What impedes a successful Third Mission? Identifying and avoiding the main barriers in transdisciplinary cooperation

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Abstract
Due to the increasing complexity of societal challenges, the mutual transfer of knowledge and technology through transdisciplinary cooperation between different actors from science, politics, business, and civil society is becoming more and more important. In this context, the role of Higher Education Institutions (HEIs) in society is changing. In addition to their core missions of teaching and research, HEIs are involved in externally oriented activities. This so-called "third mission" complements the roles of HEIs. However, in the cooperation between the different disciplines and sectors, the actors involved repeatedly encounter barriers that prevent successful knowledge and technology transfer or at least make it more difficult. These barriers are also referred to as transfer barriers.

The aim of this paper is to identify and specify the transfer barriers in transdisciplinary cooperation for innovation. For this purpose, a systematic literature review, as well as methods of participatory action research, were applied in the context of one of the largest transdisciplinary cooperation projects in Germany: münster.land.leben, which is the largest participatory transfer project at Münster University of Applied Sciences (MUAS), covering 16 subprojects and more than 75 partners from science, politics, business and society. The accompanying research of this large-scale project enabled the authors to gain a more fine grained picture of the barriers identified in literature to be enriched and specified through the practical experience of this transdisciplinary cooperation in the context of health innovation. In total, twelve transfer barriers could be identified. Theoretically, the present work contributes to the knowledge gap of transfer barriers in transdisciplinary cooperation and addresses the need to provide cooperation with knowledge to implement them successfully. Practically, the paper raises the awareness of the barriers and thus creates the prerequisite for addressing and overcoming them in a second step, to contribute to the successful implementation of transdisciplinary cooperation projects for innovation.

Keywords
transdisciplinary cooperation, transdisciplinary process, science with and for society, knowledge and technology transfer, co-creation, transfer barriers

1 Introduction

"Given the complexity and scope of major societal challenges, all potentials for the development and implementation of innovative solutions should be used and accordingly - in addition to business partners - other non-scientific societal partners should be involved in research and innovation activities and their initiation." This is what the German Council of Science and Humanities recommends in their position paper (Wissenschaftsrat, 2015). Accordingly, the European Commission has declared the development of cooperation between science and society to be an important strategic development field and correspondingly developed the funding line "Science with and for Society" (SwafS) to bring together scientific excellence, social awareness, and responsibility (European Commission, 2020).

Science with and for society, thus the involvement of Higher Education Institutions (HEIs) in externally oriented activities is called third mission (Berghaeuser and Hoelscher, 2020). This so-called third mission complements the roles of HEIs in addition to their core missions of teaching and research (Pinheiro, Langa & Pausits, 2015). Modern academic institutions see this third mission as a dialogical process that jointly develops insights from academics and external actors to bring about positive changes in various areas of society (Karlsen and Larrea, 2019).

This view focuses on the shift from a unilateral to a multilateral understanding of transfer. In this view, a high level of participation by external actors is of particular importance. Therefore, we are not only referring to transfer but to the concept of co-creation (Ramaswamy and Ozcan, 2018).

Although the relevance of transdisciplinarity and co-creation has been recognized and the amount of transdisciplinary and co-creation project is raising, in practice a huge amount of these projects fail (Babiak and Thibault, 2009). In order to prevent this failure, there is as yet no suitable set of instruments (Felt, Fochler, 2008), which can be attributed to the fact that knowledge about the inhibiting factors is still too unspecific. Therefore, the aim of this paper is to identify and specify the transfer barriers in transdisciplinary co-creation projects.

In the subsequent part of the paper, first the terms "transdisciplinary cooperation" and "transdisciplinarity" are discussed in conjunction with the methodology used to identify and specify the transfer barriers. Thereafter the barriers are described in detail and the results of this research are elaborated. The last section contains the results of the work with their theoretical and practical contribution, limitations, and suggestions for future research.

2 Theoretical background - transdisciplinary process

The term ‘transdisciplinary’ as opposed to ‘interdisciplinary’ means by definition, that not only scientists from different research fields (disciplines) work together (ref. to inter-

disciplinary), but moreover actors from different sectors, such as e.g., science, business, civil society, or politics pursue a common goal (Jahn et al., 2012; Luthe, 2017; Russel et al., 2008).

The original idea of cooperative behaviour between different sectors emerge because one actor alone cannot cope with upcoming tasks. Therefore, a conscious decision is made to pursue common goals by combining ideas, information, and resources (Snow, 2015), thus exploiting the special innovation potential that arises from networking, interaction, and participation of different actors. In this context 'transdisciplinarity' is defined as a critical and self-reflective research approach. Here, social, and scientific issues are brought together, and new knowledge is generated through the integration of findings from various sides, which contributes to both social and scientific progress (Jahn et al., 2012).

In the transdisciplinary research approach as described above, the various actors are integrated as comprehensively as possible in the entire process - from a common definition of the research question to the generation and implementation of practically relevant results. Based on the changed comprehension of transfer, the aim is to change the culture of knowledge transfer from "science for society" to "science with and for society" (Luthe, 2017).

According to Lang et al. (2012), the cooperative process in transdisciplinary cooperation is divided into three phases. Phase A includes the establishment of a research team with actors from the different sectors and the joint problem definition. Research goals are formulated regarding specific research or socially relevant questions, besides conceptual and methodological framework conditions for knowledge integration are developed. In phase B the 'co-creation' takes place, in which solution-oriented knowledge is actually being generated. In this process, various integrative (scientific) methods are applied and further developed to facilitate the differentiation and integration of the individual bodies of knowledge that come together through the transdisciplinary process. In phase C, the generated knowledge is (re)integrated into the social context. Due to the different perspectives, views, values, and contexts of knowledge that have been brought together throughout the entire transdisciplinary process, there is no classic transfer from science to society, but rather a (re)integration of the knowledge gained into the real society as well as the scientific practice.

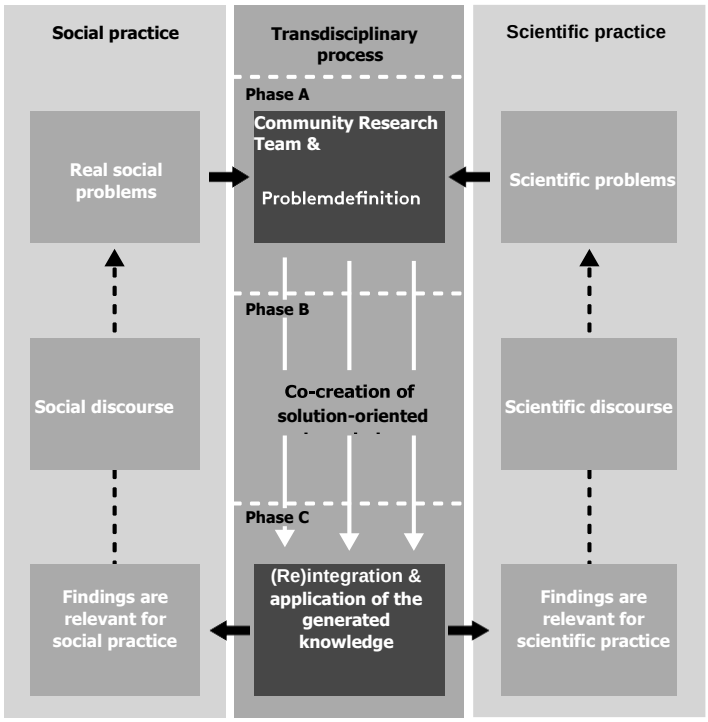

Fig. 1: Model of a transdisciplinary process (Lang et al., 2012)

In all three phases of the illustrated transdisciplinary process, transfer barriers can occur that make cooperation more difficult or even prevent its successful implementation. These obstacles lead to the fact that a large part of transdisciplinary cooperation still fails (Babiak, Thibault, 2009). To prevent this failure, there is no suitable set of instruments yet (Felt, Fochler, 2008), which can be attributed to the fact that knowledge about transfer barriers in transdisciplinary cooperation is still too unspecific. Therefore, this paper aims to identify and specify the obstacles to successful knowledge and technology transfer. The following figure illustrates an exemplary transdisciplinary process with the participation of social and scientific actors.

3 Method – literature review and participatory research

To answer the question which transfer barriers can be identified in transdisciplinary cooperation between science and social actors and how the barriers can be specified, first a systematic literature review was carried out. Subsequently, methods of participatory action research were used to enrich these theoretically gained insights with the practical experiences of the various actors from münster.land.leben. The following search terms were used for the literature research in the electronic databases Web of Science, Scopus, and Google Scholar: Barrier*, challenge*, hinder*, universit*, academic*, researcher*, scholar*, communit*, societ*, social*, transfer*, collabor*, allianc*, partnership, cross-sector*, inter-sector*, transdicipl*. All papers and book publications were considered in the search, without any prior time restriction regarding the year of publication. Publications were included in the analysis if they dealt with obstacles in transdisciplinary

cooperation. A list of 73 possible transfer barriers was compiled from literature. In a next step, these barriers identified in the literature were systematized in terms of content and aggregated in 19 categories.

To gain an initial overview of the transfer barriers experienced in münster.land.leben, independent of the theoretically gained insights from literature, an interactive workshop was conducted with the actors of the sub-projects using the methods "Brain Writing" and "World Café". Based on the workshop results, further 13 expert interviews were conducted with the operational project managers of the sub-projects. Here, the practical experiences of the sub-projects in the context of their transdisciplinary cooperation projects were discussed and further analysed. The interview insights were compared with the findings of the literature research so that consolidation and reflection of the previous findings from theory and practice could take place.

Participant	Position	Level of experience	Sub-project	Department	Gender
I01	Transfer manager	high	Sub-project 12: Transfer office The transfer management is responsible for the management/organization of the entire project.	Transfer / Health	Female
I02	Scientific Associate	medium	Sub-project 9: community between tradition and chance (Dorf 4.0) In Dorf 4.0 participatory measures are developed to ensure the long-term attractiveness of the village of Ellewick-Crosewick (Municipality Vreden, district Borken).	Electrical Engineering and Computer Science	Male
I03	Scientific Associate	medium	Sub-project 4: Reges:BOR Reges:BOR is a network for health advancement and prevention that was developed so that the people can grow up and live healthily.	Health	Female
I04	Scientific Associate	medium	Sub-project 4: Reges:BOR	Health	Female
I05	Scientific Associate	medium	Sub-project 6: Mobile innovation trailer (opentruck) The mobile innovation trailer serves as an information and communication platform, where topics in the context of health, participation and well-being are supported by multimedia.	Design	Male
I06	Scientific Associate	high	Sub-project 5: Science Marketing The sub-project Science Marketing serves as scientific-analytical unit and focuses on HEIs interaction with society (science with and for society) as a central field of research in order to tackle complex societal challenges.	Business	Female
I07	Scientific Associate	medium	Sub-project 1: Stu.bE The sub-project addresses elderly people who are affected by the risk of falling to implement a fall management system with the help of civic engagement.	Health	Female
I08	Scientific Associate	medium	Sub-project 2: Smart Mirror In this sub-project intelligent data mirrors (smart mirrors) are used as an innovative and effective medium to make health information accessible to people.	Food - Nutrition - Facilities	Female

I09	Scientific Associate	high	Sub-project 6: Mobile innovation trailer (opentruck)	Transfer	Female
I10	Scientific Associate	high	Sub-project 4: Reges:BOR	Health	Male
I11	Scientific Associate	medium	Sub-project 10: Does health come though? The aim of the sub-project is the development of strategies, forms and formats for target group-specific offers for conveying health information. It provides building blocks for instruments of a successful "Science with and for Society" approach.	Communi-cation	Female
I12	Scientific Associate	high	Sub-project 2: Smart Mirror	Electrical Engineering and Computer Science	Male
I13	Scientific Associate	medium	Sub-project 3: Healthy Lifestyle Community The health status of a municipality is assessed using maturity model. Depending on the situation. Tools are selected according to the needs of the multicipalities, which help to achieve their target maturity level step by step and at a low threshold.	Food - Nutrition - Facilities	Male
I14	Scientific Associate	medium	Sub-project 10: Does health come though?	Food - Nutrition - Facilities	Female
I15	Scientific Associate	medium	Sub-project 2: Smart Mirror	Electrical Engineering and Computer Science	Male
I16	Scientific Associate	high	Sub-project 1: Stu.bE	Health	Female

Fig. 2: Overview of the research sample

During the expert interviews, the project leaders were also asked to classify the transfer barriers according to the phases of the transdisciplinary process according to Lang et al. (2012). The classification serves to categorize the barriers and provide orientation, but should not be understood as a definitive assignment, since transfer barriers sometimes occur continuously and at several points in the process. This is based on the assumption that transdisciplinary processes should not be understood as linear, but as iterative processes (Wickson, Carew, Russell, 2006), thus encompassing the possibility of returning to previous steps during the process and of going through different phases several times.

4 Results – 12 transfer barriers

As a result of the systematic literature review, as well as the participatory action research findings from münster.land.leben, the following twelve transfer barriers emerge. Figure 2 provides an overview of the twelve transfer barriers and their classification in the transdisciplinary process according to Lang et al. (2012):

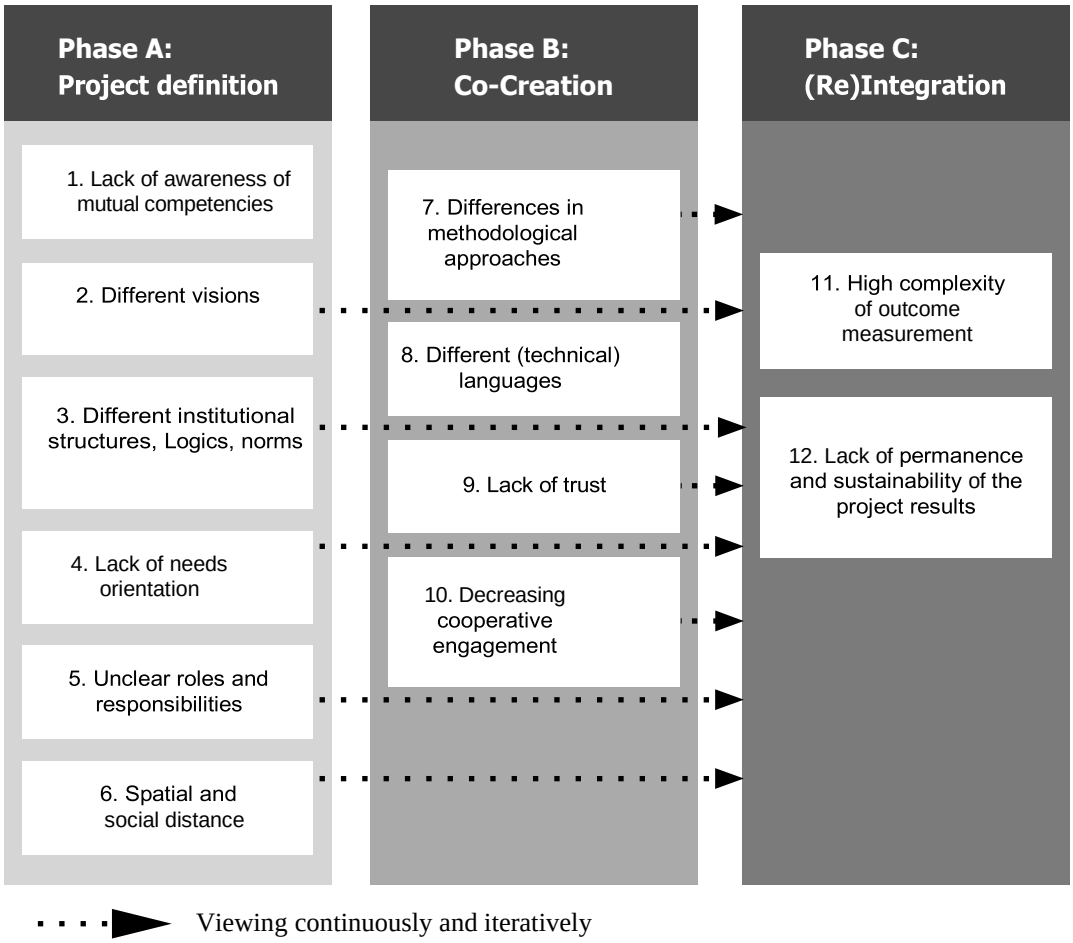

Fig. 3: Classification of transfer barriers in the transdisciplinary process

In the following, the twelve transfer barriers are described in detail and illustrated with experiences from münster.land.leben, and the classification into the phases of the transdisciplinary process are explained.

(1) Lack of awareness of mutual competencies

Actors from different sectors are often not aware of the competencies of the other actors involved in the cooperation.

Insufficient knowledge about each other's competencies can be defined as a transfer barrier that is crucial for success (Hawley et al., 2007). Each participant should first proactively present his or her abilities.

> *The decisive factor in cooperation is to make one's skills transparent on the one hand and to recognise the skills of the partners on the other. In this way, the potential that lies within can be used directly. […]. (I03)*

The added value of an expanded knowledge base is emphasised in the next quote.

> *[…], it was still not clear in detail which skills everyone could bring to the table. After awareness of this was created, the cooperation was much more*

effective, and the diversity of perspectives was perceived as enrichment by everyone. (I05)

It should be emphasised that political and social actors are often unaware of the knowledge base and expertise of universities. Universities, in turn, do not consider political and social actors as partners (El-Jardali, Ataya, Fadlallah, 2018), as only a few academics are trained or have sufficient experience in the field of knowledge and technology transfer (Jacobson, Butterill, Goering, 2004). The lack of awareness of each other's competencies can make cooperation more difficult at the beginning when forming a joint research team and is therefore assigned to phase A: Project Definition.

(2) **Different visions**

Especially in transdisciplinary collaborations, there is the risk that the actors develop different visions without a clear orientation and focus on the project.

Especially in transdisciplinary collaborations between academics and actors from society, the ideas of the project goal are often diverging. Differences in vision and orientation are a major obstacle to transfer in this context (Firman- syah, 2017; Unertl et al., 2015).

Bringing the different goals and visions of the individual sub-projects of münster.land.leben into harmony is a task of the project and transfer manager.

With 13 different sub-projects and their sub-project-specific goals, it is important to agree on a common, overarching vision for improving health, participation, and well-being in rural areas within the project. Therefore, it is even more important to create a common vision through direct and mutual exchange and to constantly reflect on it together. (I01)

The aspect of critical reflection and (if necessary and required) adaptation of a project vision defined at the beginning was particularly recognised in the participatory development of a common vision within the sub-project ‘Fall Management with Civic Engagement (Stu.bE)’ and identified by the different actors as an important prerequisite for further successful cooperation.

[…] it was necessary to reflect on the project vision developed at the beginning and to modify it several times during the project to meet the different needs of the actors involved. If we had not engaged in this joint "finding process" during the project, the success of the project would have been at risk. (I07)

A common vision is especially important from the beginning of the cooperative project work and therefore the transfer barrier "different visions" can be classified in phase A: project definition.

(3) **Different institutional structures, logics, and norms**

Each of the four sectors (academia, business, civil society, and politics) has its own structures, logics, and norms that complicate knowledge transfer within a cooperative project.

The literature confirms discrepancies between scientists and actors from society due to their involvement in different organizations with different structures, logics, and norms (Unertl et al., 2015). From the perspective of science, knowledge and technology transfer still has a low priority among many scientists and in the entire institutions. It often experiences a lack of acceptance and institutional recognition, as the focus of universities is still based on classic scientific and not on social success indicators (Bonn et al., 2016). Scientists who engage in society-based projects within and outside of academic institutions often receive insufficient appreciation for their engagement due to these lacking recognition mechanisms in the German higher education system. For example, scientists are still primarily measured by their publications in scientific journals, the implementation of teaching activities and their success in generating third-party funding; the integration of new forms of knowledge, networking with actors from business and society in the sense of the third mission, as well as external science communication to a broad non-scientific audience from politics, business and society are usually de facto disregarded (Bonn et al., 2016). This often leads to a lack of capacity for society-based research (Bonn et al., 2016; Israel et al., 1998). Furthermore, aspects of corporate culture can make successful cooperation difficult, such as different time orientations, individual ways of working, motivation, market orientation (Plewa, Quester, Baaken, 2006), or entrenched and bureaucratic ways of handling the use of resources (Trencher et al., 2014). Financial resources and time are made available for the implementation of the research project, but the prior effort to create suitable framework conditions is underestimated. A multitude of transfer mechanisms and a high complexity of funding guidelines, review committees, or accounting practices can also inhibit cooperation with social actors (Edler, Schmoch, 2001; Lloyd, Michener, 2012). Social actors, on the other hand, are often bound to processes and dynamics of the market and must react quickly and flexibly to corresponding developments.

I02 describes the transfer barrier concerning different logics and norms as follows:

> *Academics often think about societal solutions in a very analytical and solution-oriented way, but sometimes also in a complicated way. The users usually have a more practical and problem-oriented view. It is very profitable to combine both ways of thinking. […])*

The quote makes clear that a first step towards overcoming the transfer barrier is openness and willingness to accept the partly unknown, unfamiliar and often different structures, logics, and norms of the opposite party and to join the conversation.

Different institutional structures, logics, and norms represent a relevant transfer barrier in all project phases but should be in the awareness of the individual actors from the very beginning and are thus assigned to phase A: Project Definition.

(4) Lack of needs orientation

A lack of orientation and reference to the different needs of all actors in a project can hinder the success of cooperation.

It is a major challenge - and at the same time a greatest opportunity in the context of co-creation projects - that scientific research has to develop solutions in a way that they meet the needs of stakeholders from society (Bodison et al., 2015). Hence, it is crucial for researchers to understand the cultural and socio-economic diversity of society from the outset (Bodison et al., 2015). Researchers should avoid transferring their theories and models unreflectively to the actors of society if they contradict the experiences and needs of that social group (White-Cooper et al., 2009).

Ideally, the needs of the stakeholders from society should already be considered when setting the topics so that the project is also accepted and can unfold its potential. This becomes clear in the following quote:

> *[…] without focusing on and understanding the needs of those affected, science, no matter how well-positioned it is, cannot provide suitable solutions. (I07)*

At the same time, transdisciplinary cooperation should not only consider the needs of the target group in society but also those of scientists. Academics are highly interested in answering their questions in a way that meets scientific standards (Israel et al., 1998).

Since the inclusion of mutual needs is already decisive for the development of the common vision, objective, and problem definition, this transfer barrier is placed in phase A: Project Definition. Needs change over time, so this barrier remains relevant throughout the project.

(5) Unclear roles and responsibilities

Unclear responsibilities, guidelines, and allocation of tasks between the project participants as well as asymmetrical distribution of roles make transdisciplinary cooperation difficult, especially regarding management and its organization.

In the development of cooperation, role asymmetries due to unequal distribution of power and control can be perceived as a major transfer barrier (Israel et al., 1998; Strier, 2010). In addition, a lack of definition of the general distribution of roles and the associated uncertainty can make cooperation difficult (Kindred, Petrescu, 2015). The importance of defining roles together with all partners at the beginning of cooperation is illustrated by the quote of I04:

> *[…] Especially when many aspects, ideas, and perspectives come together, it helps to make the roles of each partner transparent for everyone from the beginning. […] This process takes time in the beginning, but in our experience, it pays off during the project. (I04)*

In addition to general, unclear responsibilities and role asymmetries, inadequate project leadership can be a major obstacle to the success of a collaborative project (Babiak, Thibault, 2009). Adequate project leadership is an accelerator for transdisciplinary collaboration, so that, conversely, the absence of such leadership is a transfer barrier (Winters et al., 2016).

> *The linear structure of classic research projects is particularly difficult to implement in participatory projects. New tasks, roles, and responsibilities are added or redefined during the project, which requires agile project management. (I10)*

The transfer barrier is classified in phase A: Project Definition. However, the ambiguities are also relevant throughout the other phases.

(6) Spatial and social distance

Cooperation with many different actors can be confronted with spatial and social distance from each other, making personal contact and effective communication and organisation more difficult.

Cooperation begins through the exchange of common interests, through proximity,and personal conversation with each other. The sometimes large spatial distances between the actors involved are therefore perceived as an aggravating factor, especially in transdisciplinary collaborations (Caron, Hiller, Wyman, 2014). The increased time required due to large spatial distances also means that work processes are prolonged, and the right timing becomes a critical factor (Unertl et al., 2015).

Particularly in rural areas as e.g. the Münsterland, the density of settlements is low. This spatial distance is often accompanied by various problems in organisation and communication as I02, wo is the project manager of one of the sub-projects of münster.land.leben, reports:

> *[…] Due to the great distance, each meeting represents a great effort. Nevertheless, after each meeting you see how important this personal exchange is, as it makes the coordination much better, more personal, and more efficient. It is crucial to find the right time for a meeting to receive valuable feedback. (I02)*

In times of the COVID-19 pandemic, the imperative of reducing social contacts to a minimum puts specific emphasis on this barrier, as because of the more difficult communication and the lack of personal contact it can cause difficulties in project implementation even in collaborations where there is not a great physical distance between the actors.

> *Our network thrives on regular network meetings where all actors come together, discuss, and set new priorities. Due to the distance and hygiene regulations that must be observed in the COVID-19 pandemic, we hold the*

network meetings digitally. […], the discussions are as lively as usual. Only the technical requirements pose an obstacle in some cases. [...]. (I03)

The pandemic has extended the challenge of spatial distance to collaborations in which the great geographical distance between the actors was not originally a fundamental problem, but it also shows potential for how digital cooperation can still make collaborations possible.

Spatial and social distance is a critical factor that complicates the success of transdisciplinary cooperation in every phase, from the beginning of phase A: project definition to (re)integration in phase C. Therefore, the transfer barrier is assigned to phase A: Project Definition but remains relevant until the end of the cooperation.

(7) Differences in the methodological approach

Cooperation between scientists and social actors often find differences in methodological approaches and orientations. Regarding the research methods used, there is a danger of not meeting the scientific requirements and at the same time not being relevant for the social actors.

It can be observed that the conceptualisation of scientific findings is primarily geared towards scientific publication and neglects the suitability for societal stakeholders (Simpson, 2002). Especially in research projects with the participation of social actors, there is a particular need for a methodologically stringent approach, because the field of society-based research must continuously face challenging questions regarding validity, credibility, and objectivity (Israel et al., 1998).

The following quotation illustrates that in transdisciplinary projects the scientific, as well as the social side, must always be considered in the methodological approach:

[…] Science often follows the proof of theories, but in our case, it must not lose sight of the application in practice but should focus on it as directly as possible. (I06)

As the practical experience in münster.land.leben also shows, problems can arise in the methodological approach precisely because (or despite) the consideration of the various partners. This can be attributed to the lack of experience of the actors involved in dealing with the new, participatory approach.

[…] the fact that this path must first be jointly developed in participatory research projects requires an iterative process, which often means two steps forward and one back. This often unsettles the social actors involved, who are not familiar with this participatory research methods and procedures and instead rather expects scientists to have a straight forward research design with predefined milestones and results right from the beginning. (I16)

Based on the findings from the literature and the experiences from münster.land.leben, the differences in the methodological approach are classified in phase B: co-creation, as

methodology, plays an important role especially at this point up to the measurement of results.

(8) **Different (technical) languages**

Different technical languages can lead to communicative misunderstandings that complicate cooperation and the coordination process.

Companies, universities, politicians, and civil society actors have specific technical vocabulary that is often not understood by the other actors (Eckl, 2012).

> *[…] Due to the transdisciplinary cooperation of individual actors from different disciplines as well as external companies, the respective specialist language is different, which makes communication more difficult. A basic understanding of each other's languages and the "translation" of the specific content is a crucial element here. (I09)*

The complexity of communication due to the lack of understanding of the different technical languages of the various scientific disciplines is well describes in literature (Gooch, Vasalou, Benton, 2016), but its relevance in transdisciplinary projects is made explicit by I12from the Smart Mirror sub-project:

> *[…] When different disciplines work together, it is important to have good communication skills, because truly innovative projects can only be developed if the individual actors understand each other's specialist languages and we think outside the box of our discipline. The unreserved recognition and appreciation of the other disciplines are the key to success for us thus of course misunderstandings sometimes occur in such a transdisciplinary approach and time and attention are needed to speak a common "language". (I12)*

In addition, there are often great difficulties in communicating with social actors without a scientific background (Johnson et al., 2014). In the step of transferring research results into the societal context, the translation of scientific results for people without an academic background is often neglected and therefore cannot be fully understood by people with a non-scientific background (White-Cooper et al., 2009). To counteract this, the target group should be precisely defined and accessibility factors at micro, meso, and macro levels should be considered (Schrögel et al., 2018).

The fact that the language must be tailored to the target group for good science communication is highlighted in the quote by I11:

> *[…] it is an important prerequisite to speak the same language as our target groups. Therefore, an important step is to first develop a communication concept to design communication that is appropriate for the target group and to reach the different groups in the best possible way. (I11)*

Different technical languages are particularly noticeable in the generation of new knowledge, so this transfer barrier is to be classified in phase B: co-creation. However, the technical language has a high value concerning the communication of the results, which is why the transfer barrier remains continuously relevant for (re)integration.

(9) Lack of trust

Lack of trust prevents a good relationship between the different actors in a project.

Trust has been shown to be one of the main factors for the success of collaborations (Plewa, Quester, Baaken, 2006), yet the literature identifies a major deficiency in this area and describes it as one of the greatest challenges to build trust, especially between researchers and social actors (Moeliodihardjo et al., 2012; Israel et al., 1998).

There is agreement amongst researchers that the following aspects can be responsible for the lack of trust: hierarchical relationships (Unertl et al., 2015), insufficient personal contact (Ferlie et al., 2012), unfamiliarity with relevant stakeholders (Bodison et al., 2015), and lack of unity and harmony among each other (Trencher et al., 2014). Furthermore, it requires not only the establishment of mutual trust but also the continuous maintenance of this trust (Israel et al., 1998).

> *[…] We have experienced that familiar people have an easier time getting into contact and conversation with the citizens than simply "someone" from the university, so it is extremely relevant to establish personal contact despite the time required and other difficulties, and thus to establish trust through the "human factor". (I16)*

Phase A: project definition is excluded from the transfer barrier since, at the beginning of the formation of a joint research team, trust is usually not yet present and must first be built up. Therefore, the transfer barrier is assigned to phase B but relevant until the project end.

(10) Declining cooperative engagement

As the project continues, there is a risk that the commitment of the individual actors in the project will decrease and that there may even be a loss of participating actors.

The phenomenon described in the literature of a decline in cooperative commitment over the course of the project, the decline in the feeling of mutual commitment and support, as well as the reduced exchange of information (MacDonald, 2019; Israel et al., 1998) represents a serious barrier in transdisciplinary research projects that needs to be counteracted.

> *At the beginning of the project phase, many actors were involved with great commitment in the planning, preparation, and implementation of activities such as workshops, a health market, or seminar contributions. Over time, however, a decrease in cooperative commitment is noticeable, e.g., planning meetings could*

no longer be held due to time or organisational reasons. However, short-term support in response to specific requests was and is consistently available in the communities. (I14)

The relevance of considering the various requirements and priorities and expressing the corresponding appreciation is made clear in the quote by I13 from the Healthy Lifestyle Community sub-project:

[…] the interpersonal component is important. The task is not to coordinate robots, but people and they must be motivated again and again. (I13)

The transfer barrier can be assigned to phase B: Co-creation but is continuously relevant.

(11) **High complexity of outcome measurement**

The results of transdisciplinary projects are difficult to measure because they often involve long-term changes in attitudes and behaviour. Due to this hard to quantify and therefore often not carried out impact measurement, there is a danger that the social relevance of the projects is not sufficiently considered.

Meaningful indicators that measure societal relevance are difficult to develop (Bornmann, 2012). Molas-Gallart, Tang, and Morrow (2000) attribute this difficulty in measuring relevance to the fact that research results do not always show direct relevance but have an indirect and delayed impact on society. Since projects and their results are very individual, there are no standardised evaluation models.

Due to the difficulties of measuring results, it is relevant to take these into account conceptually when planning the cooperation and setting the objectives.

[…] desired result should be measurable and thus empirically verifiable. For this reason, we are conceptualising the user dialogues with the Smart Mirror in such a way that a survey with targeted questions on the impact of the dialogues on health literacy can be linked to it. (I15)

In addition to the early consideration of outcome measurement in projects, the perspective of all participants must always be considered in the evaluation of transdisciplinary projects with different actors. I10 from the reges:BOR sub-project makes clear that sometimes the results can only be recorded holistically if not only the individual positions are taken into account, but also the connection between them:

An evaluation of the network process should concentrate on looking at the network and not just at individual positions. The great gain resulting from joint network practice for instance is more than the sum of its parts, it is something new. (I10s)

Since outcome measurement is crucial for the application and (re)integration of the generated knowledge, this transfer barrier is assigned to phase C: (Re)Integration.

(12) **Lack of permanence and sustainability of project results**

With the termination of the project, there is a risk that the results will not be sustainably secured in practice and/or that the project will not become permanent.

Because the social relevance of research results often only becomes apparent after some time (Bornmann, 2012), the consolidation and sustainability of the results can sometimes only take place at a later point in time. It is necessary to develop a strategy during the project to ensure the long-term effects of the project results.

> *[…] A strategy must be developed at an early stage to establish joint measures in society in the long term. Here we have had good experience with committed citizens and health actors who helped to develop a multiplier concept. (I08)*

The development of a strategy for the continuation and sustainability of the results can already take place during co-creation in phase B. However, the strategy is implemented at the end of the project in phase C and is thus decisive for the (re)integration and application of the generated knowledge. Therefore, the transfer barrier is assigned to phase C: (Re)Integration

5 Conclusion

Considering the complexity and scope of major societal challenges, transdisciplinary projects and co-creation are gaining relevance (Wissenschaftsrat, 2015). During the process of cooperation between different scientific and non-scientific actors, transfer barriers can repeatedly impede or even prevent the joint generation of knowledge. To be able to address and overcome this transfer barriers, deeper insights about these barriers are needed. Based on a comprehensive literature review and results from participatory action research in a transdisciplinary cooperation project, 12 transfer barriers could be identified.

On the one hand, this work contributes to the scientific state of research, as the systematic identification and categorisation of transfer barriers in transdisciplinary projects have been a research gap so far, which the results of this work help to close. On the other hand, referencing the theoretical findings back to practice and the final renewed abstraction also ensure that the results can generate not only a theoretical but also a practical added value. This procedure ensures both a scientific and practical reference of the results and the systematic categorisation of the knowledge gained from science and practice provides a holistic approach. The identification of transfer barriers contributes to their awareness, which is the decisive prerequisite for being able to address them in a further step. Hence the research contributes in a way that the currently still high number of failed transdisciplinary collaborations (Babiak, Thibault, 2009) can be proactively reduced to a minimum and contributed to their success in the long term.

Since addressing and overcoming the possible transfer barriers requires not only an awareness of these, but also suitable methods and practical knowledge, the author`s

research group is further developing a "toolbox" for better interlinking science and society. The toolbox serves as a handbook with strategic and operational tools and methods for both scientists and societal actors who participate in transdisciplinary projects to address the aforementioned transfer barriers. Accordingly, the toolbox makes a practical contribution to the methodological support of the interrelationship between science and society by helping to address and overcome barriers in transdisciplinary collaborations along the twelve transfer barriers identified in the context of this work.

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