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Integrating professional and academic knowledge: the link between researchers skills and innovation culture

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Abstract Approaches to innovation have been thoroughly studied in the last decades. It's well understood that an organizations' culture is among the crucial factors for success and renewal of organizations. Yet culture is made by people and their attitudes. Innovation culture requires skills and competence by employees which are presumably beyond the traditional basic knowledge taught at undergraduate, graduate and post graduate level. This is even more evident for university graduates who're mainly finding professional careers in the private sector who has special requirements to employees. Graduates' skills are strongly influenced by curricula and the cultural values and norms outside curricula transferred by universities to students. But frequently these skills are designed by universities without profound knowledge of the actual skills required. At the same time organizations acting as potential graduates employers value researcher skills and competencies differently from how these are perceived. The paper suggests that understanding the professional and universal skills of researchers perceived and needed is one element of innovation culture. Thereby the skills in discussion go beyond purely academic skills only; instead it is proposed that skills which increase the absorptive capacity of companies are crucial for implementing effective productive innovation management.

Keywords Researcher skills · Third mission · Education modernisation agenda · Research professionals · Innovator · Innovation culture · Open innovation · Active innovation

JEL Classification O15 · O33 · O39

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1 Introduction

Innovation is one of the driving forces have been facing challenges arising from innovation competition which is thought to be a major factor of competitiveness. Evidently organizations performances depends of employees' skills and competences and the organizations ability to transform individuals' skills into routines which are beneficial to staff members across the organization. Thus organizations who aim at this ambitious goal need to establish and live a responsible organizational culture (Battistella et al. 2016). Among the features of such an organizational culture is the level of trust between individuals and hence units and entities inside the organization which eventually determines knowledge sharing and transfer (De Long and Fahey 2000). Employers' expectations towards researchers skills and the actual skills sets of these people often diverge (De Grande et al. 2014; Moog et al. 2015). There is a significant lack of project management and business management related skills of reseachers as well as communication skills (De Grande et al. 2014; Jefferson et al. 2017).

To meeting this challenges companies are in constant demand for qualified staff which is considered to possess excellent skills in the respective domain which are in addition to technical, engineering and research skills the so called soft skills and tacit knowledge (Oğuz and Şengün 2011; Adomavičiūtė 2015). This becomes especially evident in the standard employment procedures applied by companies, not only large companies but also small businesses, which frequently assess the formal competencies but take final decisions about applicants based on the personal and soft skills of applicants. Here employees are expected to master numerous challenges in their work practices which require advanced skills, e.g. or the ability to translate theory into effective execution or practice and systems understanding or the deep knowledge of cause and effect relationships underlying the professional discipline. Self-motivated creativity or the motivated creativity of labor appears important for companies' sustainable strategic decisions and a driver of the organizations sustainable success (Carayannis et al 2016; Sharkie 2003; Smith and Rupp 2002).

Organizations', namely companies', performance is correlated with employees' skills and competences (Whelan and Carcary 2011). Thus the diversity of labor skills and competencies is one of the sources of sustained competitive organizations advantage (Ordóñez de Pablos 2004). Maintaining organizations' sustainable competitive advantage requires cultivated labor skills which in turn need to be embedded in an environment supporting to leverage these potentials (Sharkie 2003). Leveraging individual labor competences and integrating them into powerful collective assets requires the diffusion of individuals' skills—and thus the diffusion of tacit skills—inside an organization (Selamat and Choudrie 2004). Therefore employees are challenged to correspond to meta-abilities by means of developing individual influencing skills and sharing abilities and competencies that enable people to use their skills effectively. Such meta-abilities involve cognitive skills, self-knowledge, emotional resilience and personal drive (Butcher et al. 1997).

Human Resource Management literature and practice are well aware of these facts and developments for long time but little attention has been given to employees and applicants' competences and skills for company innovation culture thus far (Kiessling and Harvey 2006). One of the reasons is that company innovation culture has been hardly analysed in literature. Instead innovation literature focuses on the availability of human resources for innovation, the organization of innovation in companies and resources for innovation but less on the climate conditions which empower company staff to be innovative (Ordóñez de Pablos 2004; Collings and Mellahi 2009). In addition the nature of company innovation activities has changed during the last decade with a stronger emphasis on open innovation approaches which include an open mind-set of employees towards not only ideas and innovation projects but also cooperation with partners on dedicated innovation projects (Gokhberg et al. 2016; Meissner and Shmatko 2016; Krasnopolskaya and Mersiyanova 2014). Whereas in the 20th century the not invented here syndrome was prevalent the last years showed that such mind-sets are serious barriers for innovation (Lewis and Heckman 2006). In addition established modes of collaboration are changing from mostly bilateral towards multilateral relationships between the different partners (Brown 2015). Moreover the nature of collaboration is shifting towards integrated collaboration which means that while collaboration was initiated and implemented with precise narrowly defined scope previously, current collaborations show broader scopes and higher ambitions and expectations of all parties engaged (Gackstatter et al. 2014; Cervantes and Meissner 2014; Adegbile and Sarpong 2015). A broader collaborations' scope naturally impose new challenges on the parties involved (Shmatko 2012; Gokhberg and Meissner 2016).

In this respect skills are frequent debated as important assets for meeting these challenges but so far there is no commonly accepted and shared understanding and not even to speak definition of the term 'skills'. This leads to the unpleasant situation that even in academic debates different meanings of the term appear with respective implications for human resources management and labor related policies. Therefore the article reflects in brief on the existing definitions of the term skills and provides a workable definition which is used throughout the article.

Toner (2011a, b, p. 13) considers *skills* "productive assets of the workforce that are acquired through learning activities and a discrete set of manual tasks or 'competencies' that are assessed through the performance of practical demonstrations". Frequently skills are further distinguished hard skills and soft skills. *Hard skills* a set of complementary technical and professional skills including

- ICT specialist skills for workers who drive innovation and to support digital infrastructures and the functioning of the digital eco-system (OECD 2016) and specific technical skills required for workers in different occupations (Toner 2011a, b, p. 14).
- Competencies that employees possess such as numeracy, literacy, fluency in a foreign language, and specific job-related technical abilities (operating a machine, creating a spreadsheet, touch-typing, driving, dressing a wound, and so forth) fall under this categorie. Typically, these skills are relatively easy to measure, and are often validated with some form of qualification (Heery and Noon 2008).
- Technical or administrative procedures related to an organization's core business are included in the hard skills definition, i.e. include machine operation, computer protocols, safety standards, financial procedures and sales administration. These skills are typically easy to train, observe, quantify and measure (Coates 2006).

Soft skills are a set of complementary skills for digital-age workers required for the expanding number of opportunities for collaborative work including

- Leadership, communication and teamwork skills (OECD 2016).
- Problem solving, creativity, team work and communication skills (Toner 2011a, b, p. 8).
- Communication (verbal and written), numeracy, team work, problem solving and learning to learn. These required attributes are also on occasion expanded to include leader-

ship, motivation, discipline, self-confidence, self awareness, networking, entrepreneurship and capacity to embrace change (Toner 2011a, b, p. 14).

- Competencies that employees possess associated with activities such as customer handling, communication, problem-solving, and teamworking sometimes including loyalty, enthusiasm, punctuality, and a strong work ethic (Heery and Noon).
- A set of competencies, skills or talents in three different categories: personal talent skills, behavioral traits and personal motivators (Nielson Group 2017).

Typically people skills are hard to observe, quantify and measure (Coates 2006). Beyond hard and soft skills professional competency(-ies) are often discussed. These competencies involve the generic, integrated and internalized capability to deliver sustainable effective (worthy) performance (including problem solving, realizing innovation, and creating transformation) in a certain professional domain, job, role, organizational context, and task situation (Mulder 2014). This requires knowledge (disciplinary knowledge), skills (working with artefacts) and attitudes (accuracy, coping with pressure, integrity). A competence is a coherent cluster of knowledge, skills and attitudes which can be utilized in real performance contexts (Mulder 2014) including the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and community being served (Heery and Noon 2008) and a complex combination of knowledge, skills, understanding, values, attitudes and desire which lead to effective, embodied human action in the world, in a particular domain' (Crick 2008). Competence is therefore distinguished from skill, which is defined as the ability to perform complex acts with ease, precision and adaptability (Caena 2011).

In the following the article highlights professional skills and competences, e.g. general (analytical) professional skills, special (instrumental) professional skills and professional management skills and universal skills and competences, e.g. communication skills, personal effectiveness and leadership skills. This understanding gives an indication about the potential of skills and competencies to innovation beyond the existing correlation between human capital, productivity and economic success. Furthermore it allows to drawing conclusions on features of an organizations culture which supports innovation (Woods 2015). To support innovation organizations' culture norms and shared values which encourage employees to perform uncertain and risky projects should be openly demonstrated (Johns 2010).

It's common practice that organizations postulate to encourage researchers taking such risks but statements alone without the respective active implementation of measures inside the organization aren't productive. On the contrary if no implementation measures complement these statements the organization runs danger of experiencing a negative reputation of making announcements but not meeting own promises. To overcome this potential threat measures are needed to reward researchers for risk taking by means of recognition of individuals and teams within the organization (Handley et al. 2006). This is well in line with the increasing share of research works which finds it's reason the in the increasing scope and complexity of science and technology, both which are considered ingredients for innovation to different extend (Del Giudice et al. 2013; Amin and Roberts 2008; Archibald 2003). Thus researcher are required and expected to possess specialized knowledge and sophisticated competences—the latter being often and mainly of a rather tacit nature (Smith and Rupp 2002; Sharkie 2003; Pentland and Feldman 2008). Labor skills are often sophisticated including include problem diagnosis and troubleshooting techniques which are frequently needed in laboratory operations. Such skills are usually specific and unique to individuals and barely codify-able (Klein and Crandall 1991).

Furthermore researchers are forced and usually motivated to exchange and sharing knowledge at different levels and between different actors (Oldham and Hackman 2010; Markus 2001). However their willingness to openly cooperate by means of sharing and exchanging is often challenged by internal regulations of organizations and even human resource policies which establish researcher performance assessment schemes with a strong focus on results and outputs delivered by the individual researcher. This is also at least partially due to the researchers' initial training and education. During their extensive training and education in the postgraduate, namely doctoral studies, young researchers tend to orient their attitudes and routines towards their direct supervisors and leading scholars in the respective fields (Moog et al. 2015). This is a plausible behaviour from the individuals' point of view because the doctoral students' performance is assessed and closely guided by the supervisor. Naturally doctoral students are interested in keeping good relationship with supervisors despite the fact that their qualifying works are frequently assessed by independent committees. However one needs to keep in mind that scientific communities are rather small communities with extensive network relations inside the communities, e.g. community members are likely to follow the doctoral students' supervisors' assessments and opinion about a candidate. These relationships are among the important factors influencing the behaviours and ambitions of individuals (Lam 2007). It follows thus that the doctoral student is more likely to adapt to mainstream routines provided by direct supervisors and the related community which is not always supporting creative and self-determined work of individuals, e.g. they adapt to the organizational culture established and lived by the academic leaders (Moog et al. 2015). Moreover this strengthens the researchers attitudes to sharing with their supervisor but less so with colleagues who are frequently considered competitors but not necessarily team members.

In light of the organizations' research and innovation culture this might turn out counterproductive because individuals are hardly rewarded for open exchange instead the incentive is set to take advantage of the competencies and knowledge by others but limiting own contributions. This behaviour of individuals is initiated and supported by such incentive schemes which neglect the long term consequences, e.g. the increasing isolation of 'take away' researchers from groups and other individuals. As long as there is a substantial demand for the respective qualification the individual 'take away' researcher possesses it might be easy for them to enter new career paths in different environments. However this is true only in theory, realty shows that researchers meet at events and communicate increasingly in social networks and media. Thus the reputation of individuals will suffer in the long term. For organizations it's therefore challenging to align the internal evaluation and assessment procedures accordingly. This also holds true for organizations rules and procedures for different shapes of interactions with external partners, e.g. they need to provide incentive and encouragement of researcher to actively engage in third party interactions while also protecting the knowledge advantage and competitive position of the organization.

Against these features of innovation culture the natural question arises which competencies and skills people need to possess to match with existing innovation milieus (Svare 2016; Holtskog 2015). Arguably technical, engineering and other related competencies and skills are a type which can be acquainted by training and education throughout the individuals' educational career, e.g. primary, secondary and tertiary education mainly along with experiences made by them (Batra 2009; Whelan and Carcary 2011). Still there is a reasonable strong share of 'soft skills' which demonstrate essential for the innovation culture overall and which are specific for individuals (Selamat and Choudrie 2004). Amongst the latter are skills mainly for orchestrating teams of individuals including communication, personal effectiveness and leadership skills. Especially against the open innovation background communication skills are increasingly important assets of researchers in science and technology (S&T) areas. These skills go much beyond the initial academic writing skills but involve structural and sales/marketing oriented writing skills and presentation skills. Writing skills were strongly stressed in the last 30 years (McDowell and Baney 1983) and especially during the last decade listening skills and negotiation skills became equally important. Overall these skills sets can be summarized as *professional skills and competencies* involving general (analytical), special (instrumental) and professional management skills and *universal skills and competencies* involving communication, personal effectiveness and leadership skills. While professional and universal skills are debated sufficiently in academic literature thus far a connecting between these skills and the features of innovation culture is lacking.

Obviously professional skills and competencies do relate to the innovation culture especially to the exchange and sharing attitudes and the interactions with external partners. Typically highly qualified labor finds it to acquire additional skills by means of training than other employees (Cobb and Barker 1992). These skills are frequently included in educational programs while universal skills and competencies are strongly related to individuals thus requiring different learning and training approaches. Also it's common wisdom that professional skills and competencies are assessed by companies/employers using the common set of documents, e.g. certificates, diploma among others whereas universal skills are more frequently in the center of assessment centers and interviews employers hold with applicants (De Grande et al. 2014). As regards assessing the skills of employees human resource management frequently holds employee performance assessments which also take both dimensions into account. Yet in light of background outlined the skills requirements for researchers and engineers are changing. Therefore we postulate the following hypothesis:

1. Researchers and engineers face a changing competence mix. The actual competencies and the required competencies of researchers and engineers don't match.
2. Additional competences such as 'soft skills' or managerial competences are becoming more important and need to complement the existing knowledge focused competences.

The article proceeds as follows. Section 2 describes the methodology used to assess the competencies of researchers and engineers and Sect. 3 introduces the findings. The concluding Sect. 4 is devoted to discussion of findings from the research and engineering skills study in the light of company innovation culture.

2 Methodology and approach

Both quantitative and qualitative methods were used to test the hypothesis about STI-related skills. In the first stage, we carried out a quantitative questionnaire survey by means of formalized interviews among 935 young (aged under 40) Russian researchers and engineers and graduates of technology universities. The selected population was comprised of 589 men (63%) and 346 women (37%); 55% are researchers, employed by R&D organizations, and 45% are engineers of industrial enterprises, including innovative SMEs.

In the second stage, we collected qualitative information using in-depth, semi-structured individual interviews with the top-managers of organizations responsible for R&D

and industrial enterprises. In total, 42 interviews based on a question guide were conducted, which yielded qualitative information on the skills of young researchers and engineers required by Russian employers. The survey covers four out of fifty the most promising areas of science and technology (S&T) development in Russia: information and communication technology; nanotechnology; new materials; biotechnology.

The study takes three interconnected factors into account:

1. The skills young researchers and engineers need to adequately function in a knowledge-based society, in innovative organizations and innovative SMEs;
2. The role of universities in developing these skills;
3. Mismatches connected with conflicting objectives and interests of researchers, engineers, universities, employers and other key players.

Classical methods of measuring (assessing) more advanced skills show some limitations. The main tools for assessing skills in these surveys were tests, indirect assessments by employers of workers' skills and self-assessment of the interviewed workers. In large-scale questionnaires, the self-assessment is the most often used method. With these limitations of employees' self-assessment method in mind in our survey, we completed them by the results obtained in-depth interviews of employers and top-managers (seeing as a complementary tool to assess required skills).

The survey places the accent upon assessing general or «soft» skills reflecting the innovation culture and dispositions. Special attention was paid to studying science, technology and innovation (STI) related personnel's competencies, to measure the level of proficiency and determine how far the competencies they obtained matched the employers' requirements. The skills set includes a section on employers' needs for their employees, e.g. the request to possess good social, communication and management skills as well as willingness and ability to develop them throughout their careers. Such requirements have been highlighted in numerous studies. In contrast, specialised professional (or «hard») skills are not analysed in detail. In a large-sample questionnaire-based survey, it is difficult to address the road range of highly specific skills associated with a broad diversity of professional backgrounds of respondents. For example, even within a specific professional group, there will be considerable variations in the sorts of equipment being employed to carry out almost similar tasks, and these types of equipment experience rapid generational changes in some areas especially where they involve new information technologies.

An important methodological issue addressed in course of the study was the application of an assessment procedure in a survey by questionnaire. In this case, collecting reliable data without self-assessment procedures would be impossible. Accordingly, comparing the available and required competencies took the form of identical scales, where respondents answered the questions: «How would you assess your knowledge and skills level in the following areas?» and "What level of these knowledge and skills is required at your job?» for each of the 20 skills reflecting professional knowledge, functional flexibility, ability to mobilise available resources, readiness to innovate, etc. Thus the surveys ask about the use of professional skills in the respondent's own field, without any detailed specification of what that field is or how the knowledge is precisely configured.

The list of competencies used in the survey included the following:

Professional skills and competencies	Universal skills and competencies
• General (analytical) professional skills	• Communication skills
• Special (instrumental) professional skills	• Personal effectiveness
• Professional management skills	• Leadership skills

The assessment of the researchers' and engineers' competencies expected to be in demand in the short or in the medium term was performed during the in-depth interviews with the experts who represent the research centers and companies that will be carrying out projects, implementing innovative technologies and provide products and services in the promising areas. There were four S&T priority areas selected for the purposes of this paper, namely information and communication technology, nanotechnology, new materials and biotechnology.

Experts representing each area were asked to identify the need of companies for competencies that are essential for highly qualified personnel (project managers, engineers, researchers), as well as to suggest the potential training strategies. The expert interviews involved qualitative information on the existing competencies that will be in demand in the nearest future, as well as brand new competencies. The most valuable competencies, from the experts' point of view, were selected. The expert interviews were also used to collect the information regarding an innovation climate and dispositions of companies' management toward young innovators at the surveyed organizations.

3 Findings

3.1 Competencies in general

Analysis of the collected data revealed that the surveyed young researchers and engineers generally rated their knowledge and skill levels quite high in practically all areas. One might suppose that the respondents had a tendency to exaggerate their self-assessment, since (with rare exceptions) their self-assigned ratings didn't go below four on the scale of one to seven. On the other hand, being accepted for the posts these people actually occupy necessarily involves possession of a high level of the skills. Furthermore, cases of PhD holders rating their skill level above the required at the job were rare. Thus the assessment shows that on average, the level of skills, knowledge and abilities required by employers is regularly seen to be somewhat higher than the level of competencies the young researchers and engineers actually had.

Analysis of specific professional groups within the sample showed that competencies profiles of researchers and engineers were quite close. The profiles' configurations have minimum and maximum values of the same skills indicators. These «critical points» include the ability to work productively with others, mastery of their own field, ability to realize the task effectively, knowledge of other fields or disciplines.

The highest marks were given to variables reflecting the traditional—for young doctorate holders' area—«academic skill set» as the abilities to use computers and soft, to rapidly acquire new knowledge, to come up with new ideas and solutions. Nevertheless, the assessment of competencies required to perform the job adequately revealed that the set of most demanded skills doesn't exactly match the «academic» category, but rather reflects professional experience and efficiency (Table 1). Comparison of sets of skills deemed to be

Table 1 Ranking of the most relevant actual and required competencies of young researchers and engineers

Competencies	Researchers actual	Engineers actual	Researchers required	Engineers required
Mastery of your own field or discipline			4	5
Knowledge of other fields or disciplines			1	3
Analytical skills	5			
Ability to make your ideas clear to others	4	5	3	4
Ability to realize the task effectively			2	2
Ability to work productively with others	3	3		1
Ability to rapidly acquire new knowledge	2	4	5	
Ability to use computers and soft	1	1		
Ability to come up with new ideas and solutions		2		

most important for researchers and engineers shows that they are indeed very close, albeit the ratings are different. The researchers are expected to have a good and large professional knowledge while the engineers are asked to be able to work productively with others and to realize the task effectively.

The biggest gaps between what is needed and what skills are actually possessed were found to relate to leadership skills and communicational skills, the first of which being an ability to find customers of products or services. The surveyed young researchers assessed their proficiency with this skill as low (Figs. 1, 2), with engineers showing the worst

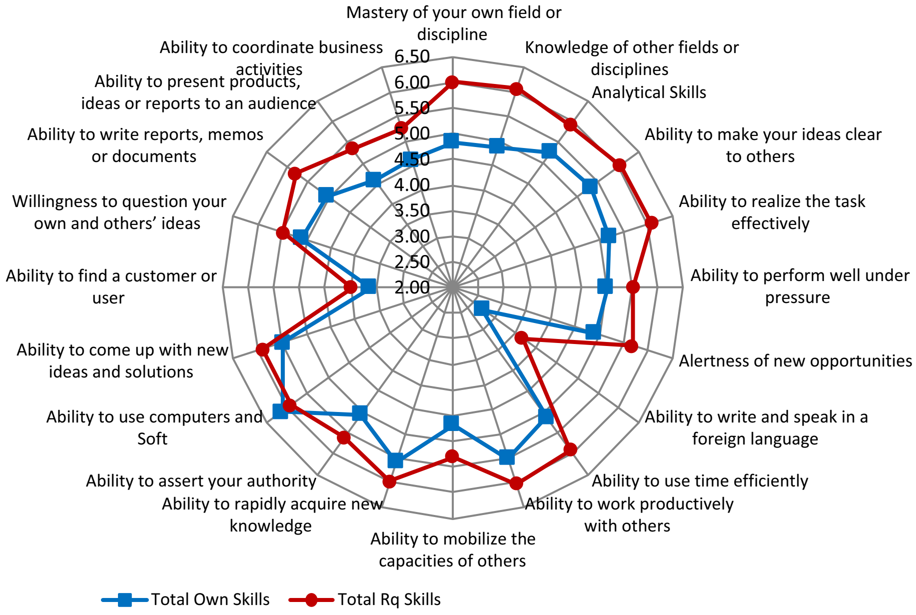
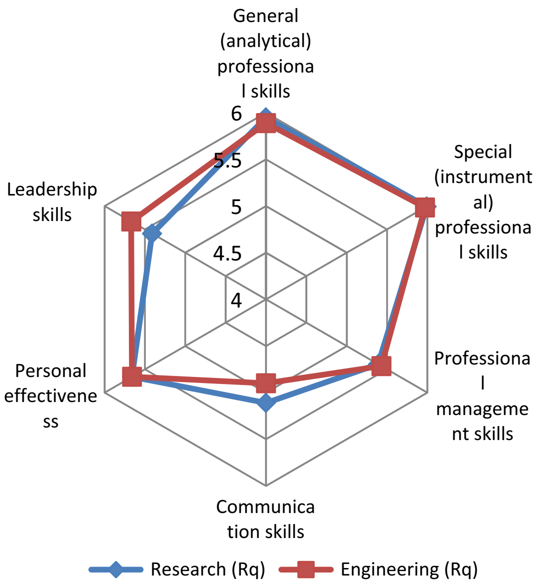


Fig. 1 Young researchers and engineers competency profile (for the whole sample)

Fig. 2 Employer's expectancies' toward skills of young researchers and engineers



assessments. On the other hand it should be noted that researchers were more critical about their skills and abilities than surveyed engineers, however these are self-assessments rather than independent judgements, and it may be that the lower ratings reflect the nature of research work, rendering self-assessments judgements were more critical by default; this remains to be investigated by other means.

Organisations which represent new application areas for engineering skills, such as technology transfer centres, industrial parks, engineering companies and implementation organisations, attract younger and more professionally advanced personnel. Engineers employed by such organisations are more active in professional communication and upgrading; they have sufficiently developed "academic" skills, and are career-oriented. Also they participate more actively in innovation activities and are more frequently involved in the development and application of radically new products/technologies/services, new business practices and new or significantly improved marketing techniques, than engineers employed by other kinds of organisations.

The picture is confirmed when observing the rating of actual and required competencies which shows significant gaps (Table 1). It shows that for instance the ability to write reports, memos or documents is a competence which scientists and industrial engineers possess but which is hardly recognized and required as a competence at all, the same holds true for the ability to work productively with others. Presumably these are competencies which are self-understood.

One competence field which is important refers to negotiation skills of both groups, e.g. scientists and industrial engineers. Neither of both groups possesses these skills although it appears being an essential requirement for both.

Surprisingly academic degree holders are required to become more aware of new opportunities, stronger presentation and communications but also negotiation skills. All these are competences which are missing in their actual competence profile. Given universities' 'Third Mission' which strongly emphasizes collaboration in different shapes these competences are a necessary precondition for mutually beneficial interaction. Moreover scientists' actual competences rank knowledge of other fields or disciplines significantly lower than it's actually required.

3.2 Special competencies

The experts matched the examined professional competencies with the list of the skills that were assessed for researchers and engineers. Special attention was given to the extent of the following skills' mastery: technical, cognitive, informational, managerial, marketing, entrepreneurial, and communication skills, as well as personal characteristics required for a successful innovative activity (professionalism, initiative, energy, creativity, team spirit, and openness to experience).

3.3 Professionalism and interdisciplinary teams

Due to the specificity of production expansion there will be a need for collaboration between specialists with different training, multidisciplinary and interdisciplinary teams. The core specialists in these teams will be those with degrees in technical and natural-scientific fields: chemists, physicists, physicochemists, and so on. Especially for the nanotechnology related industries competencies of the personnel involved in working with structural and functional materials might be analogous to the ones that are necessary to work with microelectronics, while a demand for very specialized knowledge can be limited. However, nanotechnologies will have (and already have) a significant impact on the advancements in medicine, healthcare and biology, so the demand for very specialized knowledge can as well grow.

In some organizations, every employee has to have an education in science or technology regardless of their position—be it a researcher, a technician, or a manager. In high-tech enterprises, not only researchers but also technicians are required to hold a PhD. Even at present, some employees in such companies have two university degrees. The interdisciplinary nature of the tasks for the companies requires the personnel to be familiar not only with their area but also with the allied disciplines. This tendency is believed to dominate over labor specialization, in particularly affecting the traditional understanding of professions and labor division because the lines between the positions of engineers, technicians, and managers will be getting blurry in the next 10–20 years, and "hybrid professions" appear. Among others, "innovation managers" will be affected to the greatest extent. The latter, first and foremost, would have to be a researcher or an engineer in a certain area of science with a fundamental education in technology or science, and secondarily, be a leader and have managerial skills. In addition the blurring of professional and disciplinary lines does not abolish the requirement for fundamental education in a traditional sense. The reason is that a good fundamental education is a skill of systematically approaching both learning and working. Employers are ready to train their specialists to work with certain technologies and equipment given that there is such basis. In biotechnology, for example, materials, equipment, and their applications are constantly changing, so it is necessary to master them quickly. It is a much easier task when employees are well-trained in one fundamental discipline.

3.4 Job experience

Employees' professional experience is increasingly outplacing professional trainings or doctoral degrees. The best demonstration and a proof of having the required skills and competencies are the completed projects in analogous spheres. At the same time, it is obvious that project implementation experience is a “superstructure” to professional training and education in the high-tech area. Job experiences are viewed as people collecting experiences besides the standard education which mainly relate to soft and tacit skills, such as problem solving competencies or structured work among others.

3.5 Management competencies

Frequently researchers’ and engineers’ competencies show deficiencies in project management, marketing, logistics and finance but these competencies turn out crucially important for project implementation and operation. Thus management skills along with communication skills are as professional as a mastery of methods and technologies because specialists’ competencies are integral; if management skills are missing, a specialist is not considered at all. The general trend is such that the scarcest competencies at the moment will be even more in demand in the future. Thus, if the programs and methods that can support the development of these skills are not developed, the gap will be widened.

Researchers’ skills and competencies currently are focused on solid fundamental education in science, the ability to adequately apply (theoretical) knowledge in practice, ability to learn and analytical, diagnostic and research skills. Increasingly researchers will be required to possess adaptability and ability to improvise which is eventually a skill collected by job experience. The interviews showed that in conditions uncertainties associated with forecasting of the future development of knowledge-intensive production, employers do the rate on the behavioral component of competence. Work on innovation projects also involves risks and uncertainties. It is known that researchers working in innovation projects do not have a clear division of labor, they are not limited to a narrow range of designated tasks and operate in a constantly changing situation. In this regard, the teamwork, adaptability and ability to learn quickly become crucial and come to the foreground. Missing specific knowledge and expertise researchers and engineers can get at their workplace, directly in the process of solving the problem. The most appropriate format for such training are seminars and short-term modular programs. At the same time this way of obtaining the required competencies for innovation can only be effective when the researchers have a solid basic scientific education.

Especially at the level of doctoral education it seems reasonable that doctoral candidates include a temporary industrial research in their curriculum and research activities. Such model will not train the doctoral student fully for a later career in industrial research but it grants the individual with insights into the respective routines and operations which differ reasonably from academic routines, e.g. at least prospective researchers are aware of the special conditions which both research careers offer (Woolston 2016). This is even more important when it comes to making decisions for the future career. Frequently industrial researchers aiming at entering an academic path are not aware of the duties which academics are confronted with, on the contrary such positions are often considered paradise for researcher with little administration and almost no personal evaluation and research project monitoring and controlling. Furthermore the presumption exists that project management competencies are not applicable in the academic world and also cooperation with others is hardly the case. Vice versa do academic researcher perceive industrial positions as places there no freedom for creative thoughts exists, all activities require detailed documentation and milestones and financial budgets are core issues which involves strong administration. It’s well known that both perceptions are wrong however they remain to exist.

4 Discussion

Organizations' culture is an important determinant of the innovation performance of companies. The skills and competencies of researchers and other innovation employees are per se important but taken out of the environmental context individuals' competencies and skills aren't likely to generate innovation effectively and efficiently. Innovation management practice shows that professional competencies of individuals mainly refer to the competencies collected in education, training and further education. Given the significant number of graduates in many S&T fields in line with the open access movement to research related knowledge it's not surprising that these competencies are viewed as 'valuable commodity'. The stronger focus and importance is the availability of soft skills and competencies which either belong to an individual's features or develop with growing professional (job) experience. Furthermore company practice shows that single competencies are more or less considered 'nice to have' but the real value comes from set of competencies an individual can provide. Because the skills and competencies are different between individuals, the soft skills 'exchange and sharing with others' gains more importance. This is due to the fact that innovation is commonly a collective undertaking instead of a sole individuals' undertaking only, therefore the team thinking and group work is indispensable for lasting success. However in a group of individuals one might frequently find group members with open minds and willing to exchange and share but other members with mindsets favoring the 'take' instead of exchange. Moreover company employee performance measurement schemes take employees competencies and skills into account but ignore the corporate cultural environment which is thought to address values and ethics.

The study of Russian companies in the four S&T priority areas have enabled to evaluate and demonstrate on the basis of competencies, which employers require from young researchers and engineers, that the culture of cooperation and open exchange of new knowledge is rather poorly represented yet. The most demanded competencies still remain professionalism, continuous improvement, assertiveness and endurance (e.g. mastery of your own field or discipline, knowledge of other fields or disciplines, ability to realize the task effectively, ability to rapidly acquire new knowledge, ability to assert your authority, ability to use time efficiently). Communication skills and values of sharing along with egalitarian and willingness to question own and others' ideas not only underdeveloped, but not really claimed by the employer.

Obviously organizations which favor innovation development are challenged to develop and/or maintain an innovation culture which is supportive to the individual's characteristics including norms and believes but which also stimulates creativity and competition between individuals. Considering the four main company innovation culture features risk, belief, exchange and sharing and interaction with external partners the following conclusions can be drawn for researchers' skills and competences:

Personal effectiveness is a researcher competence which can be trained and developed. A company culture supporting innovation will include dedicated training measures to equip employees with skills to organize their activities following aims and goals which they set or which are set by others. This includes considering aims and goals for groups or teams and raising the awareness among team members that the overall performance is only as good as the performance of the weakest element in the group. Over time freshly hired employees are developing and building *leadership skills* which brings them into the position to take leadership but also to understand leadership by others hence increasing mutual trust. Trust in own competencies and skills but also in those of others is an absolute precondition for a functioning effective and efficient team work. Furthermore researchers are expected to be willing and able to engage in continuous learning and improvement.

Taking these features together innovation projects are defined and structured following the basic project management principles but as from the very beginning on leadership and team members are aware of the risk of failure. Exchange and sharing is a skill frequently trained to university graduates. This is rooted in the ongoing common group work practice which is typical for many educational programs hence considered a *general professional skill*. Thus researchers do possess the basic skills for exchanging and sharing information and knowledge but company innovation culture is challenged to further develop and leverage these. This issue arises especially in teams whose performance is mainly assessed by quantitative indicators measuring the output but less taking account of individuals' contributions. Frequently organizations do establish training programs to support team work and exchange between team members but as long as the underlying principles of exchange and share are not included in performance assessment schemes and resulting incentive programs employees are unlikely to apply these competencies. A similar observation can be made for *professional management skills* and *communication skills*, e.g. the targeted and dedicated communication within a group of people and to outside the group people.

The main skills for interacting with external partners are only seldom included in the *general (analytical) professional* skills, sometimes in *special (instrumental) professional* skills and *professional management* skills. Interactions with external partners are often an issue of company routines and rules, e.g. being supported or being rejected which is naturally also due to the nature and scope of activities. However researchers can be considered communicative people enjoying the exchange and interaction with third parties but as long as the institutions' culture limits the freedom of interaction a reasonable potential of exploiting research competencies is not used. Competencies relating to personal effectiveness equally incorporate third parties interactions.

The gaps shown in the actual use of competencies and the perceived value of these competencies allow the conclusion that the researchers are embedded in organizations which do not consider a company innovation culture important for the institutions performance and sustainable success.

5 Conclusions

Eventually it can be argued that the gap between skills which researchers possess and which are required and perceived is smaller in small companies than in large companies. This is mainly due to the distance between top management and researchers (or innovators) and the flexibility or organizations. The *distance between top management and researchers (or innovators*) implies that top management often perceives the formal skills and competencies of researchers as being sufficient to meet the top down formulated innovation aims and goals. However with increasing size of organizations top management perceives the importance of researcher skills different from what is needed at the operational (bottom) level. Also due to organizational barriers which exist throughout the hierarchy levels bottom driven initiatives are often less likely to be realized and rewarded to the fullest extent. This is reasoned in the vertical and horizontal barriers between units and hierarchy levels which impose increased competition between units and the consequent limitations in sharing and exchanging information, knowledge and ideas. Small organizations frequently demonstrate significantly higher *flexibility* in meeting user demands and thinking out of the box. Flexibility doesn't mean ongoing restructuring and reorganization but refers to aligning resources and competencies according to the actual needs and requirements of innovation activities. Therefore these organizations are characterized by an innovation culture which crosses organizational and institutional borders by means of supporting open exchange and sharing. Furthermore organizations aiming at flexibility demonstrate a closer proximity to the actual user needs and thus requirements towards application of innovations.

The article has found empirical evidence that the skills of researchers and the perceived skills value don't match but there is a significant gap. It's argued that organizations need to be aware of researcher's competencies and develop them further mainly by establishing and living an organizational culture which is supportive to innovation and the exchange and sharing between individuals. The human factor needs to be more in the focus of management but less weight given to financial controlling and reporting in comparison. The open innovation paradigm needs to be extended by the human factor towards the 'active innovation' paradigm which stresses the individual as the main driver of innovation in organizations.

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