

***R&D Campus as Space for Regional Sustainable Development:
(Un)Productive Factors and Future Needs for Innovation***

Josephine Lappia
Research Centre Urban Talent
Ilse van den Donker
Research Centre Urban Talent
Marlies Bedeker
Research Centre Sustainable Solutions

Rotterdam University of Applied Sciences, Rotterdam, The Netherlands

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ABSTRACT

Contemporary economical problems require new innovative solutions. The potential role of higher education (HE) as a change agent for regional sustainable development is investigated. Stakeholders from firms, education and government within an R&D Campus form Innovation Teams and Communities of Practices (CoPs) in the domains of building, moving, powering and maintenance. However how to contribute to a safer, cleaner and attractive living environment? Productive, unproductive factors and future needs are analysed from the perspective of HE to enhance regional sustainable development. Several research and data collection methods converged into five main factors that Innovation Teams and CoPs have to tackle in the next period. The followed method for joint problem analysis guarantees highly involved stakeholders.

Keywords: regional sustainable development, innovation teams, communities of practices, R&D Campus, working and learning landscapes, knowledge economy

Track: Knowledge Economy

R&D Campus as Space for Regional Sustainable Development: (Un)Productive Factors and Future Needs for Innovation

1. Introduction

Despite unprecedented economic growth in the final decades of the 20th century, today's world is confronted with increasing social, environmental and economic problems. Persistent poverty, armed conflicts, natural disasters and far-reaching economic and financial crises all highlight the need for more sustainable technological and economic development models. With *The Rio Declaration* and its *Agenda 21* the international community has committed itself to a change process that works towards economic equality and equity, better protection of the ecosystem and the promotion of a more secure and prosperous future for all on the globe. Our current way of problem solving however is inappropriate for making this change. Contemporary problems require new, innovative solutions based on values, knowledge, skills, attitudes and behaviour emerging from the principles of sustainable development. Agenda 21 calls upon all stakeholders involved, whether governmental, non-governmental, firms, non-profit or individuals, to take responsibility and initiate action to stimulate sustainable development. Education is recognized as a key player for promoting sustainable ways of problem solving, raising awareness, stimulating active involvement and facilitating people in acquiring the capacities needed for innovative and multidisciplinary sustainable problem solving (Agenda 21, 1992).

With the *Declaration of the Decade of Education for Sustainable Development* (DESD, 2005-2014) the United Nations further encourage education to take the role as catalyst of change. Unesco (2012) argues that the commitment to strive for a more green and inclusive society implies that sustainable development is an essential ingredient of educational curricula and programs. Known solutions within the business world to stimulate sustainable economic development are the enhancement of regional collaborative learning, open source innovations, communities of practice and the development of flexible and innovative professionals (Rodrigues and Viedma, 2006).

However how to create such green and inclusive society striving for sustainable development when at the same time the conclusion is that our current way of problem solving is inappropriate for making this change? When the available knowledge seems to be outdated? Or when known solutions are difficult to realize? What might happen when higher vocational education responds to Unesco's call to take the role of change agent and starts facilitating the collaborative learning of sustainable problem solving? Could reconstructed higher vocational education in joint collaboration with firms within a R&D Campus as a *micro economic cluster* (Rodrigues and Viedma, 2006) realize such sustainable and economic development? Or does higher education rather tend to reproduce existing social, cultural and political systems (Apple, Au and Gandin, 2009; Levinson and Holland, 1996; Saltman, 2009; Shor, 1993)?

Main aim of the undertaken research study of a technical R&D Campus is to reveal: *What factors influence whether regional sustainable development is enhanced by reconstructed curricula of higher vocational education when taking the role of change agent within a R&D Campus as a micro economic cluster?*

Located in the heart of the Port of Rotterdam in the Netherlands, the former shipyard of the Rotterdam Dry Dock Company currently houses RDM Campus; an R&D Campus where government, education and firms meet in order to collaborate, co-create and innovate. By means of joint research, education and entrepreneurship the collaborating partners aim to realize added value for the regional economy in the industrial sector (Hooijer and Muris,

2009). Campuses like RDM Campus are increasingly in the spotlight of both education and firms. In times of rapid (technological) change the capacity for competitiveness by adequate and well-timed responses is crucial for economic survival and growth. Joint efforts of government, education and firms to develop this capacity in a sustainable way, offer possibilities to fill the gap between education and practice, to increase the innovative clout of local firms, to support the development of the regional knowledge economy and to strengthen the economic resilience of the region (Rodrigues and Viedma, 2006; Viedma, 2003). This collaboration between three central stakeholders is often called the Golden Triangle (Fig. 1).

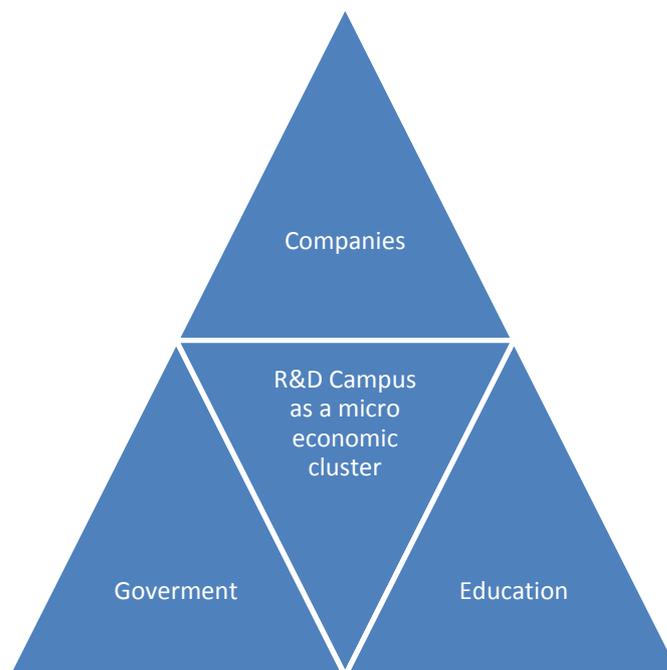


Figure 1. Golden triangle of central stakeholders involved in R&D Campus as a micro economic cluster

RDM Campus emphasizes that sustainable development is a key ingredient of both the aspired results *and* the collaboration process (Hooijer and Muris, 2009). With their focus on sustainable development, the founding fathers of RDM Campus (Port of Rotterdam Authority, Rotterdam University of Applied Sciences and Albeda College for Vocational Training) actively contribute to Rotterdam's scenario to become a healthy, attractive and economically strong metropolis for residents, firms and visitors. A city ready to cope with the competition that emerges in the international economic arena.

Living up to this ambition Rotterdam faces the challenge to invest in innovation, to develop a strong knowledge economy and to commit serious efforts in the areas of environment, energy and health (Rotterdam Climate Initiative, 2007; Municipality of Rotterdam, 2007). With earlier initiatives the Municipality of Rotterdam already took the responsibility to design and implement measures for energy saving, better air quality and the improvement of the living environment in several of the city's neighbourhoods. Recent ambitions take a step further and describe Rotterdam as a climate resilient, CO²-free city and a first rate energy port. The transition towards such a safe, attractive and clean city however requires efforts of all *stakeholders*, whether it be government, firms or education, and stipulates the importance of collaboration between them (Rotterdam Climate Initiative, 2007). RDM Campus creates space – physical and social – for collaboration focused on innovation, knowledge-creation and entrepreneurship by means of Innovation Teams and Communities

of Practices (Fig. 2). The assignments of Innovation Teams are practical problems submitted by firms located at the RDM Campus. In collaboration with representatives of these firms and in the context of Communities of Practices in the domains of building, moving, powering and maintenance, students work on practical solutions for these problems: solutions that serve the firms *and* contribute to a safer, cleaner and more attractive living environment.

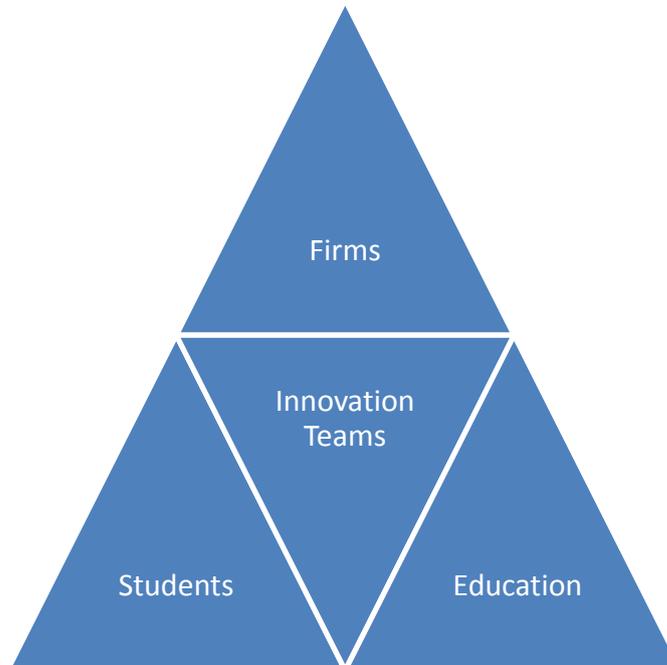


Figure 2. Stakeholders involved in Innovation Teams at R&D Campus

From 2009 to 2011 51 Innovation Teams were active in the RDM Campus in Rotterdam. About 388 multilevel students have contributed to projects for firms involved into the offshore industry, energy delivery services, local public transport providers and logistics and transport. The students that participate in an Innovation Team are assembled from different educational levels such as vocational training, higher technical and commercial education of the University of Applied Sciences and scientific education at the Technical University. In addition, Innovation Teams can be multidisciplinary. Students of different courses are working together in domains such as technical engineering, logistics, mechanical and automotive engineering and commercial economics.

The period from year 2012 to 2014 will focus on further professionalization of the stakeholders (from government, firms or education) involved in the Innovation Teams to improve the quality and focus on building connections to (existing) Communities of Practice in sustainable building, moving, powering and maintenance. To engage stakeholders into that change process a Community of Learners (CoL) is started by the program director, program manager, the researchers and a trainer. The purpose of the Community of Learners is to share knowledge, help the joint implementation of the reconstructed curriculum by Innovation Teams and Communities of Practice and building upon former results. In the first months of 2012 the Community of Learners engages - as a starting point of view - with fifteen lecturers. They all have a lot of experience in working with and in Innovation Teams as senior colleagues of the students. Researchers focus how the implicit knowledge of the lecturers can be made explicit.

2. Methodology

In this research study three research and data collection methods are combined. First an explorative literature study is conducted. Second a meta analysis (Smulders, Van Wijk and Zitter, 2011) of 21 'Innovation Arrangements' from different Institutes of Vocational Education in the Netherlands based on their project documents and evaluations is studied. Third a case study is conducted at one specific R&D Campus, the RDM Campus in Rotterdam in the Netherlands. Part of the case study is an action research project in which data is collected among the stakeholders of the RDM Campus and a collective problem analysis is performed.

2.1 Different research and data collection methods

The explorative literature study is conducted searching for theories and research projects that reveal factors that enhance or inhibit the role of the change agent of education. The literature covers several disciplines of which critical education, knowledge economy, communities of practices, regional intellectual capital, anthropology of education and educational policy are the basic anchors. Anthropology of educational science has been used to conduct an action research project and to justify and enhance the way of the ongoing implementation of the case study Innovation Teams and Communities of Practices at RDM Campus. The scientific fields are included into the eclectic process of '*theory guided bricolage*' (Gravemeijer and Cobb, 2006) when the theory helps to clarify phenomena found in practice.

The meta analysis of 21 'Innovation Arrangements' – a stimulation subsidy from 2005 - 2010 in the Netherlands was commissioned by the subsidizing party and available to reveal the factors that help to overcome the indicated innovation gaps within the 'Innovation Arrangements'. Empirical data collection is conducted and a problem analysis among stakeholders involved in the R&D Campus is undertaken. Stakeholders were involved in the Innovation Teams from 2009 until 2011. They have been interviewed and survey data is collected from a questionnaire to analyse the productive, the unproductive factors and the future needs that according to stakeholders enhance or inhibit regional sustainable development.

2.2 Interaction between methods and triangulation

Combining the different research methods and data sources provides a sound verification process of triangulation that is suitable to the contextual situation at the R&D Campus and the necessary conceptual clarification. In the start-up phase from 2009 – 2011, less effort is undertaken to find justification by means of a literature study for the set-up of the new curriculum for the reconstructed higher education. While implementing the Innovation Teams into the traditional curricula, the main attention in this start-up phase went into realizing the needed preconditions in traditional curricula. Less attention went to the way lecturers could start offering their students curricula that meet the new purpose of raising students into sustainable development. Nor the question how to incorporate realistic new content into Innovation Teams, nor the new way how this new content could be offered in educating students as being the junior colleagues of the lecturers, got much attention. Students as well as lecturers will be involved into a practical assignment of which nobody knows the right solution on forehand. So the case study applied a method to enhance the change process and reveal an initial problem analysis that is based on the intentions and

interventions of the involved stakeholders. The stakeholders are at first found into the group of regularly involved lecturers coaching Innovation Teams. By applying a ‘snowball method’ in action research the amount of stakeholders involved in that process is to be enlarged towards coaches of firms and government, until all stakeholders are involved.

3. Findings

To find an answer to the research question: *What factors influence whether regional sustainable development is enhanced by reconstructed curricula of higher vocational education when taking the role of change agent within a R&D Campus as a micro economic cluster?* The findings from the three data sources are described and combined into a triangulation matrix.

3.1 Insights from the explorative literature study

Taking the role of the genuine change agent implies a thorough reconstruction of the purpose, the content and the process of education including those who should be empowered to engage in it (Apple, Au and Gandin, 2009). Since sustainable development is such a contested, normative and revolutionary concept the reconstruction process is educational, cultural and political. Innovative, sustainable problem solving demands for an integrated, multidisciplinary approach, a critical attitude towards predominant and taken-for-granted patterns, participatory, collaborative and situated teaching and learning methods, a focus on individual as well as system learning and context awareness (Loeber, Mierlo, Grin and Leeuwis, 2007; Unesco, 2012). Education must – in summary – cope with questions about the design and practice of learning processes (Loeber, Mierlo, Grin and Leeuwis, 2007), the legitimacy of knowledge and who holds it, commitments between education and the larger society and the dynamics of power relations (Apple, Au and Gandin, 2009).

Known solutions to stimulate sustainable economic development are the enhancement of regional collaborative learning, open source innovations, communities of practices and the development of flexible and innovative professionals (Rodrigues and Viedma, 2006). By initiating such collaborative learning arrangements and inviting multiple stakeholders to join, RDM Campus faces some specific challenges with respect to the process of collaboration, learning and working. Connecting education and firms in collaborative learning arrangements brings together a wide variety of stakeholders. Although they differ in several aspects such as age, educational background, professional discipline or formal role, their membership of a Community of Practice or an Innovation Team establishes the connection between them. These learning communities are forms of sociocultural practices in which participants negotiate meaning through participation and reification (Wenger, 1998). If RDM Campus truly aims to function as change agent, creating the community alone is not enough. Explicit and critical attention should be paid to processes of production and reproduction, for example in the collaboration between education and firms (Saltman, 2009), between students coming from different social, cultural and educational backgrounds (Levinson and Holland, 1996) and between different generations (Apple, Au and Gandin, 2009; Shor, 1993). The learning and working process should therefore be organized in such a way that it generates feelings of joint enterprise, mutual engagement and a shared repertoire (Wenger, 1998). Interaction, critical reflection to reveal tacit assumptions and an atmosphere of reciprocity and trust are mentioned as factors that influence the effectiveness of both the learning process and the (sustainable) results aimed for (Loeber, Mierlo, Grin and Leeuwis, 2007; Shor, 1993). Therefore the agenda of the collaborative learning and working process should at least contain issues like norms, values, discourse, knowledge, power, identity, meaning and interpretation (Hamann and Rosen, 2011; Shore and Wright, 1997).

Initiating collaborative learning arrangements and inviting multiple stakeholders to join with the aim to stimulate sustainable economic development also requires explicit attention for the intended effects on the regional economy (Mosse, 2004; Rodrigues and Viedma, 2006). Therefore, collaborating partners should make explicit what kind of changes they seek to provoke (Hamann and Rosen, 2011; Loeber, Mierlo, Grin and Leeuwis, 2007) and reflect upon the concrete outcomes of the collaborating process and if these indeed generate the effect aimed for (Hamann and Rosen, 2011; Mosse, 2004).

RDM Campus explicitly aims to stimulate regional sustainable economic development by initiating and facilitating regional collaborative learning (Hooijer and Muris, 2009). From earlier studies into collaborative learning arrangements (Lappia, 2010 and 2011) the importance of connecting four levels of learning is emphasized: individual learning processes with team learning, organizational learning and community learning. As mentioned earlier these collaborative learning arrangements are characterized by diversity in multiple ways. In order to stay focused on the intended effect of the outcome on regional sustainable economic development, the collaborating process should reveal the policies and agenda's of the participating stakeholders (Hamann and Rosen, 2007; Mosse, 2004). Knowledge about policies and agenda's helps to illuminate the relationship between learning and putting the learning outcomes into practice because they bring tacit theories and assumptions about sustainable development to the surface (Loeber, Mierlo, Grin and Leeuwis, 2007), they shed light on factors like motivations, objectives and priorities individual stakeholders hold with respect to the collaboration and they make clear if participants mention implementation of a successful outcome as part of the collaborating process (Mosse, 2004).

3.2 Gaps to be bridged according to a meta study

Main finding of the meta analysis of 'Innovation Arrangements' within 21 Institutes of Vocational Education shows that initiatives like Innovation Teams are more successful when they overcome the gap between the needed professionalism among stakeholders and the existing professionalism (Smulders, Van Wijk and Zitter, 2011). The professionalization gap is successfully bridged whenever:

- Stakeholders are more (or even fully) aware of the goals (rationale) of the sustainable development that the whole Community of Practice is striving for;
- Stakeholders are able to change their insight of the goals (rationale) of the sustainable development into goal oriented interventions towards their participating students;
- Stakeholders are professionalized in a result driven way in order to overcome the revealed transformational gaps.

The transformational gaps within initiatives like Innovation Teams that Smulder, van Wijk and Zitter (2011) found in their meta analysis at 21 Institutes of Vocational Education are the gaps between (1) firms needs and educational needs; (2) individualized talent coaching and the limited possibilities for suitable education and (3) the inflow-outflow of technical education.

3.3 Problem analysis and future needs according to stakeholder analysis

On the basis of the empirical data collection and problem analysis among ten stakeholders involved in the RDM Campus a lot of different subfactors were found in their citations. Their citations were divided into three categories: productive subfactors, unproductive subfactors and future needs to attain regional sustainable developments by

Innovation Teams. These stakeholders are all lecturers involved in an Innovation Team and participate in the Community of Learners.

Although stakeholders all named different sub factors and theoretical saturation is not yet reached we have been able to categorize the citations into four substantive factors:

- *Connecting firms and education*
This factor includes all citations about (un)productive factors and future needs of collaboration between the firms that are involved and the multi-level education by vocational training and higher education.
- *Realizing realistic business projects*
This factor includes all citations about (un)productive factors and future needs of realizing realistic business projects initiated by companies who are involved in the Innovation Teams.
- *Collaborating between multi-level education*
This factor includes all citations about (un)productive factors and future needs of joined collaboration between students of higher education (university and polytechnic) and vocational training.
- *Learning within Communities of Practice*
This factor includes all citations about embedding more continuous learning projects within the R&D Campus and connecting to exciting communities or creating new Communities of Practice.

Table 1 Number of citations by stakeholders divided into categories

Factor	PF	UPF	FN	Example statement
Connecting firms and education	6	3	4	'Collaboration between students and professionals motivates students' 'Sometimes the project assignments are too much work for the students' Connection between educational qualifications and the assignments from companies
Realizing realistic business projects	17	4	3	'Working on realistic projects motivates students and has a large learning effect on them' 'The expectations of companies are not always clear ' 'Challenging project assignments and clients'
Collaborating between multi-level education	7	6	1	'Intermediate vocational education students continuing their study into the next level of the university of applied science' 'There is a gap between the technical skills of the multi-level students'
Learning within Communities of Practice	0	0	7	'Connect ourselves to communities who already exist'
Shaping preconditions within cultural and political factors	0	10	4	'Too much bureaucracy and only a few rights lower in the organization' 'More focus on results and content and less on the processes'

In addition to these four substantive factors, a number of preconditions also appeared to be important. Therefore we have a fifth factor that involves the preconditions and the more cultural and political factors raised by the stakeholders. Table 1 shows the connection between the five factors and the number of productive subfactors (*PF*), unproductive subfactors (*UPF*) and future needs (*FN*) that are raised by the stakeholders. In the last column there is an example statement given for each factor. The factor ‘Realistic projects’ has the most productive factors and the factor ‘Preconditions and more cultural’ factors has the most unproductive factors. Striking is that the factor *Communities of Practice* only includes future needs.

Table 2 shows the connection between the five factors in which the citations are categorized into the four levels of learning in which workplace learning takes place: individual level of the participant (student, lecturer, employee), group level (the team), organizational level (preconditions, structure, culture of the organization) and community level (all the participants involved in the development and coaching of workplace learning). Table 2 shows that the factor ‘Realistic Projects’ has the most productive factors on the level of group learning. The factor ‘Community of Practice’ has only future needs on the level of community learning. And the factor ‘preconditions and more cultural and political’ has the most unproductive factors on the level of group learning. Also striking is that on the level of community learning the stakeholders haven’t mentioned any productive factors.

Table 2 Connection between factors including the sums of (un)productive subfactors and future need and levels of learning

Factors	Individual level			Group level			Organization level			Community level		
	<i>PF</i>	<i>UPF</i>	<i>FN</i>	<i>PF</i>	<i>UPF</i>	<i>FN</i>	<i>PF</i>	<i>UPF</i>	<i>FN</i>	<i>PF</i>	<i>UPF</i>	<i>FN</i>
Connecting firms and education	2	0	3	3	2	0	1	1	1	0	0	0
Realizing realistic business projects	5	2	0	11	2	0	1	0	1	0	0	2
Collaborating between multi-level education	3	2	0	0	1	0	4	3	0	0	0	1
Learning within Communities of Practice	0	0	0	0	0	1	0	0	0	0	0	6
Shaping preconditions within cultural and political factors	0	0	0	0	9	3	0	0	0	0	1	1

Table 3 shows that all found factors in the empirical study are supported by the two other data sources and methods, except for Communities of Practice. The citations from the empirical data collection also only covered future needs. Wenger (1998) are often cited by other researchers but their claims are not yet substantiated by the findings in the meta study nor the empirical study.

Table 3. Triangulation matrix of findings in three data sources per factor

Data sources → Factors ↓	1	2	3
	Literature study Based on multidisciplinary literature research	Meta study Based on project documents and evaluations	Empirical case study Based on citations of stakeholders of R&D Campus
Connecting firms and education	<i>Establishing connections between education and firms in collaborative learning arrangements; Interaction, explicating assumptions and reciprocity and trust influence the effectiveness of learning process and results (Loeber, Mierlo, Grin and Leeuwis, 2007; Shor, 1993)</i>	<i>Gap between firms needs and educational needs</i>	<i>Collaboration between multi-level vocational education and the firms involved</i>
Realizing realistic business projects	<i>Organize learning and working process in such way that it generates feelings of a joint enterprise, mutual engagement (Wenger, 1998).</i>	<i>No findings?</i>	<i>Realistic projects assigned by companies raises motivation among students; coaching of students forces lecturers to explicit their tacit knowledge</i>
Collaborating between multilevel education	<i>The development of flexible and innovative professionals</i>	<i>Gap between inflow-outflow of technical education; Gap between individualized talent coaching and the limited possibilities for suitable education</i>	<i>Joint collaboration between students of higher and intermediate vocational education</i>
Learning within Communities of Practices	<i>The enhancement of regional collaborative learning, open source innovations, communities of practice; Organize learning and working process in such way that it generates (...) a shared repertoire (Wenger, 1998).</i>	<i>No findings</i>	<i>Embedding outcomes of single Innovation Teams into continuous learning processes within (existing) CoP's</i>
Shaping preconditions, within cultural and political factors	<i>Explicit attention to processes of production and reproduction (Apple, Au and Gandin, 2009; Hamann and Rosen, 2011; Levinson and Holland, 1996; Saltman, 2009; Shor, 1993) The agenda of the collaborative learning and working process contains norms, values, discourse, knowledge, power, identity, meaning and interpretation (Hamann and Rosen, 2011; Shore and Wright, 1997); Knowledge about policies and agenda's in order to illuminate the relationship between learning and putting the learning outcomes into practice (Loeber, Mierlo, Grin and Leeuwis, 2007; Mosse, 2004).</i>	<i>Gap between the needed professionalism among stakeholders and the existing professionalism</i>	

4. Conclusions

The research study found good convergence within the triangulation for four factors. These four factors substantiate *whether regional sustainable development is enhanced by reconstructed curricula of higher vocational education when taking the role of change agent within a R&D Campus as a micro economic cluster*. These factors are: (1) Connecting firms and education, (2) Realizing realistic business projects, (3) Collaborating between multilevel education and (5) Shaping preconditions within cultural and political factors. For the factor Learning within Communities of Practice only theoretical evidence was found and empirical future needs. So Communities of Practice can be seen as a future ambition and future factor. This mainly theoretical perspective offers an emerging challenge for sustainable development and regional knowledge economy.

The stakeholders in the technical R&D Campus found out that all unproductive factors within their student groups they encounter are merely failures of their own attitudes or non cooperative behavior. Empowered by this action research project and professionalization program the stakeholders meet each other in genuine dialogues during meetings of the Community of Learners. The feeling of being in a joint enterprise grows every time. Mutual engagement to reassure that factors are made productive is growing as well. So the next step is to discuss and transform Table 2 into a dynamic learning and working agenda for the next year of the Community of Learners. Productive factors can be used on individual learning level to diminish the unproductive factors or to realize future needs. Unproductive factors of the factor preconditions are mainly revealed on group level, so what learning and working actions should be undertaken by the stakeholders as a group or Community of Learners? To tackle this challenge these unproductive factors are better not only seen as issues for the account of the program manager and director to diminish.

Future research will have to focus at one hand on the *micro educational level* by revealing the grown effectiveness of the stakeholders who often participate in the professionalization meetings. By showing that their students report better learning results. From literature it is known that such feedback motivates lecturers and coaches from firms the most in continuing their attention and efforts to make the Innovation Teams and the role of Communities of Practices within the R&D campus into a success. Future research should at the other hand incorporate evaluation of the *micro economical level* by adoption appropriate mechanisms and a regional IC framework to systematically evaluate the path the R&D Campus as micro economic cluster is following, to avoid potential lock-ins or undesired deviations and to be able to take corrective actions. Every small step within an Innovation Team at this R&D Campus attributes to the local ambition of creating regional sustainable development and in the end to the global ambition of realizing a sustainable and prosperous future for all on the globe.

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