. towards exploitation partners). Upstream cooperation is often about collaboration with universities, research institutes or other technology suppliers, where it is mostly about the handling of implicit knowledge (cf. Hess and Rothaermel, 2008, p. 5). In OI, the management of 'inbound processes' for the absorption of available community knowledge is also relevant (cf. Hafkesbrink and Schroll, 2010), as is technology-sourcing (cf. Van de Vrande et.al., 2009), crowdsourcing and lead-user involvement (cf. Baldwin et al., 2006). In contrast, downstream cooperation is primarily concerned with the exploitation of the organizations own explicit knowledge, which is passed on to external partners via licensing or other exploitation rights (cf. Teece, 1992). Methodical skills for the Inside-Out management have to support the following tasks in the so called 'Outbound Process' (cf. Savitskaya and Torkkeli, 2009; Lichtenthaler, 2008): planning of exploitation opportunities; identification of the technology environment of the company and of exploitation partners; negotiation of collective partnerships and cooperation agreements; implementation of technology transfer (patent licensing, copyright transfer, joint ventures, etc.); and controlling the contract situation.

These tasks can be supported by specific methodical skills that - apart from professional expertise to evaluate technologies – may enable the inbound and outbound process effectively, e.g. analysis and planning skills (preparation of Make-/Buy- or Keep/Sell- decisions), diplomatic skills (in negotiations with external partners in the market place), ability to judge and decide (e.g. in Make-/Buy- or Keep/Sell-decisions), networking skills (for the establishment and maintenance of a network of partners in technology purchase or technology marketing), project management skills (for the implementation of Inbound-/Outbound projects), research techniques (for obtaining market information), strategic thinking and acting (for the impact evaluation of Inbound-/Outbound projects).

Methodical competencies for change management should enable a change agent to prepare and perform dynamic adjustments of the organizational structure, organizational culture and management strategy. The objective of change management is the creation, expansion or modification of the organizations resource base (cf. Hess and Rothaermel, 2008, p. 1). According to Lewin (1948), change processes occur in three stages: Unfreezing - Changing/Moving – Re-Freezing/Keep Moving. These phases are influenced by two organizational context factors, namely 'drivers' (impelling forces) and 'restraining forces' (preventing forces). During 'Unfreezing', existing organizational structures or cultures have to be thawed, employees have to be convinced of the necessity of change, etc. Here it is important to strengthen the drivers for change - e.g. through the implementation of specific incentive schemes and forms of participation – in order to overcome barriers. During 'Changing/Moving' processes and structures have to be reorganized and re-institutionalized on a level higher ('Refreezing'). To this end, different methodical skills are important especially to handle increased variety in change processes such as abstraction and judgment capabilities (for the promotion of rational insight), change management competencies (for the change agent), ability to integrate opinions (to promote decision-making in team structures), moderation-/mediation competencies throughout the change process (for conflict resolution).

'Refreezing' means at the same time the institutionalization of new rules and the setting up of routines, for the developed, maintained altered state organization, at least temporarily (until a new cause for organizational change) is stabilized. For, 'Refreezing', the following methods can be effective skills to routinization, allowing the stabilization of the new state (or the new regime), e.g. abstraction and modeling capabilities (to control rule development and for the design of routines), analysis and planning skills (fitting of the routines in the organizational processes and structures),

change management competencies (for the change agent), problem solving and well-structured thinking (in terms of the institutionalization of new processes and structures), project management skills (to control organizational development projects). Methodical competencies for routinization must therefore be aimed at the promotion of experiential learning in the new regime, on binding the knowledge in form of routines in the organization and in business processes, and in assisting production focus and goal achievement (efficiency targets) (Bledow et al., 2009, p. 9). Thus they should be directed towards decreasing variety.

Methodical competencies for Inventions/Implementation: Invention is at the core of exploration processes. It requires creative skills that lead to inventions or generally to new problem-solving potential (cf. Middendorf, 1981). It belongs to the so-called "fuzzy front-end activities" in the innovation process, where initial individual or group-based learning processes take place (cf. Val-Jauregi, 2006; Stevens and Soparnot, 2007). Methodically it is about supporting the processes of discovery, idea generation, idea evaluation and concept definition, which may, in the end, lead to an invention (cf. Cooper and Kleinschmidt, 1995). In times of increasingly OI, also issues of co-ideation and co-creation (cf. Hafkesbrink and Schroll 2010a) are also discussed, i.e. the concerted creation of new ideas and problem solving potentials together with external innovation partners. Methodical skills for fuzzy front end activities must support the management of a non-sequential process because invention processes are often interactive, iterative and dynamic. The methodical tools to aid the process of idea generation (thus increasing variety) include e.g. 'Six Thinking Hats' (cf. de Bono, 1990) or development tools such as 'House of Quality' (cf. Akao and Mazur, 2003).

Besides methodical skills such as: abstraction skills (e.g. progressive abstraction as a creativity technique; Schlicksupp, 1999), analysis and planning skills (for structuring invention processes), ability to judge and decide (for support during evaluation processes), R&D project management skills (for project management), process management skills (e.g. business process re-engineering), particular social-communicative skills are relevant because of the strong interaction processes as well as the specific personal skills required. The latter three methods are also the core competencies in supporting intra-organizational implementation e.g. of NPD-processes (NPD = New Product Development) that are based on the ideas and concepts in the exploration phase. Here, of course, in an industrial context the boundaries between professional and methodical competencies are fluent, since for many professional NPD processes manifold professional and methodical skills are needed (cf. Steiner, 2006).

Methodical competencies for effectiveness/efficiency orientation: An appropriate, i.e. problem-oriented use of methodical skills can eventually improve both the effectiveness of exploration as well as the efficiency of exploitation. More 'organic' methodical competencies (e.g. abstraction skills) play a greater role in exploration, whilst more 'mechanistic' methodical skills (e.g. process management competence) play a greater role in exploitation phases. Overall, we can say that methodical competencies for variety enhancement (e.g. abstraction skills, mastery of different learning techniques, multitasking, mastery of research techniques) fundamentally support processes of exploration, as they are likely to generate new expertise to the organization, as well as enabling the transition to a new technology path or business model. By contrast, methodical competencies to support experiential learning (e.g., coaching, ability to integrate opinions, modeling skills, structured thinking) rather support processes of exploitation (in the sense of decreasing variety), as incremental improvements of existing processes, products, etc. on the existing technology path or business model are reached.

Relevance of Social Competencies in Exploration and Exploitation.

Social competencies play a supporting role in all stages of the OI exploration and exploitation process, as all related transactions require social-communicative interactions. But social skills on their own do not enable either the generation of new information and solutions (cf. Kauffeld et al., 2002) or the exploitation of existing knowledge. Instead, they only support the exchange of information, serve as the mechanism to understand communication partners and should help to establish necessary social relations that underlie the exploration and exploitation process.

Social competencies for knowledge exploration: Socio-communicative processes are an integral part of knowledge acquisition, i.e. the identification of carriers and sources of knowledge, and knowledge assimilation, the implementation of routines for analyzing, processing, interpretation and understanding of information (cf. Flor et al., 2011). In the phase of identification of sources of knowledge, important roles are played by: communication skills and sociability; social networking skills to establish and maintain channels of communication into knowledge communities (cf. Hafkesbrink and Evers, 2010); trustworthiness (observance of values and principles, i.e. integrity in dealing with other people) to prepare exchange processes and negotiation situations with knowledge holders; and appreciation for the work of others. Knowledge assimilation often also occurs frequently in teams within the company. Here specific social skills (such as communication skills, presentation skills, and the ability to reach consensus) are beneficial for work groups and their specific modes of knowledge acquisition, since they facilitate the interaction and interdependence of each member significantly (cf. Jurkowski and Hänze, 2010, pp. 234-237). Finally, the handling of information uncertainty or ambiguous information (ambiguity tolerance) plays an important role in judgments as to whether such information (e.g., a trend) is important for the company or not.

Social competencies for knowledge exploitation: social and communicative skills are also a key enabling factor for the transformation and utilization of newly acquired knowledge. Within the process of knowledge transformation, a common barrier is the different language of R&D-, production- and marketing employees. Ideas, new problem solving capabilities, and new technologies are often not mediated in an intra-organizational way, as no 'common code' exists. The ability to build social relationship structures helps to transform knowledge (cf. Jansen et al., 2006). In the process of knowledge transformation employees must explicate their (tacit) knowledge. This is a process that often involves face-to-face communication, and thus is the core of social interaction ('socialization'). Therefore, the willingness and ability to transfer knowledge is required (cf. Nonaka and Takeushi, 1995). In the process of knowledge transformation and recovery, actors 'sell' their ideas often internally, partly against the resistance of risk-averse managers (cf. ter Wal and Salter, 2011) which, in addition to communicative abilities, also requires a certain degree of persuasion and enthusiasm or assertiveness.

Social competencies for outside-in and inside-out collaboration: Inbound and outbound processes not only include preparatory (e.g. planning of procurement or exploitation options) and subsequent assessment (e.g. controlling of contracts), but also various interactive stages, in which it involves the identification of and communication of technology partners or suppliers. In this domain, different media, stakeholders and communication channels such as journals, patents, websites, exhibitions, technology brokers, networks, etc. play an important role (cf. Kutvonen and Torkkeli, 2008).

In many of the related transaction processes, both explicit and implicit knowledge play an important role. Thus, in addition to essential methodical skills, social and communicative skills become relevant in outbound and inbound processes, as tacit knowledge usually is transmitted only by face-to-face communication. These include

discourse-/mediation-/negotiation abilities (e.g. for negotiation with external with external partners), ability to manage conflicts, to take criticism, to reach consensus (e.g. for the proper management of knowledge inflows and outflows in cooperative networks), ability to bring about a balance of interests (e.g. to balance exploration and exploitation networks), assertiveness (e.g. in negotiation phases), social networking skills (e.g. to support networking tasks), persuasive and inspirational abilities (e.g. in negotiation phases), trustworthiness and appreciation (e.g. to stabilize cooperative networks).

Social competencies in change management and routinization processes: Looking at change management, social skills are needed to implement a participatory approach in change processes. Here a variety of interaction and communication processes is needed to remove barriers for employees, not only to prevent them from being concerned, but also to involve them as stakeholders, so that they can jointly develop solutions for organizational and personal adjustment problems. This includes the following competencies: discourse-/mediation-/negotiation abilities (the core individual competence in organizational development processes), ability to manage conflicts, to take criticism, to reach consensus (e.g. to conduct and lead workgroups), ability to bring about a balance of interests (e.g. to conciliate interests of leadership and employees), assertiveness (e.g. to stabilize and substantiate decisions), empathy (e.g. to understand behavioral patterns of employees), ability to develop a common sense of responsibility (the core of leadership capabilities), ability to strengthen cohesion in a team (integration) (one of the core competences in OD-projects), ability to motivate (for organizational change), trustworthiness and appreciation (the basis for successful OD-projects).

Social competencies for invention and implementation: In highly exploratory processes, such as in NPD, an innovation-friendly communication culture has to be created that stimulates interaction and communication processes between the parties from the perspective of the organization. This is essential as a framework. Such dialogue cultures are often undirected, are based on ad-hoc interactions and use multiple channels and media. To support these processes, the following social competencies are relevant (in addition to the already described methodical skills): ambiguity tolerance (for dealing with ambiguous information in a team), willingness and ability to transfer knowledge (in processes of knowledge absorption), ability to manage conflicts, to take criticism, to reach consensus, ability to balance different interests (e.g. to resolve conflicts in a product development team), communication skills (to promote a culture of dialogue), cooperation and team integration skills (e.g. integration into a development team), ability to motivate (Ability to motivate team members and enthusiastic about your ideas), appreciation (for the work of team members).

As part of the implementation processes, social and communicative skills must support experiential learning experiences for the deepening of professional knowledge. The aim is, to continuously improve routine exploitation processes (e.g. production, service delivery, quality assurance, distribution, etc.) by improving team performance. For that the following social skills are required: assertiveness (an opinion in the team can enforce and ensuring social acceptance), ability to create a common sense of responsibility (important for a group result in routine processes), ability to promote integration and cohesion in a team (the core competence for team management), collegiality (to promote team cohesion), communication skills (especially in general communication), cooperation and team integration skills (ability to integrate into a team), loyalty (to promote team cohesion)

Social competencies to promote effectiveness and efficiency orientation: while in the domain of methodical skills a classification based on organic and mechanistic species is still possible, it is difficult to advance such a classification for social skills.

Many of the aforementioned social skills are likely to focus on effectiveness ("doing the right things"), and may be even beneficial to improve efficiency ("doing things right"). Social skills, in particular those to support exploratory activities (i.e. skills that are more variety enhancing), are supposed to promote effectiveness by directing social interactions towards discovery contexts, flexibility, re-orientation, learning, creativity, etc. Social skills that particularly support exploitative activities (i.e. skills that are more inclusive and narrowing) are likely to affect efficiency because they are more directed towards discipline, cohesion, security, routines, etc. and thus may be characterized as narrowing variety.

Relevance of personal competencies in exploration and exploitation.

Personal competencies reflect the personality of active players. This competence dimension is the basis for the acquisition of social-communicative, methodological and technical/professional skills. Here an unambiguous assignment of dedicated personal skills to the phases of exploration and exploitation is difficult. Therefore the following comments are rather cursory. The tendency is that: for exploration activities such personal skills are asked for that put the actor into a learning mode to capture new knowledge. For exploitation activities, such personal skills are conducive to support the application of knowledge in the context of a known issue.

Studies on the competence of innovation staff in **knowledge exploration and invention** (cf. Kaltenegger, 2008) highlight the following personal skills:

- Creativity, initiative, commitment, curiosity, flexibility, frustration tolerance, value orientation, spontaneity, and discipline in the implementation (ibid, p. 109),
- Self-reflection, openness to experience (e.g. active imagination, independent thinking, curiosity) (cf. Barrick and Mount, 1991; Costa and McCrae, 1992),
- Aesthetic appreciation, varied interests, appeal through complexity, high energy, independent judgment, autonomy, intuition, self-confidence, conflict resolution, etc. (cf. Barron and Harrington, 1981; Comacchio and Bonesso, 2011, p. 5).

During phases of **knowledge exploitation and implementation**, the share of creativity, personality, and variety enhancing personal competencies may be lower, since such personal competences are in demand that focus on routines, such as *authority, assertiveness/persistence/persistence, patience, strength of character (advocacy of beliefs), ambition, accuracy, punctuality, diligence, execution, and reliability*.

In **inbound and outbound processes,** besides *comprehension* and *creativity* (as for the evaluation of technology potentials), – personal competencies – such as *authority, assertive/confident demeanor, entrepreneurial thinking and action* – are required to support negotiation situations.

In **change management processes** personal skills are required such as *stress resistance* (to cope for the initial shock of change), *frustration tolerance* (for dealing with spontaneous rejection), *comprehension to promote rational insight* (to internalize and integrate the new knowledge (knowledge), *openness and emotional stability* (for acceptance of change), and willingness for training (to adapt to changing situations). When routinization and institutionalization of the changes are carried out, other personal competencies to narrow variety play an important role, e.g. *authority, assertiveness/persistence/persistence, patience, strength of character (advocacy of beliefs), ambition, accuracy, punctuality, diligence, execution*.

Finally, **effectiveness** should turn out more likely as a result of variety enhancing and efficiency – again with variety reducing personal skills.

Résumé on Individual Competencies for Exploration and Exploitation

We can now summarize the previously described empirical findings and hypotheses. For individual competencies that support **exploration activities**, attributes are needed that are directed at:

- combining and expanding knowledge (professional skills),
- coping with complexity in the context of variety enhancement (methodical skills),
- cooperation in the framework of interaction relationships (social skills)
- self-reflection in a personal action routines (personal skills).

For individual competencies that shall support **exploitation activities**, attributes should focus on

- knowledge concentration (professional skills),
- simplification and variety narrowing (methodical skills),
- hierarchy for control of work processes (social skills) and
- authority in the implementation of personal action (personal skills).

Innovation actors must deal regularly with the inherent tensions between these properties, especially in OI processes. The question is, if ambidextrous skills are available that resolve these tensions, or at least pair together those complementary skills which are able to reduce the tensions and make them manageable.

We can now introduce the following arguments for individual exploration and exploitation, as well as for individual ambidextrous competencies:

Individual Exploration Competencies

- In exploration phases it is indispensable to add new professional knowledge to existing knowledge. The more professional knowledge exists within the firm, the more opportunities for combining old and new knowledge are available (cf. Ericsson, 2007). In combining knowledge domains new competencies emerge that represent converging technology domains etc. (cf. Hafkesbrink and Schroll, 2010). Consequently, if a technology path will be changed, existing knowledge may become obsolete, and it has to be unlearned (cf. Cegarra-Navarro et al., 2011; Mäkitalo-Keinonen and Arenius, 2010; Cepeda-Carrión et al., 2009), as otherwise it may lead to a cognitive lock-in in the innovation process. "Unlearning can be understood as a context where employees can change their habits and routines and forget old knowledge, and substitute new habits and knowledge, as part of a major process or which might be described as learning" (Cepeda-Carrión et al., 2009, p. 3).
- The process of professional knowledge generation in exploration phases is supported by methodical, social and personal competences (interdisciplinary competencies) enabling the process of learning. Hence preconditions must be fulfilled so that knowledge can be identified and assimilated (e.g. by applying specific learning methods) and that implicit knowledge is shared. Thus personal competencies are essential for initiating knowledge sharing and accumulation.

Individual Exploitation Competencies

- In the case of exploitation, existing knowledge is improved incrementally, especially by experience accumulation, i.e. the application of existing knowledge within a specific work context, in the framework, for example, of a production process.

- Experience based learning takes place alongside established technology paths, i.e. on the basis of an existing production process or product.
- Methodical, social and personal competencies (interdisciplinary competencies) support improvements in experience based learning on the existing technology paths. Methodical competencies enable experience based learning with the aim of incrementally improving existing processes. Specific social competencies are needed to strengthen discipline in a team. Personal competencies, such as authority, lead to a sustainable efficiency orientation.

Individual interdisciplinary ambidextrous competencies

The question now arises, as to whether there are individual interdisciplinary competences that equally support exploration and exploitation? These may be defined as 'ambidextrous' competences. The literature review so far encourages the idea of such ambidextrous skills.

However, our thoughts on such ambidextrous individual competences go a step further, since it may be necessary to be equipped with individual ambidextrous meta-skills especially to manage the tensions or convergence processes that exist between exploration and exploitation such as:

- Ambidextrous methodical competencies need to support the emergence of professional knowledge for exploration and exploitation processes at the same time, e.g. knowledge brokerage, topsy-turvy-thinking, multi-tasking, dialectic thinking, etc.
- Ambidextrous social competencies should at the same time enable and support social integration and discipline (cf. Gibson and Birkinshaw, 2004), e.g. diplomatic and rhetorical capabilities, tolerance to ambiguity, mediation capabilities, etc.
- Ambidextrous personal competencies need to provide the ground for the development of social and methodic competences, e.g. capability to combine alternative logics, emotional ambivalence, capability to think outside the box, etc.

In addition there may exist professional ambidextrous competences – which we call **Professional Hybrid Competencies** – because they do not serve exploration and exploitation equally, but emerge as a result of technology convergence, etc. In a dynamic and converging technology environment, professional skills from multiple sources and disciplines must to be combined in one individual or must be divided amongst a team considering a specific work or task division. This depends on the lifecycle of knowledge to be integrated, on the availability of specialists in that area, on the size of the firm, and on the phase of the innovation process (cf. Hafkesbrink et al., 2013).

On this basis Professional Hybrid Competencies emerge which may be displayed as 'T-shaped Skills' (cf. Karjalainen and Salimäki, 2008; Oskam, 2009) providing the ground for establishing core competencies within the innovation process. Such T-Shaped Skills are dependent on the convergence of technologies (e.g. mechatronic engineer, video-journalist, bio-informatician etc.).

Table 2 defines selected individual ambidextrous interdisciplinary competencies and provides references from the literature.

Table 2. Examples of individual interdisciplinary ambidextrous competencies (own compilation)

Competence-Item	Commentary	Source

Dialectic thinking/trade-off- or synthesis thinking	"There is more than one truth“	Forster et al. (2003); Bledow et.al. (2009)
Emotional ambivalence	Simultaneous presence of negative and positive emotions	Fong (2006)
Knowledge brokerage	Integration and meshing up of knowledge from separate sources	Hobus and Busch (2011)
Topsy-turvy-thinking	Turn everything upside down	Gibson and Birkinshaw (2004)
Paradoxical cognition	Openness against strategic contradictions	Smith and Tushman (2005)
Strategic entrepreneurial thinking and action	Management-Competencies between emergence and planning	Lewis et al. (2002)
Capability to lead discourses, diplomatic capability	Moderation of conflicts in cross-functional teams	Lovelace et al. (2001)
Hybridization of alternative logics	Connecting multiple institutional responses as a reaction to change	Perkmann et al. (2011)
Lateral thinking	Substantial part of ambidextrous thinking (left mode of brain = rational thinking, right mode = creative thinking)	De Bono (1990); Faste (1994)
Ambiguity tolerance	Requisite variety, capability of perspective-taking and interpretive skills are factors leading to generate useful ambiguity, while analytic skills are required to reduce ambiguity	Brun (2011); Jansen et al. (2009)
Multitasking	Fulfilling multiple roles within a certain time frame	Mom et al. (2009)
Integration of opinions	Learning and achieving convergence through conversation among members	Berson et.al. (2006); Lubatkin et.al. (2006)
Rhetoric Capabilities	Applying e.g. Mission Statements to give orientation to employees for a common philosophy	McCarthy and Gordon (2011); O’Reilly and Tushmann (2004)

Based on our analysis, table 3 displays the relevant methodical, social and personal competencies along the dichotomic axes of exploration and exploitation:

- To accomplish the day-to-day work and innovation tasks certain constitutive interdisciplinary competencies must exist, such as patience, stress-resistance, self-confidence, emotional stability, etc. These competencies provide the basic enabling levers for acquiring social and methodical competences for exploration and exploitation (Quadrant I).
- Interdisciplinary exploitation competencies (1st order competencies) serve as a lever to reduce variances with the aim of best possible exploiting existing

professional knowledge. These are e.g. process management skills, time management skills, adaptive learning skills, timeliness, diligence etc. They provide the ground for incremental improvements of existing processes and for routinizing business models (Quadrant II). Interdisciplinary exploration competencies (1st order competencies) serve as a lever to enhance variances with the aim of exploring new potentials and professional competences. These are e.g. creativity, openness, generative learning, transformational leadership, reorganization capabilities, etc. They serve as a basis for (radical) innovation processes (Quadrant III).

- Ambidextrous interdisciplinary competences (2nd order (meta-) competences) serve as a lever to solve role conflicts in balancing exploration and exploitation processes. These are e.g. dialectic (relativistic) thinking/trade-off- or synthesis thinking, emotional ambivalence, knowledge brokerage, topsy-turvy-thinking, paradoxical cognition etc. (Quadrant IV).

We assume for all individual interdisciplinary competencies that the development requirements of these competencies do not alter significantly as the size of the organization changes, but we consider – as a result of SME scarce resources – that SME managers and employees have to play more complex hybrid or ambidextrous roles in day-to-day business and in innovation as compared to large companies (cf. Hafkesbrink et al., 2013).

Table 3. Individual interdisciplinary and ambidextrous competencies (own compilation)

Exploitation (increasing variety)	Exploitation (diminishing variety)
Quadrant III: interdisciplinary exploration competencies	**Quadrant IV: ambidextrous interdisciplinary competences**
transformational leadership; willingness for further training; entrepreneurship	integration of opinions (balance of interests); ability for hybridization of alternative logics; diplomatic skills
mastery of research techniques; creativity; openness; ability to inspire and convince others	ambiguity tolerance; multitasking ability; dialectic thinking
reorganization capabilities; generative learning; ability to create a mutual sense of responsibility	rhetorical skills; lateral thinking; emotional ambivalence
empathy; coaching skills; appreciation	mediation skills; knowledge brokerage
assertiveness; long-term thinking; error tolerance	
frustration tolerance; motivation; social networking capabilities; tustworthiness; structured thinking	topsy-turvy-thinking; paradoxial cognition
divergent thinking; capacity for cooperation/ teamwork; communikation	
ambition; project management	
perceptivity; analytical and planning skills; willingness and ability to transfer knowledge	implementation know-how, reliability
self-organization; media-/ presentation skills; moderation skills	time management skills; convergent thinking
strength of character; abstraction ability; loyalty	process management skills; modeling capabilities
persistance	authority
emotional stability; problem-solving ability; ability to simplify	near-time thinking
patience; stress-resistance; self-confidence; adaptive learning skills	accuracy, diligence, timeliness; transactional leadership
Quadrant I: constitutive interdisciplinary competences	**Quadrant II: interdisciplinary exploitation competencies**

4. Summary and Outlook

In this paper we developed a new link between the well known OI- and a new Ambidexterity model that provides a heuristically rich access to the challenge of deriving competencies dimensions, categories and indicators to describe the complex skills needed for the entire OI process.

In our conceptual framework we presented 5 dimensions of organizational competencies, recurring on the ambidexterity view of exploration and exploitation activities in the OI process:

Dimension	Exploration	Exploitation
Knowledge management/ -absorption	Identification/ assimilation of knowledge	Transfer/ valorization of knowledge
Collaboration with external partners	Outside-In collaboration capability	Inside-Out collaboration capability
Stability/ organizational learning	Dynamic adaptability	Routinization
Innovation process	Inventive capability	Imitation/ replication capability
Performance	Effectiveness	Efficiency

Fig. 8. Organizational Competencies for OI derived from the Ambidexterity Model

Thus, on the organizational level, core organizational competencies should be available to balance the different tensions between exploration and exploitation of resources. We learned that specific explorative competences are needed in OI processes as opposed to normal (incremental and/or closed) innovation processes. From an intensive literature review we learned that the modes of resources exploration and exploitation, as the basic phases of any innovation process, are moderated by a specific shape of organizational antecedents (i.e. specialization, coordination, etc.) that play an important role in moderating the performance of organizational competences. We presented an OI Audit that refers to these organizational competencies and antecedents by operationalizing more in detail the particular items displayed in fig. 8.

In addition, as being a central element of the ambidexterity model, we learned about the moderating effects of individual competences on resources exploration and exploitation in the innovation process. We presented a conceptual framework to define relevant professional, methodic, social and personal competencies for OI processes following the analytical distinction between exploratory and exploitative tasks for individual innovation actors.

From the description of these individual competencies we learned that there are rather exploratory individual competencies that better fit with the challenges of exploration and rather exploitative individual competencies that better fit with the challenges of exploitation.

The material and the analytic framework presented in this paper may serve as a template for:

- comprehensive empirical studies on industry needs for competencies

development for OI by HEIs. For this purpose, it needs to be streamlined into a manageable format that does not overstress industry in a questionnaire survey;

- conducting more in-depth case studies on OI processes, as it delivers a rich heuristic basis for interviews in the firms, joint research partner organizations etc.

For both empirical tasks a specific research agenda has to be set up that also covers the second order loops between organizational antecedents, their moderating effects on individual competencies development and cumulating effects of individual and team learning bottom-up to organizational learning and to organizational competences.

Also for both empirical tasks, a differentiation between inter-organizational and intra-organizational characteristics of organizational antecedents should be considered.

Finally we pointed out that – especially for SMEs in case a task division is not appropriate due to the number of employees – there are complex challenges of contextual ambidexterity in a sense that one individual actor has to perform different roles in the innovation process that may cause conflicting demands etc. (see again table 3).

Since this is definitely virgin soil, we hope that further research will gain new insights in these relationships as they are of interest for both industry and HEIs in the area of OI and Ambidexterity.

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