HARMONI

INDUSTRIAL COOPERATION ON REGULATION AND STANDARDISATION

List of areas with high transferability potential

Deliverable D5.2

Project HARMONI "Harmonised assessment of regulatory bottlenecks and standardisation needs for the process industry"
Grant agreement: 768755
From August 2017 to October 2019

Lead Author: ECREF gGmbH
Date: 10/07/2019

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 768755

DELIVERABLE FACTSHEET

Project start date	August 2017
Project end date	October 2019
Project website	www.spire2030.eu/harmoni
Deliverable number	D.5.2
Deliverable title	Harmonised assessment of regulatory bottlenecks and standardisation needs for the process industry
Lead Partner	ECREF gGmbH
Work Package no.	WP5
Task no. and title	5.2 "List of areas with high transferability potential"
Version	1
Version Date	10/07/2019

Diffusion list

Dissemination level	
X	PU = Public
	PP = Restricted to other programme participants (including the EC)
	RE = Restricted to a group specified by the consortium (including the EC)
	CO = Confidential, only for members of the consortium (including the EC)

Authors and contributors

Lead author	ECREF gGmbH
Author/s	Conseil Européen de l'Industrie Chimique (Cefic) DIN e.V.
Reviewers	Fundación CIRCE

Documents history

Version	Date	Main modification	Entity
Draft 1	31/12/2018	-	ECREF gGmbH
Draft 2	27/06/2019	Corrections & quality assurance	CIRCE, DIN eV.
Final	28/06/2019	Corrections	ECREF gGmbH

DISCLAIMER OF WARRANTIES

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 768755"."

This document has been prepared by HARMONI project partners as an account of work carried out within the framework of the EC-GA contract no 768755.

Neither Project Coordinator, nor any signatory party of HARMONI Project, nor any person acting on behalf of any of them:

(a) makes any warranty or representation whatsoever, express or implied,
  (i). with respect to the use of any information, apparatus, method, process, or similar item disclosed in this document, including merchantability and fitness for a particular purpose, or
  (ii). that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or
  (iii). that this document is suitable to any particular user's circumstance; or

(b) assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if Project Coordinator or any representative of a signatory party of the HARMONI Project, has been advised of the possibility of such damages) resulting from your selection or use of this document or any information, apparatus, method, process, or similar item disclosed in this document.

ABBREVIATIONS

Asbl	Association internationale sans but lucrative (engl. "Association without lucrative purpose"; Belgian non-profit organization)
D5.1	Deliverable 5.1
DKE	Deutsche Kommission Elektrotechnik
EC	European Commission
EEN	Enterprise Europe Network
e.V.	eingetragener Verein (engl. "registered association")
GA	Grant Agreement
LC(A)	Life Cycle (Assessment)
MO	Missed Opportunities
ISy	Industrial Symbiosis
PPP	Public Private Partnership
R&D	Research and Development
R&D&I	Research and Development and Innovation
SME	Small- and Medium Sized Companies
TC	Technical Committee
TOT	Transfer of Technology
TRL	Technology Readiness Level
WP	Work Package

PARTNERS SHORT NAMES

CIRCE	Fundación CIRCE – Centro de Investigación de Recursos y Consumos Energéticos
CEFIC	Conseil Européen de l'Industrie Chimique
CEMBUREAU	Association Européenne du Ciment
A.SPIRE	SPIRE
DIN	DIN – Deutsches Institut für Normung e.V.
ECREF	European Centre for REFfractories gGMBH
ECREF / FGF	Forschungsgemeinschaft Feuerfest e.V.
ECREF / VDFFI	Verband der Deutschen Feuerfest-Industrie e.V. (German Refractory Association)
FEHS	Institut für Baustoffforschung e.V.

PUBLISHABLE SUMMARY

This deliverable compiles results from desk work and research activities on how to measure and improve the transfer of different types of innovations within a company.

After a short introduction to the fifth working package, the reader will be provided with the most relevant definitions. The third chapter elaborates the methodology used for this document's research and links the working package to former working packages within the HARMONI project but also to related literature. Besides a literature review, the research was based on earlier deliverables and selected good practices examples collected within interviews, workshops and other meetings with HARMONI stakeholders (associations, EU project coordinators and the industry) such as workshops and the STAIR platform.

The fourth chapter depicts indicators and critical success factors for corporate innovation transferability, including remarks on approaches to foster innovation transferability within SMEs. Those indicators can mostly be assessed with self-explicated quantified indicators such as a seven-point-Likert scale and were clustered in the following **key indicator clusters to assess innovation transferability**:

- Integration of innovation transfer in the company's strategy
- Innovation culture and readiness
- Innovation- and Life Cycle Management, incl. agile methods
- Bureaucracy
- Monitoring incl. IP monitoring and indicators
- Skills and skill development
- Information management
- IT-based challenges and digital tools
- Management of external relations
- Funding, financing, investment decisions

The **critical success factors** for innovation transfer have been depicted within the deliverable as **self-explicated quantified indicators** and are clustered into the areas above. Those are as following:

- *Agility*
- *Agreement on project goals; clear objective of innovation projects*
- *Availability of information*
- *Availability of innovation transfer promoters on all employee levels / on management level*
- *Right business model*
- *Compliance*
- *Development of skills*
- *Effective indicators*
- *Effective networks*
- *Experience and skills*
- *Financing innovation transfer*
- *Handling of information*
- *Intensity and/or size of network Knowledge transfer from/with external sources*
- *Learning from failure*
- *Knowledge and qualification existent*
- *Monitoring processes*
- *Motivation of employees*
- *Openness to innovation transfer*
- *Product management capabilities*
- *Project management capabilities*
- *Readiness for innovation transfer*
- *Role of management*
- *Role of standardization for innovation transfer*
- *Role of the industrial association*
- *Similarity*
- *Support of innovative ideas*
- *Trust*
- *Utilizing information technology*
- *Visibility as a potential cooperation partner*

Those indicators were collected in a bottom-up and top-down research approach. This research includes the Best Practices that were observed during the entire HARMONI project, results from earlier WPs and other surveys, but also related external sets of indicators as well as further literature.

It becomes obvious that especially the management of external relations and networks is of high relevance, but also the availability and development of skilled people as well as the usage of digital tools that are of especial importance for the performance of the company and the indicators above.

The fifth chapter provides the reader with areas of innovation transferability and identified channels to transfer innovation. The identified key areas of potential transfer opportunities are shown below:

Potential key areas of improved knowledge transfer	Potential key areas of technology transfer	Social, political, economic & industrial trends
a. Accelerated deployment of the R&D&I opportunities identified within SPIRE b. Access to funding and new business models, e.g. for circular economy c. Cluster initiatives to leverage outreach d. Innovation management (high exchange of approaches, Best Practices, Lessons Learnt) e. Management attitude & corporate culture f. New materials / surfaces g. Process modification and refinement h. Logistics i. Licensing in different life cycle phases j. Skills & training k. Smart Specialisation	a. Construction technologies b. Information technology, IT applications and software; IT-security technology and monitoring applications c. Key Enabling Technologies, especially - Nanotechnology - Advanced materials - Advanced manufacturing d. Production technology including mechanical engineering and machinery e. Testing facilities (DIN e.V. & DKE 2018) f. Resource and energy efficient process industry* - Feedstock - Processes and process intensification, incl. ISy - Market application - Waste2Resource - CO_2 to fuel/chemicals	*These trends form a third type of transfer since they require deepened knowledge exchange & cooperative learning* a. Digital transformation & Industry 4.0 b. Enhanced use of optimisation technique c. Pro-environmental activities - Circular Economy - Energy management - CO_2 valorisation - Renewable energies - Waste recycling d. Lightweight products e. Measuring devices f. Monitoring technologies g. Industrial Symbiosis (ISy)

* See SPIRE Roadmap 2030 (Tello & Weerdmeester 2013).

Those identified trends and key areas of transferability have then been discussed with experts from the SPIRE industry, narrowing the pre-defined key areas of transferability down to SPIRE-specific areas as well as complementing the same accordingly. A very relevant source was the SPIRE roadmap as well as the SPIRE Vision 2050 Document. The new SPIRE Roadmap 2050 is currently under development and strongly recommended as further literature.

TABLE OF CONTENTS

LIST OF FIGURES

1 INTRODUCTION

1.1 Introducing the fifth working package (WP5)

The European process industry represent a major part of the manufacturing base in Europe, including over 450,000 individual enterprises that generate more than 1,6 billion € turnover.[1] It is technologically sophisticated and innovation-orientated. The HARMONI project was launched as part of the Horizon 2020 programme in order to analyse non-technological barriers to innovation and innovation transfer as well as measures to develop solutions to foster innovation activities in the European process industry.

The overall objective of Work Package 5 (WP5) is to support the process industry with cross-sectorial transferability of innovations in the process industry. The work developed in WP 5 is presented in three deliverables:

a) **Deliverable D5.1:** analysing the main non-technological barriers to cross-sectorial innovation transfer
b) **Deliverable D5.2:** analysing the main areas with cross-sectorial transferability potential *Examples and Best Practices might be showcased, recommendations how to transfer innovation ("solutions") will be developed. A set of indicators to analyse the cross-sectorial transferability potential of an innovation (e.g. a new financing scheme) should be set up.*
c) **Deliverable D5.3** merges earlier WP results into a methodology that fosters the transferability of innovations across sectors. It will identify the most transferable technologies such as services or equipment to complement the results from this deliverable

The aim of this paper is to provide an overview on the given topics as well as related links for deep-dive knowledge. This paper cannot provide detailed solutions for all barriers and areas identified but shall support stakeholder to be informed on opportunities more easily and to find individual solutions.

1.2 Objectives of this document

As a result of deliverable D5.1, we have identified challenges to innovation transfer. Those were split into real barriers to cross-sectorial innovation transfer and missed opportunities.

Social, institutional and technical innovations are considered to be the main drivers of structural change and the international competitiveness (Baudson 2008; Neck et al. 2014). Based on Schumpeter, researchers often define innovation as "anything that is both new and useful" (Hill 2014; Neck et al. 2014: 58, Rogers 1983). This can be a process, product, market and organisation as well as new combinations of those types (service, business models) (Schumpeter 1934).

Innovations can contribute towards efficiency increases (Jordan et al. 2014) and enable long-term as well as transient competitive advantages. This is especially important in times where companies face a progressive shortening of life cycles and a decreasing half-life of knowledge (Baudson 2008). Achieving effective innovation is a complex task and during this process, companies - especially SMEs - often face barriers (Strobel und Kratzer 2017).

There are various approaches on how to foster innovation activities and -success at companies, a very important way if doing so is innovation transfer. With this background, this deliverable aims to

- Identify and define (mostly quantifiable) indicators for transferability in the process industry
- Spot areas with a high transferability potential between sectors in the process industry
- Identification, description and exchange of good practices examples of the transfer of non-technological and technological innovations within the process industry

[1] See Eurostat (https://ec.europa.eu/eurostat/).

The document compiles results from desk work and research activities, D5.1 and earlier HARMONI deliverables (exploited and complemented), furthermore results from the workshop on "Enhancing the transferability of solutions across SPIRE sectors". This workshop took place in January 2019 under the "2019 HARMONI Summit" umbrella.

This work focuses on:

- the transferability potential between the sectors of the process industries that are in scope of the HARMONI project, but not beyond those sectors,
- horizontal innovation transfer only, but not on vertical innovation transfer (from research to market launch; across the different TRL),
- Innovation management, as a previous step for enabling a smooth technological and services transfer within the company, independently of the typology of this innovation

The key output from this document is a list of areas with high transferability potential across the project-relevant sectors as well as a list of indicators categorized accordingly, focusing in innovation management issues.

2 DEFINITIONS

2.1 Innovation and technology transfer

In times of low economic growth, degradation of the environment and societal instability, companies must be innovative as well as able to transfer innovations from other sectors and companies. Especially the process industry has a high number of established companies with historically grown structures, processes and a specific corporate culture.

In order to stay competitive long-term, companies need to act ambidextrous, which means they exploit existing processes while building new competitive advantages at the same time (exploration). Especially for long established companies or SMEs ambidexterity can be challenging and established are considered to be rarely per se entrepreneurial (Wolcott and Lippitz 2009).

"*Large companies have a way of eroding their entrepreneurial underpinnings*"
- Thonberry 2001: 527

Since companies have only limited resources to invest, most companies face a trade-off that arises between exploration and exploitation (Markides and Chu 2009: 5). Innovation transfer can save costs and reduce innovation efforts.

Innovations can be transferred within an organization, outside of the organization to another organization or into the organization from another organization e.g. by cooperating with other organizations or copying an existing innovation. Generally speaking, any innovation transfer takes place through the transfer of data, information or knowledge, explicitly by exchanging those or implicitly through the copying of products, processes, etc. This can furthermore occur across different Technology Readiness Level (TRL) or on the same TRL (for detailed description please see D5.1).

The HARMONI project focus is on innovation transfer between organizations from different sectors, i.e. cross-sectorial innovation transfer. This can include the transferability between two countries. We use the 10-categories-scheme by Keeley to structure the types of innovation which can be transferred:

Category	Type of innovation
Configuration	Profit model
	Network
	Structure
	Process
Offering	Product performance
	Product system
Experience (marketing)	Service
	Channel
	Brand
	Customer engagement

Figure 1: Own graphic adapted from Keeley et al. 2013

All categories have transfer potential. Technology transfer (TOT) is one kind of innovation transfer, however much more well-known in the process industry.[2] Generally speaking, a technology is defined as the collection of techniques, skills, methods, and processes that are used for production or to achieve objectives. As such it can encompass a variety of innovation, however one innovation is sufficient to change the complete technology.

"Technology transfer across borders in today's globalized world has become an everyday phenomenon." (Rössing 2006)

TOT occurs by sharing information, methods or samples of manufacturing, but furthermore skills, facilities and other adequate resources. Some organizations are known for having an Office of Technology Transfer dedicated to identifying research which has potential commercial interest and strategies for how to exploit it, e.g. the Centre for Technology Licensing, Edinburgh Research and Innovation, Harvard University Office of Technology Development, Technology and Licensing Office, University of Washington's TechTransfer, VentureCatalyst Program etc.

Possible approaches for TOT and cooperatively bringing new technologies to market include licensing agreements and joint ventures, but also (research) spinouts for the case that an organization does not have the resources or skills to develop a new technology. Funding can be supported by raising venture capital or governmental support. Barriers to TOT in practice will be discussed in later chapters. HARMONI research has shown that experts agree that the channel to transfer technologies or innovation in general depend on the type of innovation.[3]

2.2 Diffusion of innovation

The innovation must be widely adopted in order to self-sustain. The commercialization of innovation creates their market value and enables them to self-sustain. After the development and persuasion phase, the innovation will be implemented in the market and diffused across sectors, markets, industries, etc. Diffusion, by definition, takes place among people or organizations. Theories on the diffusion of innovation seek to explain how, why, and at what rate new ideas and technology spread. Adopters evaluate an innovation on relative advantage, compatibility with existing systems, complexity/ difficulty to learn, testability, reinvention potential and observed effects. These qualities interact and are judged as a whole.

Communication channels allow the transfer of information, therefore communication patterns or capabilities must be established between parties as a minimum for diffusion to occur. Main elements in diffusion research provide ideas on potential areas of innovation transfer: (1) corporate innovation, (2) communication channels[4], (3) time to adopt innovation, and (4) the social system. This process relies heavily on human capital (see Rogers 1983).

[2] See observations made during the HARMONI project including results from the 2019 HARMONI Summit.
[3] See observations made during the HARMONI project including results from the 2019 HARMONI Summit.
[4] Communication channels allow the transfer of information and are necessary for diffusion (Rogers 1983) and therefore transferability.

2.3 Open innovation

Open Innovation was defined as the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively (Chesbrough 2003). Open innovation is a concept that automatically allows knowledge transfer through the collaboration.

See further: European Commission - DG Growth and Innovation 2018.

2.4 Indicators

There are several indicators known and used in business, management and innovation practice. Although some sources claim to have a perfect set of indicators to achieve full comprehensiveness in the analysis of a company's performance, each company should decide on its own which indicators are with to be assessed, which ones are required and where the effort of assessing the indicators is too high in relation to their outcome.

In the business and economic context, indicators fulfil different functions to assess relevant information about an industry, market, company, etc. from a broader data set. As a result, one can benchmark the relevant objective against other objectives or make and legitimize decisions based on clear, target-orientated and widely understood information.

Indicators should be designed as following:

- Meaningfulness of the indicator and adequateness for the task given
- Target-orientation with regards to the characteristic to be assessed, e.g. transferability
- Economic thought, i.e. the utility of an indicator should justify the effort to assess it
- Reversibility and clarity
- Representativeness to correctly depict a specific aspect that allows conclusions about the objective as a whole
- Usability for decision-making in order to assess risks and opportunities, coordinate related fields, provide information for decision makers

Indicators can then inter alia leverage a company's actions to

- control for target achievement since indicators support the comparison of ex-post assessments of earlier defined targets or assumptions,
- plan measures in the case of a gap between target and real achievement,
- control behaviour of management, employees, cooperation partners and other stakeholder (a badly chosen indicator may lead to mismanagement of respective group),
- align indicators and strategy, e.g., using Balanced Scorecards.

Indicators can be categorized differently e.g. with regards to a company's economic success, liquidity, return, capital structure, etc. However, within this WP, no general categorization is used, but a specified in order to better fulfil the project requirements.

3 METHODOLOGY

3.1 Literature review

The document compiles results from earlier tasks conducted within the HARMONI project[5], literature review including other EC-funded projects, SPIRE research and the P4P-survey as well as research results collected during the 2019 HARMONI Summit in January 2019 (see Annex C, p. 40). In addition, some external sources will be assessed such as practical experience of SPIRE and other EU-funded projects, previous information from industrial associations, NCPs, knowledge transfer institutions, and selected SMEs and large companies.

The comprehensive literature review was key words based, including words such as "transferability, indicators, success factors, standards, (non-) technological barriers in process industry, technical challenges, list of emerging technologies, areas of transferability, knowledge transfer, TOT, etc. ".

Case studies were selected from both the extant literature and from knowledge gathered during interviews with subject matter experts in order to cover the full value chain in the analysis. It was observed that there is no literature on "areas of (solution / innovation) transfer in the process industry" as well as related terms. Also "success factors on transferability" had to be deducted from different sources and related topics since they were not discussed in literature.

There is more on the more specified topic on technology transfer with dedicated magazines such as the Journal of Technology Transfer by the Technology Transfer Society. The magazine provides a forum to exchange ideas that enhance and build an understanding of the practice of technology transfer as well as to jointly explore the environment that affect technology transfer practices, including global trends, public policy developments, regulation and legal issues. Readers only interested in the transfer of technological innovation are recommended to get more specific information on such in that kind of related literature.

3.2 Overview on the evaluation of results from WP2, WP3 and WP4

As stated earlier, this document compiles results from earlier tasks conducted within the HARMONI project. Research results in this document are therefore based on earlier deliverables and selected good practices examples collected within interviews, workshops and other meetings with HARMONI stakeholders (associations, EU project coordinators and the industry). The identification procedure used so far can be depicted in the following table (see next page), excluding further literature review.

[5] Please see deliverables D2.3, D3.1 and D4.1 for more information as well as the attached analyses of those earlier research results with regards to the requirements for task 5.2 in the Annex (all chapters), pp. 38 ff.

Regulation and regulatory processes	Standards and standardization processes	Other non-technological barriers to innovation
a. Interviews with industrial representatives in EU projects / EU Project Coordinators (WP 2, Task 2.1) b. Analysis of position papers of and interviews with industrial associations (WP 2 + 3) c. A survey on regulation among the industry (WP 3, Task 3.1) d. Workshops with industrial associations (March 22nd, 2018) and with companies (April 26th, 2018) (Task 2.3)	a. Interviews with industrial representatives in EU projects / EU Project Coordinators (WP 2, Task 2.1) b. Analysis of position papers of industrial associations (WP 2) c. Identification of TCs of EU standardisation bodies linked to process industry (WP2) d. A survey on standardization among the industry (WP 2+4, Task 2.2) e. Workshops with industrial associations (March 22nd, 2018) and with companies (April 26th, 2018)	a. Interviews with industrial representatives in EU projects / EU Project Coordinators (WP 2, Task 2.1) b. Analysis of position papers of industrial associations (WP 2) c. Identification of TCs of EU standardisation bodies linked to process industry (WP2) d. A survey on standardization among the industry (WP 2+4, Task 2.2) e. A survey on regulation among the industry (WP 3, Task 3.1) f. Workshops

3.3 2019 HARMONI Summit

In addition to research results from earlier WPs, indicators for transferability have been collected and validated during the 2019 HARMONI Summit (Session 1A, "Learning from success - tools and standardisation to grow and transfer innovations" on 17th January 2019, 9 – 12 o'clock). It was also possible to validate the research results of task 5.1 as well as to collect a satisfying amount of other good input for Task 5.2 and 5.3. Later chapters contain the collected and analysed results, also see ANNEX C – 2019 HARMONI Summit Minutes, p. 39.

09:30 - 12:00 including a coffee break

Workshop 1A

Learning from success
- tools and standardisation to grow and transfer innovations

- Innovation management is no rocket science – how to boost corporate performance through innovation transfer and standardization
  - *Eva Diedrichs. Founding Managing Director at IMP³rove - European Innovation Management Academy*
- Modern innovation management – develop the right business model for innovation
  - *Nizar Abdelkafi. Fraunhofer Center for International Management and Knowledge Economy*
- From blacksmith to Digital Native – building innovation paths in established companies
  - *Alexander Hajek. Key Account Manager, Bernd Münstermann GmbH & CO KG*
- Best Practice in innovation transfer. How to replicate water management approaches in an EU context - *Durk Krol. Executive Director, WssTp*

Session Moderator: *Ann-Kathrin Blanke, ECREF gGmbH. Sönke Nissen/Christian Grunewald, DIN e.V.*

Q&A and working sessions in smaller groups

Figure 2: Agenda of Session 1A, "Learning from success - tools and standardisation to grow and transfer innovations" on 17th January 2019, 9 – 12 o'clock

3.4 Tools to collect indicators on innovation management and entrepreneurship[6]

The critical success factors / indicators for innovation transferability were collected in a bottom-up and top-down research approach. This research includes the Best Practices that were observed during the entire HARMONI project, but also related external sets of indicators which we present in the following.

The innovation tool IMP³rove was initiated by the European Commission, DG Enterprise and Industry, in 2006 and became a European pre-standard documented in the CEN Workshop Agreement CWA 15899 in 2010. In 2014, the IMP³rove – European Innovation Management Academy EWIV has been founded as a non-profit organization by A.T. Kearney GmbH and APRE, now covering over 80 countries worldwide. In 2017, the European Commission awarded three projects to IMP³rove Academy "in order to further leverage their holistic approach to foster the innovation eco-systems in Europe, and to utilize the IMP³rove Academy's expertise in innovation management capability development of start-ups, SMEs and business advisors" (also financed through Horizon 2020).[7]

The IMP³rove Assessment supports the identification and evaluation of innovation management capabilities and performances as key drivers for competitiveness, stating to use a holistic approach (key priority of HARMONI, see task 2.3 - fiche 1).

Since the assessment is based on the world´s largest benchmarking database on innovation management and the European Standard on innovation management (see CEN/TS 16555), it seems like a very good source to deduct indicators for innovation transferability and corporate entrepreneurship. The company's overall performance is broken down into following dimensions[8]:

- Innovation Strategy
- Innovation Organisation and Culture
- Innovation Life Cycle Processes
- Enabling Factors, such as IT, project management, IPR or HR management
- Innovation Results (output of innovation management activities and indicators of success)

Two other easy-to-understand-tools that supports companies to measure their internal corporate entrepreneurship capability is the Corporate Entrepreneurship Assessment Instrument (CEAI) by Kuratko et al. (2014) and the Community Innovation Survey (European Union – Eurostat 2008).
The CEAI instrument consists of 48 Likert-style questions and has been shown to be psychometrically sound (Kuratko et al. 2014). Its dimensions are management support for corporate entrepreneurship, work discretion, rewards / reinforcement, time availability and organizational boundaries.

4 INDICATORS FOR INNOVATION MANAGEMENT AND TRANSFER

4.1 Overview

"You can't manage, what you can't measure."
– Peter F. Drucker, economist

So far literature does not provide a set of indicators which assess a process industry's innovation transferability, therefore we deducted adequate indicators through taking into account earlier WPs and utilizing existing indicator for the company's sets general performance, its external relations (with suppliers, competitors, clients), different management fields as well as across the value chain (see also: Dutta et al. 2016). We furthermore build on the company's capability to deal with barriers to innovation

[6] Imp³rove also offers assessments on the digital innovation quotient of a firm, the innovation management capabilities in line with economic, ecologic and social sustainability as well as a root cause analyses on a firm's innovation management.
[7] IMP³rove – European Innovation Management Academy EWIV (Ed.) (sa)
[8] IMP³rove – European Innovation Management Academy EWIV (Ed.) (2014)

transfer and its ability to leverage opportunities. We have mostly formulated easily understand phrases to identify critical success factors. One can whether rather disagree or agree to these phrases. The critical success factors are clustered so that each company can decide which categories to answer to.

Since these critical success factors are not easily quantifiable, we recommend to apply a five- or seven-level Likert scale with a weighted evaluation according to the relevance of the criteria in order to get self-explicated quantified indicators. Therefore, if applied, we also recommend to distribute the survey more broadly within the company in order to ensure more objective data rather than very distinct personal results.

Companies can use these phrases partially or all of them to reflect their vision and activities with regards to innovation transfer as well as to search for gaps between their future aspirations in that field and their current status. Optionally, participating companies can create benchmarks when sharing their results – this can be especially useful when looking for new cooperation and innovation transfer partners. The **cluster of the critical success factors / indicators** are as following:

- Integration of innovation transfer in the company's strategy
- Innovation culture and readiness
- Innovation- and Life Cycle Management, incl. agile methods
- Bureaucracy[9]
- Monitoring incl. IP monitoring and indicators
- Skills and skill development
- Information management
- IT-based challenges and digital tools
- Management of external relations
- Funding, financing, investment decisions

The **critical success factors / indicators** for innovation transfer, which have been clustered into the areas above, have been collected in a bottom-up and top-down approach as well. They can be formulated in self-explicated quantified indicators as following:

- Agility
- Agreement on project goals; clear objective of innovation projects
- Availability of information
- Availability of innovation transfer promoters on all employee levels / on management level
- Right business model[10]
- Compliance
- Development of skills[11]
- Effective indicators
- Effective networks
- Learning from failure
- Knowledge and qualification existent
- Monitoring processes[12]
- Motivation of employees[13]
- Openness to innovation transfer[14]
- Product management capabilities
- Project management capabilities[15]
- Readiness for innovation transfer
- Role of management
- Role of standardization for innovation transfer
- Role of the industrial association

[9] Exploration and exploitation activities require substantially different, often conflicting structures, processes, capabilities and cultures (Markides & Chu 2009, Tushman & O'Reilly 1996: 24; Sheremata 2000: 389).

[10] Stressed also by participants from the 2019 HARMONI Summit. We recommend to look at the research results from the INSPIRE project during which a set of tools was developed to help Industrial players to re-evaluate their business model innovation (BMI) strategy. See more: http://www.inspire-eu-project.eu/inspire-tools/.

[11] Stressed also by participants from the 2019 HARMONI Summit.

[12] Should be applied structured and broadly. May indicate assumptions on the risk-taking behaviour and other attitudes.

[13] Motivation of employees covers also sufficient freedom to work creative / integration of creative people.

[14] Openness to innovation also indicates assumptions on the risk-taking behaviour of a company or individual.

[15] Project management capabilities were mentioned as important skill within the survey among companies (WP 2+3, Appendix, D5.1).

- Experience and skills
- Financing innovation transfer
- Handling of information
- Intensity and/or size of network Knowledge transfer from/with external sources
- Similarity[16]
- Support of innovative ideas
- Trust[17]
- Utilizing information technology
- Visibility as a potential cooperation partner

A country's, market's and product's transferability can be assessed as well to get more comprehensive results, however we focus on the company's innovation transferability as previous step for the technology transferability to be studied in Task 5.3. The next abstract will elaborate further on this factors by depicting the survey.[18]

4.2 Integration of innovation transfer in the company's strategy[19]

Operationalization of critical success factors	Critical success factors
Our innovation (transfer) projects have their basis in the general corporate strategy, they are derived from it (presence of a long-term innovation strategy)	Readiness for innovation transfer
We continuously seek for new ideas	Openness to innovation transfer
We continuously seek for new markets	
We have a budget for research projects dealing with or enabling innovation transfer (which is not directly covered though customer assignments)	Financing innovation transfer
We have a budget for cooperation projects that focus on non-technological innovation transfer	
We have a budget for cooperation projects that focus on technology innovation transfer	
I have a sufficient amount of information about all the institutions we work with	Effective networks; handling of information
I regularly check if I know all of our external relationships and understand related activities	Effective networks; Compliance
I am well aware of all laws and rules that could be related to developing and transferring innovations (e.g. IPR, Anti-Trust, GDPR) [20]	Compliance
I ensure that within my company all laws and rules that could be related to developing and transferring innovations (e.g. IPR, Anti-Trust, GDPR)[21]	

4.3 Innovation culture and readiness

Operationalization of critical success factors	Critical success factors
We have a clear vision for the future	Readiness for innovation transfer
We have clear targets for your innovation transfer activities	
Our manager are willing to get involved in something new / innovation activities, e.g. aquire new markets	
We continuously seek for new ideas	Openness to innovation transfer
We continuously seek for new markets	
In our company we transfer relevant information for innovation projects in an open and transparent communication approach within each entity	Openness to innovation transfer; handling of information
In our company, we transfer relevant information for innovation projects in an open and transparent communication approach across entities, e.g. between factories or across borders	
If necessary, we can design the work conditions of our employees individually e.g. using home office or flexible working hours	Motivation of employees

[16] Came up on the 2019 HARMONI Summit and includes similar visions, similar objectives, similar problems or similar materials or processes of two or more companies that enable innovation transfer.

[17] Came up on the 2019 HARMONI Summit. The lack of trust among partners and within/between industries is also a key challenge when discussing innovation in the field of Industrial Symbiosis, see more: EPOS project (*https://www.spire2030.eu/epos*).

[18] In the case of questions or suggestions please contact the responsible project partner ECREF gGmbH.

[19] If those indicators are implemented within a survey, a first chapter on general company data has to be implement as a first page. This includes company size, company age, number of employees, economic sector, etc.

[20] Expertise in IPR and other legal issues was also mentioned as an important skill within the survey among companies (see also Annex in D5.1 and for more on IPR in: European Commission (Ed.) (2019e).

[21] The EU funds five IPR helpdesks staffed by experts who can provide free advice and training sessions on IP issues: The European IPR Helpdesk (https://www.iprhelpdesk.eu/) and four specialised helpdesks supporting European SMEs in China, India, South-East Asia and Latin America.

The performance evaluation of employees is designed rather individual, e.g. individual target setting	
I have recently provided an idea for a new project/product/ process/service/technology into discussion	
Innovative ideas of employees e.g. for new products or processes are supported by non-monetary incentives e.g. awards, time for development	Motivation of employees; support of innovative ideas
Innovative ideas of employees e.g. for new products or processes are supported by monetary incentives	
The company has many employees that actively support innovation transfer activities	Motivation of employees
Our managers actively support technological / non-technological innovation activities	Availability of innovation transfer promoters on management level
Our managers actively support non-technological innovation / technology transfer	Role of management
Our managers follow up on activities with regards to innovation and innovation transfer	
My ideas are followed up on by the management	Support of innovative ideas
The employees that support innovation transfer can be found on all hierarchy level	Availability of innovation transfer promoters on all employee levels
How would you rate staff attitudes to innovation & innovation transfer? (1-7) • Excited / passionate about innovation • Open rather than sceptical towards new unusual ideas • Open rather than sceptical towards new processes developed within the company • Open rather than sceptical towards new processes being copied from external sources • Open rather than sceptical towards new cooperation and project partners • Able to think out-of-the-box • Focusing on business impact • Hierarchy level does not exist	
Innovation is important	Availability of innovation transfer promoters on all employee levels; trust
Innovations from our company are more advanced than innovations from other companies of the same sector	
Innovations from other sectors may be very helpful for as well	
I have conducted a project on innovation or technology project before	Experience & Skills
Our company regularly implements new innovation such as new processes	Change management and technology adoption
Our company regularly implements new technology	
If something new is implemented, employees are informed about the reasons and the benefits	
I think that the changes being implemented are communicated in an reasonable and adequate manner	
How do others view your firm's capacity for innovation?[22]	
For managers only:	
Do you have a list of potential business areas for future innovation activities	Readiness for innovation transfer; support of innovative ideas
We have established a corporate suggestion scheme or another systematic approach to bring in and share ideas with the company	
We continuously seek for new ideas	Openness to innovation transfer; role of management
We continuously seek for new markets	
Our employees show an above average engagement and motivation to work creative	Motivation of employees
Our employees show an above average engagement and motivation to search for innovations that can be transferred	
We consider innovation failure as a good chance to learn and improve	Learning from failure
We have established a systematic approach to learn from failure	
We provide our employees with training on innovation transfer	Experience & Skills
We provide our employees with training on technology transfer	

[22] The ability to produce and commercialize a flow of innovative technology over the long term.

We follow up on ideas of our employees	Role of management; support of innovative ideas
We ask employees for feedback about changes being implemented	Change management and technology adoption
We take care that employees receive training on new technologies that are being implemented in the company	

4.4 Innovation- and Life Cycle Management

Operationalization of critical success factors	Critical success factors
We conduct Life Cycle Assessments for all our products. *If not, for how many products do you conduct the Life Cycle Assessments? (in percentage)*	Availability of information
How many months does it take for your most profitable product (group) from project authorization to the break-even-point?	
How many months does it take for your most profitable product (group) from project authorization to sale?	Availability of information; product management capabilities
We have external support or ask for external information when conducting LCAs	Knowledge transfer from/ with external sources
We systematically and methodically control the financial and technical risks of innovation projects (e.g. using risk- and portfolio analyses such as SWOT) throughout each Life Cycle phase	Monitoring processes
Our innovation projects are almost always completed during the planned period	Project management capabilities
In innovation transfer projects, we take into account the interests of other business partners at an early stage in innovation projects	
I think that we have enough feedback processes in our teams in place *If not, please clarify your situation.*	
Number of patents registered	Right business model; financing innovation transfer
Number of copyrights/trademarks/ registered designs	
Number of spin-off companies created	
Number of projects evidencing ability to carry out new activities or enter new areas.	

4.5 Bureaucracy

Operationalization of critical success factors	Critical success factors
My department's processes are flexible so that we are able to react to changes quickly	Agility
Other departments' processes are flexible so that we are able to react to changes quickly	
Innovation projects in the company are characterized through fast and short decision paths	
We have agile methods in place	
We request advisory for applying agile methods or we have you done so when using them first	
We have more than five hierarchy levels within the company	Bureaucracy
To what extend are different hierarchy levels involved in innovation transfer search?	
To what extend are different hierarchy levels involved in innovation transfer realization?	
I understand the decision processes at local and regional governmental level	
I understand the decision processes at national governmental level	
I understand the decision processes at European governmental level	

4.6 Monitoring[23]

Operationalization of critical success factors	Critical success factors
We have a broad set of sources to get information that are relevant for innovation activities *Please clarify.*	Availability of information; handling of information
We have processes in place to identify and evaluate relevant markets on a regular basis	Monitoring processes
We have processes in place to monitor new innovation on the market	
We have processes in place to identify and evaluate future markets on a regular basis	
We have processes in place to identify and evaluate competitors on a regular basis *If not, please clarify your situation*	

[23] The European Commission provides a number of good monitoring tools, see more in: European Commission (Ed.) (2019c): Monitoring Innovation and Business Innovation Observatory (for easy access to the latest innovative trends in industry and business).

We have processes in place to monitor our external company network	Monitoring processes
We have IPR experts in place (covering know-how protection, trade-mark protection and patenting)	
We have processes in place to monitor intellectual property protection activity of competitors	
Number of audits or assessments on the innovation transferability per year[24]	
We have good, company-specific indicators in place to evaluate the relevant markets for innovation transfer	Effective indicators
We have good, company-specific indicators in place to evaluate the eight SPIRE sectors in the European process industry with regards to their innovation transfer potential	
We have good, company-specific indicators in place to evaluate the the sectors in the process industry outside of Europe with regards to their innovation transfer potential	

4.7 Skills and skill development

Operationalization of critical success factors	Critical success factors
The required skills for innovation projects and innovation transfer projects are existent, e.g. - specific knowledge - management of interdisciplinary topics - project management or communication skills	Knowledge and qualification existent; project management capabilities
Employees have skills to effectively manage transfer projects from/to/in cooperation with external companies	
In innovation transfer projects, we are able to connect the right employees and their skills to project teams who are required to match the project targets	Development of skills
In innovation transfer projects, the project team is supported to get in touch with the required departments within the company, e.g. sales and finance	
The required skills for innovation projects and innovation transfer projects are continuously further developed and followed-up on	
Employees have the opportunities to get knowledge beyond topics of their daily tasks or on an interdisciplinary level	Development of skills (beyond daily task scope)
We proactively try to bring new knowledge and skills into our company - by employing new workers from other companies - by employing new workers from directly after they graduate - by employing external project manager and / or consultants - by hiring research institutions	Knowledge transfer from/with external sources
Number of experts working for us, who have working experience in another sector from the process industry (in Europe or abroad)	Knowledge transfer from/with external sources
Number of companies in your neighbourhood that introduced a new-to-market innovations within the last three years[25]	
Number of employees who left the company in the last three years	
Number of employees who joined the company in the last three years	
Number of employees who joined the company in the last three years directly after graduating	
In overall, which languages do people employed by the company speak good enough to use it for business activities?[26]	Knowledge and qualifi-cation existent; know-ledge transfer from / with external sources
What are the local languages spoken in markets that your company or your business partner are exporting to?	
What are the local languages spoken at your suppliers'-, cooperation partners'- or clients' markets?	
Number of researchers participating in innovation (transfer) projects	

[24] You can whether use this assessment in a quantified and weighted version or take a look at the following examples of innovation management audits: Innovate! austria; InnoAudit; A.T. Kearney's Best Innovator contest (see references for links).

[25] Companies are more likely to introduce those innovations if other companies in their direct neighbourhood had introduced those in the previous period as well, but also if firms with such innovations have moved out of their neighbourhood. This is because "innovation activities strongly rely on external knowledge. Innovative ideas of users, advanced technology from suppliers, new knowledge generated in science and research, innovations of competitors, or support from consultants and other service providers are often crucial inputs to innovation (Cassiman & Veugelers 2006, West & Bogers 2014). [...] Geographical proximity can certainly facilitate the exchange of knowledge (Jaffe et al. 1993, Thompson 2006, Singh & Marx 2013)." In: Rammer & Kinne 2016: 1.

[26] Being able to communicate in various languages, especially in English, was also mentioned as an important skill within the survey among companies (see more Annex of D5.1).

Number of PhDs obtained through innovation (transfer) project activities or involved in innovation (transfer) activities	Development of skills; project management capabilities
Number of dual apprenticeships involved in innovation (transfer) activities	
Number of training courses/activities realized	
Average number of years of employment within the company	
Average age of all employees within the company	

4.8 Information management

Operationalization of critical success factors	Critical success factors
We have implemented Industry 4.0[27]	Availability of information
During the last three years, how important to your company's innovation projects were each of the following information sources? The degree of importance is defined in "high, medium, low, not used". (see CIS 2008) Internal sources Within your enterprise or enterprise group Market sources Suppliers of equipment, materials, components, or software Clients or customers Competitors or other enterprises in your sector Consultants, commercial labs, or private R&D institutes Institutional sources Universities or other higher education institutions Government or public research institutes Other sources Conferences, trade fairs, exhibitions Scientific journals and trade/technical publications Professional and industry associations	

4.9 IT-based challenges and digital tools[28]

Operationalization of critical success factors	Critical success factors
Are you a technology company?	Utilizing information technology
We have a lot of personal data from our customer that require protection	
Our company uses IT-based tools to get and handle information in a structured manner	
Our company uses IT-based tools to manage its client relationships	
Our company uses IT-based tools to manage internal processes	
We have effective software in place	
Our IT-Systems are up-to-date	
Employees receive sufficient training on new tools	
The implemented IT tools help to improve the communication within the company	
We use Search Engines to assist with innovation transfer from / to our company	
We use Decision Support Systems to assist with analysis and decision-making in our company	
Our current decision support tools are well developed in the areas of product or process-specific economic and environmental assessments	
I feel confident that digital tools could not improve the company's processes *Disagree? Please clarify.*	
Number of software packages/applications developed	
Number of innovations related to development of measurement techniques, control devices and instruments, software/ simulation models, characterization tools, production concepts, organisational models, improved knowledge management tools	

4.10 Management of external relations[29]

Operationalization of critical success factors	Critical success factors

[27] Over the life cycle of a product, a large amount of information is accumulated beginning with the design and development process, via operation, during the course of maintenance, repair, alterations and changes of use or ownership, until its re-use or recycling (DIN e.V. & DKE 2018). Depending on the type of innovation, these data may benefit the development and transfer of innovation.

[28] For more help to digitalize a plant, please check: Siemens Digitalization Consulting (see: References - Recommended links).

[29] This cluster checks for available knowledge about and understanding of SPIRE sectors as well as beyond. This is relevant to identify similarities, join forces and apply standards and promote technology transfer. See also: FUDIPO project (https://fudipo.eu/).

We transfer relevant information for innovation projects to our external project partners openly and transparently	Handling of information; knowledge transfer from/ with external sources
We systematically and methodically control the financial and technical risks of new cooperation	Monitoring processes
We are member of an association - National-wide - European-wide - Internationally	Intensity and/or size of networks; visibility as a potential cooperation partner
We are member of more than one association	Openness to innovation transfer
We aim on joining a(nother) association	
Our association on national level does a good job	Role of the industrial associations
Our association on national level actively supports innovation transfer	
Our association on national level has a big and effective network	
Our association on European level does a good job	
Our association on European level actively supports innovation transfer	
Our association on European level has a big and effective network	
We are member of a cluster network - National-wide - European-wide - Internationally	Intensity and/or size of network; visibility as a potential cooperation partner
We aim on joining a cluster network	Openness to innovation transfer
We collaborate with other companies from the same sector - For research activities - To test and / or demonstrate new products - To test and / or demonstrate new processes - To test and / or demonstrate new services - Other (please specify)	Openness to innovation transfer; visibility as a potential cooperation partner
We collaborate with other companies within the process industry - For research activities - To test and / or demonstrate new products - To test and / or demonstrate new processes - To test and / or demonstrate new services - Other (please specify)	Openness to innovation transfer; visibility as a potential cooperation partner
We are member of a smart specialization initiative	Knowledge transfer from/ with external sources
We aim to develop smart specialisation within the region	Openness to innovation transfer
We actively maintain contacts with external research and development institutions	Intensity and/or size of networks
We actively maintain contacts with other companies, associations and organizations even beyond the day-to-day business from the same sector	
We actively maintain contacts with other companies, associations and organizations even beyond the day-to-day business from a different sector	
In innovation projects, we are able to rely on business partners who meet the special requirements of the project	
Our customers are involved in product development throughout the development process	
Other sectors are involved in product development throughout the development process	
The feedback of our customers (for example in the form of complaints and suggestions) is not only recorded but systematically evaluated and implemented	
The feedback of our project partners is collected and systematically evaluated	
How many external players are you in regular contact with for innovation purposes?	
How many of your external partners have you cooperated with in at least one project related to innovation during the last three years?	Intensity and/or size of networks
How many people currently work on innovation projects in which external partners are involved?	
Acquainted companies from the same or a different sector within the process industry have a similar vision than our company.	Similarity

Acquainted companies from the same or a different sector within the process industry show similarities with our company in their use of materials, their search for new materials or their production processes.	
Acquainted companies from the same or a different sector within the process industry show similarities with regards to their emissions, energy consumption or search for alternatives	
Acquainted companies from the same or a different sector within the process industry are looking for solutions for the same or similar problems	
Acquainted companies from the same or a different sector within the process industry struggle with the same legislation.	
We use norms to learn about innovation that can be transferred to our company	Role of standardization for innovation transfer
We actively participate in the development of standards on national level	
We actively participate in the development of standards on national level	
We have a contact person at the national standardization body e.g. DIN	
We have a contact person at the European standardization body (CEN/CENELEC)	
Number of standards or norms contributed to	
Please indicate the type of innovation co-operation partner by location and by degree of involvement. Use the following categories: *Your country / Other Europe / Unites States / India / China / Other countries (see CIS 2008)* - Other enterprises within your group - Suppliers of equipment, materials, components or software - Clients or customer - Competitors or other enterprises in your sector - Consultants, commercial labs, or private R&D institutes - Network partners - Universities or other higher education institutions - Government or public research institutes	Availability of information
Where in your value chain do you have existing cooperation and who are your cooperation partners (suppliers, competitors, customer, subsidiary of the same company, other)? <u>Primary activities</u> - Inbound logistics - Operations / Production - Outbound logistics - Marketing and Sales - Service <u>Support activities</u> - Human resource management - Technological development, incl. IT-infrastructure - Procurement	Availability of information
For what technology area would you like to find new cooperation partner?	-
Our company regularly participates at fairs and networking events	Visibility as a potential cooperation partner
Our company regularly participates at fairs and networking events, at least six times per year	
Number of participations (presentations or posters) in conferences, symposia, etc.	
Number of events related to exchange of good practices	
Number of events related to dissemination of industrial results	
Number of projects increasing the access to expertise	
Number of projects evidencing cross-sectorial participation (quantification should occur at sector participation level)	
Number of projects evidencing cross-sectorial benefits (i.e. technology transfer, best practices)	
Number of publications in peer review journals	

4.11 Funding, financing, investment decisions[30]

Operationalization of critical success factors	Critical success factors
Amount of budget for R&D per year	Financing innovation transfer
Amount of budget for innovation transfer per year	
Amount of costs due to innovation transfer per year	
Sources of R&D-budget	
We receive funding by one of the European financing programs	Financing innovation transfer; effective networks
We receive funding or aid by the state	
We receive funding or aid by the regional government	
We receive funding or aid by the local government	
We cooperate with financial intermediaries such as venture capital organisations	
We have considered alternative financing instruments such as business angels, joint ventures, growth stock market, crowdfunding etc.	Financing innovation transfer
We have access to funding by as business angels, joint ventures, growth stock market, crowdfunding (due to existent network, knowledge, etc.) *If not, please clarify.*	
We have an easy access to funding also for more risky innovation ideas	
We have contact persons at regional development councils	Knowledge and qualification existent; effective networks
We have at least one financing and funding expert being employed more than 75% for that job within the company	
We can at least list ten sources that are potential funding or financing opportunities	
We are familiar with the application documents for funding and financing	Knowledge and qualification existent; compliance
We are familiar with the application procedures for funding, e.g. by employing an expert or within the R&D responsibilities	
We are familiar with the application procedures for financing, e.g. by employing an expert or within the R&D responsibilities	
We are familiar with the obligations and rules related to funding, e.g. by employing an expert or within the R&D responsibilities	
We are familiar with the obligations and rules related to financing, e.g. by employing an expert or within the R&D responsibilities	
We regularly inform ourselves about new funding opportunities in the field of innovation and innovation transfer	Availability of information; monitoring
We regularly monitor information provided on the website "EU Access to Finance Portal" and similar information sources	
Number of projects evidencing higher benefits than costs	Project management capabilities
Number of innovation transfer projects evidencing quantified improved commercial performance (i.e. increased turnover, profitability, market share)	
There is a lack of incentives for innovation transfer in the process industry	Incentives
Our national government incentives innovation transfer	
The European government incentives innovation transfer	
The incentives for innovation transfer are sufficient	

4.12 Remarks on SMEs and recommendations

Small- and medium sized enterprises (SMEs) have a different starting point compared to big sized companies, oftentimes linked to fewer resources, skill sets strictly limited to the number and talents of people employed as well as little affinity with information technology depending on the age, mind-set and economic sector of the company. Hence, they are subject to specific constraints and different needs, sometimes requiring increased support. Jordan et al. (2014) conducted qualitative interviews among German SMEs and intermediaries to elaborate a policy mix at the federal level that could help SMEs to overcome barriers for resource efficiency innovations. Their identified major barriers show strong similarities to our research comprising deficits in innovation culture, inter-firm cooperation along the value chain, finance, awareness and take-up of government funds. Strobel and Kratzer further observed a negative influence on the innovative performance of SMEs through internal obstacles, a lack of know-

[30] For tools to ease Access to Funding, see more in: https://ec.europa.eu/growth/industry/innovation/funding.

how, capacity overloading, unclear roles and tasks as well as the external obstacle governmental bureaucracy (Strobel & Kratzer 2017).

This deliverable goes along with the recommendation to public bodies to create a more distinct policy mix that "comprises the interlocking and synergistic elements of government funding schemes, innovation agents and innovation laboratories" (Jordan et al. 2014). Furthermore, especially the access to funding / financing of innovation should be eased by establishing improved information hubs for SMEs and providing them with sufficient knowledge and consulting to overcome resource gaps.

For innovation capabilities, CEOs generally desire collaborative, communicative, flexible and creative employees (IBM Global Business Services 2010; IBM Global Business Services 2012). Therefore it is recommended to foster those skills e.g. by enabling collaboration through adequate communication and collaboration structures as well as "healthy competition" within Europe through standards or incentives. Furthermore the interviews in D2.1 emphasized the role of the CEO and other top management level, who have to be on-boarded and, if required, trained to a more innovation-friendly mind set.

Having identified the indicators of innovation transferability and their cluster, the next step is to identify the key areas in which these indicators are applicable and where technologies can be transferred. By considering the channels that are required to do so, chapter five goes beyond previous chapters.

5 Areas and Channels of Innovation Transferability

5.1 Potential areas of innovation transfer

Having mentioned Transferring innovation to other sectors within an industry increases innovation potential and can foster the total innovation success of this industry. Especially the SPIRE sectors that have been analysed within HARMONI are rather conservative. To give a more specific example, many companies of the refractory sector (Ceramics), are extremely innovative in the field of new product development but might neglect other fields of innovation, such as services or business models (see also D5.1). In this sense, the transfer of innovation and related knowledge within these sectors can increase the global competiveness of the European process industry a lot. So far, however, the potential areas of transferability (especially besides technologies) within the European process industry have not been defined. The basis for doing so is provided by the well-known Porter value chain which is considered applicable to all companies independent from their size, organizational structure, products, etc. (see Porter 1985 for a more detailed description).

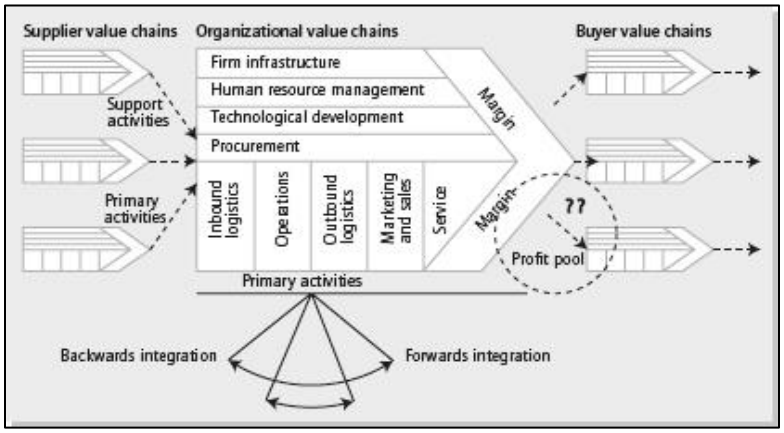

Figure 3. Porter's value chain, adapted by McKeown 2015 from: Porter, M. E. (1985): Competitive Advantage: Creating and Sustaining Superior Performance.

This value chain depicts the commonly and understandably categorized activities a company should pay attention to when analysing their potential areas of cooperation, areas of knowledge and technology transfer as well as possibilities to strengthen or build up external relationships. During this process the value chain supports the development of a matrix-like structure of analysis that ensures a **holistic**

approach (see HARMONI fiches) and overview on the later mentioned categories in this chapter with regards to each company specific activity.

The areas of transferability have been collected through extensive research on fields of technologies or working activities by different institutions and different industries. A very relevant source was the SPIRE roadmap.[31] Besides the key topics of the HARMONI project, the identified TCs in WP4 having a connection to more than one industry, the industrial policy categories by DG Growth as well as a broader categorization of shared fields can be found on the CEN website (see: www.cen.eu/work/areas; those are considered as shared interests and therefore as potential fields of transferability also). In addition, we have utilized the technology fields by Clusterportal Baden-Württemberg (see: www.clusterportal-bw.de/clusterdaten/technologiefelder).

Those identified trends and key areas of transferability have then been discussed with experts from the SPIRE industry, narrowing the pre-defined key areas of transferability down to SPIRE-specific areas as well as complementing the same accordingly.

The P4P survey has been used to identify those categories with a wide application in different sectors, in order to pre-identify the technological areas with high transferability potential based on already funded projects in such areas. This work will be further elaborated within Task 5.3. to indicate the most promising technologies in terms of their cross-sectorial replicability.

Below one finds the non-weighted result of the **analysis on potential areas of knowledge and technology transfer within the European process industry**:

Potential key areas of improved knowledge transfer	Potential key areas of technology transfer	Social, political, economic & industrial trends
a. Accelerated deployment of the R&D&I opportunities identified within SPIRE b. Access to funding and new business models, e.g. for circular economy c. Cluster initiatives to leverage outreach d. Innovation management (high exchange of approaches, Best Practices, Lessons Learnt) e. Management attitude & corporate culture f. New materials / surfaces g. Process modification and refinement h. Logistics i. Licensing in different life cycle phases j. Skills & training k. Smart Specialisation	a. Construction technologies b. Information technology, IT applications and software; IT-security technology and monitoring applications c. Key Enabling Technologies, especially - Nanotechnology - Advanced materials - Advanced manufacturing d. Production technology including mechanical engineering and machinery e. Testing facilities (DIN e.V. & DKE 2018) f. Resource and energy efficient process industry* - Feedstock - Processes and process intensification, incl. ISy - Market application - Waste2Resource - CO_2 to fuel/chemicals	*These trends form a third type of transfer since they require deepened knowledge exchange & cooperative learning* a. Digital transformation & Industry 4.0 b. Enhanced use of optimisation technique c. Pro-environmental activities - Circular Economy - Energy management - CO_2 valorisation - Renewable energies - Waste recycling d. Lightweight products e. Measuring devices f. Monitoring technologies g. Industrial Symbiosis (ISy)

This analysis shows that finding categories and transferable technologies that cover all sectors within the process industry equally is challenging. In any case, companies are generally required to have a strong network, excellent information systems and should be more open to cooperation in order to find opportunities to transfer innovations.

[31] See especially cluster initiatives across the European Union as well as the SPIRE Roadmap 2030 (Tello & Weerdmeester 2013).

5.2 Channels that foster innovation transfer

There are different channels and means to transfer an innovation: by cooperating and collaboration, by sharing knowledge informally or just by copying. In order to improve a sector's or company's innovation transferability, that sector or that company must improve its channels to transfer innovation. Having an effective network as well as communication and monitoring processes in place is just one side, knowing the most important channels for transfer is the other side.

The following abstracts will elaborate shortly on some most important channels of innovation transfer and provide some Best Practices that have been collected in interviews (task 2.1) and via desk work. For direct links to the organisations and websites mentioned, see "References – Links references […]".

5.2.1 Innovation networks, cluster and smart specialisation

External innovation networks bring companies with similar interests together[32] and as such they are effective channels of innovation and knowledge transfer. Scientists state that "according to the weak-tie-theory originally advanced by Granovetter (1973), distant and infrequent relationship (i.e. weak ties) are efficient for knowledge sharing because they provide access to novel information by bridging otherwise disconnected groups and individuals" (Hansen 1999). The same effect becomes visible in innovation networks, clusters and similar approaches.

To provide support and information to small and medium-sized businesses (SMES) seeking to boost their business, the Commission sponsors several support networks (see more: European Commission (Ed.), 2019b), e.g. the Enterprise Europe Network (EEN; see https://een.ec.europa.eu/). The EEN is a one-stop-shop for business needs, comprising about 600 partner organisations in more than 50 countries and providing support on access to market information, on overcoming legal issues and on identifying potential business partners across Europe.

The same advantages occur in clusters. The European Commission defines cluster as follow:

"Clusters are groups of specialised enterprises – often SMEs – and other related supporting actors that cooperate closely together in a particular location. In working together SMEs can be more innovative, create more jobs and register more international trademarks and patents than they would alone."

– European Commission (2019b): EU Cluster Portal

Clusters mostly operate together in regional markets to serve different purposes, such as above-mentioned knowledge transfer and experience exchange, an improved access to funding through jointly applying for it or better risk management as well as stronger positions when negotiating with suppliers and other contractors. 150 of the about 2000 clusters statistical clusters in Europe are already considered to be world-class in terms of employment, size, focus and specialisation. Priority sectors are e.g. industries related to Circular Economy and digital industries. The European Commission highlighted clusters as being able to facilitate cross-sectoral and cross-border collaboration (European Commission 2019h) as has launched several initiatives to facilitate clusters as a tool to support SME innovation and growth, such as:

- European Cluster Observatory
  for statistical information, mapping tools and analysis of EU clusters and cluster policy as well as events and activities for clusters
- Cluster Excellence for benchmarking and training tools for cluster organisations
- Cluster Internationalisation
  to enable EU clusters to profile themselves, exchange experience and search for partners
- The European Cluster Collaboration Platform (ECCP)
  an action of the Cluster Internationalisation Programme for SMEs to provide cluster organisations with modern tools, networking and information support

[32] According to feedback on the 2019 HARMONI Summit, similarity is considered as a very strong or even the best indicator for innovation transferability between two or more companies or sectors (see Annex C - 2019 HARMONI Summit Minutes, p. 40).

Companies should also take a look at the European Cluster-Related Initiatives such as the European Business and Innovation Centre Network, the European Cluster Alliance and the SME Internationalisation Portal. Another closely related channel of innovation transfer is "Smart Specialisation".

"Smart Specialisation is […] characterised by the identification of strategic areas for intervention based both on the analysis of the strengths and potential of the economy and on an Entrepreneurial Discovery Process (EDP) with wide stakeholder involvement […] including but certainly not limited to technology-driven approaches, supported by effective monitoring mechanisms."

– European Commission: Smart specialisation platform (2018)

For more information on Smart Specialisation see the Smart Specialisation Platform by the European Commission (http://s3platform.jrc.ec.europa.eu).

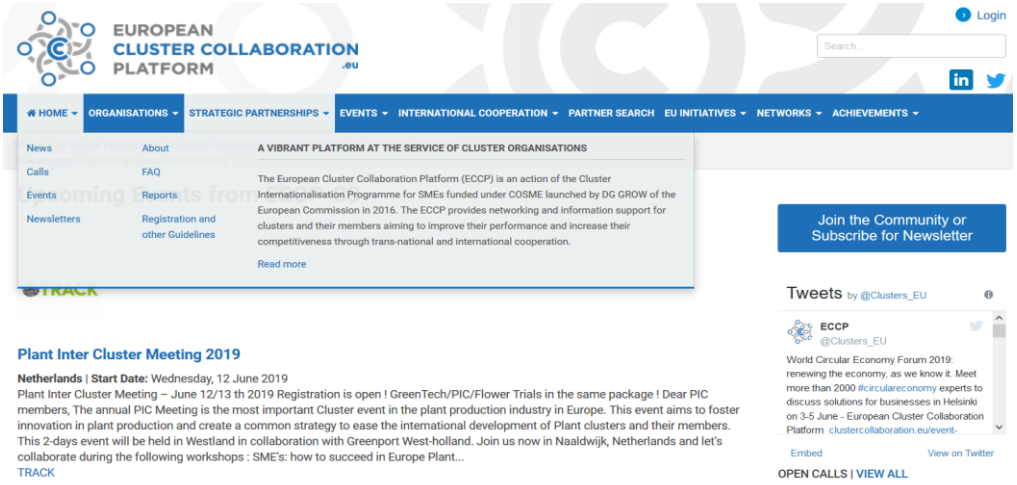

Figure 4: Screenshot European Cluster Collaboration Platform (www.clustercollaboration.eu) as of May 29th, 2019.

5.2.2 Role of standardization

Standardisation bodies help to harmonize the understanding and application of networks, processes, materials, etc. By jointly developing and amending norms, the industry can have a proactive role in transferring and even more distributing their innovative ideas across the sectors.

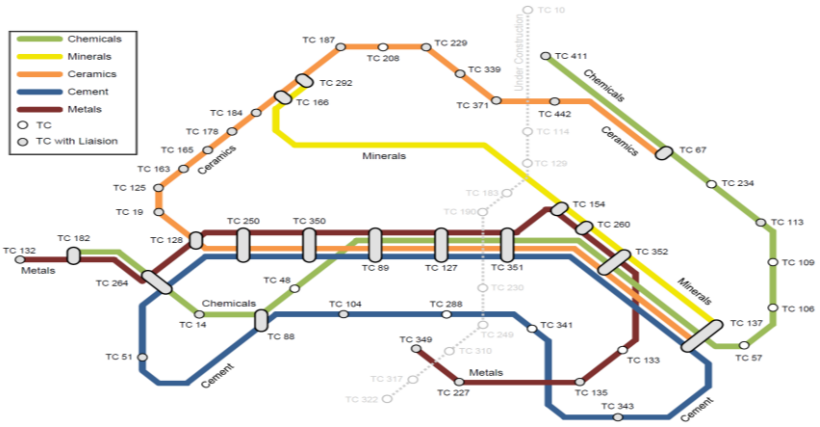

Figure 5: Mapping of the current participation of the process industry in the CEN/CENELEC TCs, see D4.1

The HARMONI project partner DIN e.V. has established a comprehensive overview on the sectorial interfaces at Technical Committee (TC) level. The map above depicts the current participation of the process industry in the CEN/CENELEC TCs.[33] Areas for transferability exist when two or more sectors are involved in the same TC.

[33] The map is based on the information generated throughout the project period focusing on the participation of the associations but adding further data from the survey among the companies.

For new technologies, existing standards and/or those under development must be examined to determine whether they are applicable and can be transferred. (DIN e.V. & DKE 2018).

It is to be mentioned, that the access to the collected knowledge is not limited to Europe only or to specific companies (as compared to clusters). Therefore, companies are strongly recommend to use their opportunity of having impact on the norms and hearing about some innovations early and from first hand, while also paying attention to what can be shared on a much broader and rather unsecured level. For more information on norms and standardisation please see the website of our project partner DIN e.V. (www.din.de) or CEN (www.cen.eu) / CENELEC (www.cencenelec.eu).

So the principles, elements, indicators and underlying processes of innovation transfer are not standardized. We recommend to fill this gap in order to support especially SMEs to establish and foster innovation transfer in their company.

5.2.3 Role of associations

European industrial associations are not only closely connected to their member, but also to many other sister entities in several countries and the associations on European level. Therefore, associations can act as a one-stop-shop and information hub for their members; furthermore, they can support the matching and establishment of effective cooperation by utilizing their network[34] and proactively participating in networking events, fairs, conferences, etc.

It is to mention that the resources of especially small associations are very limited, oftentimes only strongly limiting the scope of the association's activities as well as the opportunities and strength to support their industry. An increased monetary support or incentives from the national and/or European level could support associations with a comparable little number of companies that however represent a key technology sector or are otherwise more important to the European competiveness than their pure size would indicate. All associations have different working organisations and processes in place to define a common sectorial position (in general at technical level via specific working groups and subsequently endorsed at strategic level e.g. by the Association Board or Steering Committee). As shown in the Appendix A, some working groups' topics are similar so that synergies could arise and be used more effectively. Furthermore, a central interface for the exchange of information between the associations is recommended and can be used as a lever for better lobbying and access to standardization representatives, governmental committees, press offices and other service providers.

5.2.4 Shared learning and testing facilities[35]

By sharing learning or testing facilities, e.g. for First-Of-A-Kind-Demonstrations, companies do now only have an effective opportunity to financially co-support the innovation testing phase and to save costs but can also transfer innovations or related knowledge to other companies of the same sector but even to other sectors. Open Innovation Test Beds are entities offering access to physical facilities, capabilities and services required for the development, testing and upscaling of nanotechnology and advanced materials in industrial environment (European Commission (Ed.), 2017).

Some websites of national regulatory bodies help companies to find adequate testbeds, such as the website of the German Federal Ministry for Economic Affairs and Energy (Federal Ministry for Economic Affairs and Energy (Ed.), 2019). Nevertheless, an unexperienced google search does not lead to good results, i.e. testing facilities or demonstration labs, and it is to assume, that companies and specially SMEs struggle to easily get the required information. We recommend an easily-to-be-found portal on EU level that provides a list of testing facilities for the process industry. Links that were found in the field of digitalization and Industry 4.0:

- OneLab (https://onelab.eu/) – Platform for Computer Networking Testbeds

[34] See also: SCALE-UP project (http://www.northsearegion.eu/scale-up) and related interview (R4R) in D2.1.
[35] For this complete subchapter see also: DIN e.V. & DKE 2018.

- Fed4FIRE+ (www.fed4fire.eu/) – largest federation worldwide of Next Generation Internet testbeds
- I4KMU (https://i4kmu.de/) - German contact point by the German Federal Ministry of Education and Research for funding Industry 4.0 projects, new digital products, processes and services

Besides testing facilities, also shared demonstration platforms and non-sector-specific fairs help to transfer innovation cross-sectorial. A good example is the Hannover Messe in Germany which is known as the world's leading trade show for industrial technology (see more: www.hannovermesse.de).

5.2.5 Other

Besides those aforementioned selected channels of innovation transfer, companies can be creative when finding even more such as using specific technologies and technology platforms, reference models, manuals and guidelines, but also feasibility studies, blueprints, prototypes, Best Available Techniques and pilot projects. Communication schemes across SPIRE sectors could also be set up by working groups or multidisciplinary expert teams that cooperate on specific topics that concern more than one sector (e.g. waste, circular economy, emissions) or that identify (new) business models.

Building on the interviews collected with EU-project representatives in task 2.1, we find that EU-projects are excellent vehicles to transfer innovation as well, vertically and horizontally.

Furthermore other types of cooperation can foster innovation transfer such as co-creation, collaborative engineering along the value chain, open innovation approaches, business angel networks, joint ventures and innolabs or the regional development of triple helix.[36] Cross-sectorial initiatives, such as SPIRE aisbl[37] or cross-sectorial projects and events, have a key role in fostering innovation transfer within and across the European industries. Those initiatives, projects and events bring people from different sectors together and should pursue an overarching, cross- sectorial innovation approach, that inter alia includes:

- research and technological progress, public sector and social innovation concepts, novel business models, as well as education and the strengthening of innovative mind-sets and thoughts,
- the co-creation of solutions / innovation within the sectors and across value chains through converging technologies (e.g. steel and chemistry, or minerals and water, etc.),
- the acceleration of innovation rate as well as positive environmental and competitive impacts within the industry and along the respective value chains through innovation transfer,
- the identification of innovations in one sector that have proven to increase resource and energy efficiency and can be adapted and transferred to other sectors (see also: D5.3), and
- the ease of use of technology building blocks across sectors such as modelling, monitoring and automation, also in a cross-sectorial manner.

Zimmermann and Thomä (2016) have established a set of approaches to promote innovation in less R&D-active segments of the SME sector and main-target enterprises which can be used for innovation transfer approaches.

	Reducing financing obstacles	**Reducing obstacles in the area of the organisation and skills[38]**	**Reducing bureaucratic barriers**
Age of company	Young enterprises	Older enterprises	Older enterprises
Size of enterprise	Small enterprises		
Economic sector	Less research- and knowledge-intensive segments of the	Enterprises from traditional low-tech segments	Construction

[36] University-Industry-Government interaction in a triadic relationship. Concept was developed in the 1990s by Etzkowitz (1993) and Etzkowitz & Leydesdorff (1995) to increase innovation in knowledge-based societies and foster innovation through the restructuring and enhancement of organizational arrangements and providing incentives. See more: Ranga & Etzkowitz (s.a.); Etzkowitz (2008).

[37] Based on SPIRE website (www.spire2030.eu) and Roadmap 2030 (Tello & Weerdmeester 2013).

[38] E.g. skill shortages, transfer of knowledge, innovation management.

Skilled crafts Strategic orientation	manufacturing and services sector Enterprises with growth strategies	Crafts enterprises Incremental innovators	Incremental innovators

Figure 6: Approaches to promote innovation in less R&D-active segments of the SME sector (Zimmermann & Thomä 2016)

There are various types of business models or initiatives by the EU and EU projects as well as companies in a customer-producer-relationship that automatically cooperate by nature. Those cross-sectorial initiatives have a key role in fostering innovation transfer within and across the European industries. A Best Practice to demonstrate effective cross-sectorial cooperation is SPIRE aisbl ("Sustainable Process Industry through Resource and energy Efficiency").[39] The non-profit international association A.SPIRE brings together cement, ceramics, chemicals, engineering, minerals and ores, non-ferrous metals, steel and water, also cooperating with Non-SPIRE-sectors like glass, paper and pulp. It is fully aligned with the strategic goals defined by the European Commission in the Europe 2020 strategy and across its various flagship initiatives such as "Innovation Union", "Industrial Policy for the Globalisation Era", "Resource efficient Europe" and "Agenda for new skills and jobs". The SPIRE roadmap pursues an overarching and cross- sectorial innovation approach, which inter alia includes research and technological progress, public sector and social innovation concepts, novel business models, as well as education programs.

Also, ministries can help to transfer innovation especially when being responsible for education and research, economy, innovation or digitalisation. Legally required innovation transfer officer (e.g. for a 50% position at least) have been brought into discussion by some summit participants but due to inter alia high costs involved, a stronger involvement of innovation manager, specialized industry consultancies and IT experts is rather recommended. Those can identify (requirements for) future technologies, set up effective data management systems, introduce platforms for an improved coordination in order to support market penetration and consequently foster innovation transfer in the process industry. A STAIR platform could be a solid foundation and a first step towards this ambition.

So far many of these cross-sectorial initiatives have limited impact due to limited resources, time and capacities, but could have even broader outreach and impact through increased (financial) support, human resources and the replication of successful outcomes. Generally, it can further be stated that the regulator must allow innovation transfer and foster dissemination mechanisms and digitalized communication channels such as fiber optic internet instead of broadband internet.

5.3 Best Practices of successful innovation transfer

Besides those aforementioned Best Practices of innovation transfer channels, we collected Best Practices on successful innovation transfer itself. Several of those have been collected in task 2.1 which identified regulatory bottlenecks and standardisation needs through interviewing 26 representatives from EU projects. As aforementioned, we find that EU-projects are excellent vehicles to transfer innovation as well, vertically and horizontally.

This has for example been demonstrated in an EU project that AkzoNobel participated in (please see the interview from April 11th, 2018, with Riaan Schmuhl from the ALTEREGO project in D2.1 for more details).

The project itself inter alia stresses the need to promote a better cooperation of final user and technology provider as well as to establish new business models that decrease the risks linked to innovation through this cooperation, better access to funding and shared facilities. The cooperation between end-user and technology provider can be difficult and oftentimes final users do not have the opportunity to test their prototypes under real production conditions. The access to testing facilities can be very beneficial in that case. As part of the EU project AkzoNobel got access an other´s company

[39] See more on SPIRE website (www.spire2030.eu) and Roadmap 2030 (Tello & Weerdmeester 2013).

facilities, which were partly funded by the EU project. This allows both companies to share data and knowledge as well as to transfer innovation.

Shared learning and testing facilities are very good practices of how innovations, especially technologies, can be transferred on a cross-sectorial level.

Furthermore, another detected Best Practice from the interviews (T2.1 of HARMONI project) is the COCOP project (*https://www.cocop-spire.eu/*) that optimizes complex industrial plants which can again increase innovation transfer. Already during the project knowledge transfer was established effectively by jointly writing handbooks, operation guidelines, etc.

On the other hand, Interreg-projects (www.interregeurope.eu/projects) are an fruitful program towards innovation transfer. These projects establish interregional cooperation networks between industrial cluster and research institutes within the process industry in order to foster the transfer of Key Enabling Technologies and bring impulses for economic advantages and innovation.

Lastly, another Best Practice can be provided using the example of the Labs Network Industrie 4.0 (LNI 4.0). LNI 4.0 was jointly set up by companies from the initiative Plattform Industrie 4.0 in cooperation with BITKOM, VDMA and ZVEI in order to test new technologies, business models and application scenarios (use cases) that are relevant to Industry 4.0. Within an ideal laboratory and experimental environment, the technical and environmental feasibility of an idea can be tested already before market launch and without the cost effort of building such labs oneself. Through another cooperation with the Standardization Council Industry 4.0 (SCI 4.0), test results can be directly incorporated into the further development of standards and specifications, creating a holistic approach of innovation transfer.[40]

Platform Industrie 4.0 was created in 2013 by the three industry associations BITKOM, VDMA and ZVEI and is currently lead-managed by the Federal Ministry for Economic Affairs and Energy (BMWi) and the Federal Ministry of Education and Research (BMBF). It brings together representatives from the business sector, the scientific sector, trade unions, politics and consumer groups in a collaborative process to foster topics such as research and innovation, security of networked systems[41], legal frameworks, employment and (further) training in Germany.

[40] SCI 4.0 was founded by DIN and DKE in order to be the point of contact in Germany for all matters relating to standardization in the context of Industrie 4.0 and to being together the interested parties in that field. It also represents the interests of its members in international bodies and consortia. SCI 4.0 actively supports the concept of practical testing in test facilities by initiating informal standardization projects tailored to meet specific needs.

[41] "The subject of information security is crucial when it comes to ensuring the reliable functioning of industrial applications." (DIN e.V. & DKE 2018)

6 Conclusions and outlook

Achieving effective innovation transfer is a complex task and during this process, companies - especially SMEs - need support to jointly tackle this challenge. The overall objective of the fifth WP of the HARMONI project aims to support the process industry with cross-sectorial transferability of innovations. As a result of Task 5.1, barriers to cross-sectorial innovation transfer and missed opportunities have been identified, while Task 5.2 deals with indicators for innovation management inside companies to foster the transfer of innovations, especially of technical solutions. Also, this deliverable has identified key areas for potential innovation transfer as well as how to improve a company's innovation transferability.

Critical success factors for corporate innovation transferability have been collected and created, taking into account the different requirements of SMEs. In total **10 key clusters** to assess innovation transferability were characterised. Those success factors can mostly be assessed as self-explicated quantified indicators. The subsequently identified 29 critical success factors that serve as indicators itself are manifold and have been collected through comprehensive research. This research includes the Best Practices that were observed during the entire HARMONI project, results from earlier WPs and other surveys, but also related external sets of indicators as well as further literature. Especially the management of external relations and networks (incl. knowing those well) is of high relevance, a reduction of the lack of trust between (potential) business partners, but also the availability and development of skilled people as well as the usage of digital tools. Also, the facilitation of a dialogue between final users and technology providers in the search of potential applications remains one of the main challenges. The indicators might generally vary per company or per sector; also not all indicators must apply equally.

Identified **key areas of potential transfer opportunities** are a key output from task 5.2. They have been divided in depicted as potential areas of improved knowledge transfer, potential areas of technology transfer and social, political, economic & industrial trends:

Potential key areas of improved knowledge transfer	Potential key areas of technology transfer	Social, political, economic & industrial trends
a. Accelerated deployment of the R&D&I opportunities identified within SPIRE b. Access to funding and new business models, e.g. for circular economy c. Cluster initiatives to leverage outreach d. Innovation management (high exchange of approaches, Best Practices, Lessons Learnt) e. Management attitude & corporate culture f. New materials / surfaces g. Process modification and refinement h. Logistics i. Licensing in different life cycle phases j. Skills & training k. Smart Specialisation	a. Construction technologies b. Information technology, IT applications and software; IT-security technology and monitoring applications c. Key Enabling Technologies, especially - Nanotechnology - Advanced materials - Advanced manufacturing d. Production technology including mechanical engineering and machinery e. Testing facilities (DIN e.V. & DKE 2018) f. Resource and energy efficient process industry* - Feedstock - Processes and process intensification, incl. ISy - Market application - Waste2Resource - CO_2 to fuel/chemicals	*These trends form a third type of transfer since they require deepened knowledge exchange & cooperative learning* a. Digital transformation & Industry 4.0 b. Enhanced use of optimisation technique c. Pro-environmental activities - Circular Economy - Energy management - CO_2 valorisation - Renewable energies - Waste recycling d. Lightweight products e. Measuring devices f. Monitoring technologies g. Industrial Symbiosis (ISy)

Those identified trends and key areas of transferability have then been discussed with experts from the SPIRE industry, narrowing the pre-defined key areas of transferability down to SPIRE-specific areas as well as complementing the same accordingly. The outcome of this document is fully aligned with SPIRE roadmap 2030 and the SPIRE Vision 2050 Document, and aims at contributing to the new SPIRE Roadmap 2050, currently under development. The T5.3 will complement this report with the most promising technological pathways.

Lastly, social science should be integrated as a key factor for technology implementation. The D5.2 aims to promote the use of the aforementioned indicators. To this end, and as an input to future analysis, some questions are suggested (ANNEX C) to be part of the annual survey that A.SPIRE sends to the SPIRE granted projects. This will allow to collect new ideas and challenges to keep on supporting innovation management best cases in the future under the umbrella of the SPIRE initiative.

REFERENCES

General sources

A.SPIRE (Ed.) (2018): SPIRE 2050 Vision. Towards the Next Generation of European Process Industries. Working Document, in: https://www.spire2030.eu/sites/default/files/users/user85/Vision_Document_V5_Pages_Online.pdf, last retrieved: 30/06/2019.

A.SPIRE (Ed.) (s.a.): 1st SPIRE Thematic Workshop on Industrial Symbiosis, in: https://www.spire2030.eu/news/new/1st-spire-thematic-workshop-industrial-symbiosis-0, last retrieved: 13/02/2019.

Baudson, T. G. (Ed.) (2008): Kreativität und Innovation. Beiträge aus Wirtschaft, Technik und Praxis; eine Publikation des MinD-Hochschul-Netzwerkes.

Brent, A. & Labuschagne, C. (2006): Social Indicators for Sustainable Project and Technology Life Cycle Management in the Process Industry. In: The International Journal of Life Cycle Assessment 11, pp. 3–15.

Chesbrough, H. (2003): Open Innovation: The New Imperative for Creating and Profiting from Technology.

DIN e.V. & DKE (2018): German Standardization Roadmap. Industrie 4.0. Version 3.

Drucker, P. F. (2002): The Discipline of Innovation. In: https://hbr.org/2002/08/the-discipline-of-innovation, last retrieved: 29/05/2019.

Dutta, S & Lanvin, B & Wunsch-Vinvent S (2016): The Global Innovation Index 2016. Winning Global Innovation, in: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2016.pdf, last retrieved: 29/05/2019.

Engelen, A. et al. (2014): Corporate Entrepreneurship: Unternehmerisches Management in etablierten Unternehmen.

European Commission (Ed.) (2019a): Access to finance for SMEs. In: https://ec.europa.eu/growth/access-to-finance_en, last retrieved: 29/05/2019.

European Commission (Ed.) (2019b): EU Cluster Portal. In: https://ec.europa.eu/growth/industry/policy/cluster_en, last retrieved: 29/05/2019.

European Commission (Ed.) (2019c): Innovation. In: https://ec.europa.eu/growth/industry/innovation, last retrieved: 29/05/2019.

European Commission (Ed.) (2019d): Industrial policy. In: https://ec.europa.eu/growth/industry/policy_en, last retrieved: 29/05/2019.

European Commission (Ed.) (2019e): Intellectual property. In: https://ec.europa.eu/growth/industry/intellectual-property_en, last retrieved: 29/05/2019.

European Commission (Ed.) (2019g): Support to SMEs and entrepreneurs, in: https://ec.europa.eu/growth/smes/support/networks_en, last retrieved: 29/05/2019.

European Commission (Ed.) (2019h): Towards an Industrial Renaissance, in: https://ec.europa.eu/growth/industry/policy/renaissance_en, last retrieved: 29/05/2019.

European Commission (Ed.) (2017): H2020 Programme – Explanatory Notes on Open Innovation Test Beds. Work Programme 2018-2020. 5ii Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing, in: http://ec.europa.eu/research/participants/data/ref/

h2020/other/guides_for_applicants/h2020-supp-info-innotestbeds-18-20_en.pdf, last retrieved: 29/05/2019.

European Commission (Ed.) (2014): Cross-sectoral analysis of the impact of international industrial policy on key enabling technologies: final report – Study.

European Commission (Ed.) (2013): Public-private partnerships in Horizon 2020: a powerful tool to deliver on innovation and growth in Europe.

European Commission - DG Growth and Innovation (Ed.) (2018): Pathways to sustainable industries. Energy efficiency and CO2 utilisation: Publications Office (Research & innovation projects for policy).

European Commission – Eurostat (Ed.) (2008): Community Innovation Survey 2014 (CIS 2014). The harmonised survey questionnaire, in: https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp, last retrieved: 29/05/2019.

European Commission - Projects for Policy (Ed.) (2019): Projects for Policy (P4P). In: https://ec.europa.eu/info/research-and-innovation/strategy/support-policy-making/scientific-support-eu-policies/p4p_en, last retrieved: 29/05/2019.

European Commission – Smart specialisation platform (Ed.) (2018): S3 platform - What is Smart Specialisation?, in: http://s3platform.jrc.ec.europa.eu/what-is-smart-specialisation-, last retrieved: 29/05/2019.

Etzkowitz, H. (2008): The Triple Helix: University-Industry-Government Innovation in Action.

Etzkowitz, H. & Leydesdorff, L. (1995): The Triple Helix - University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development, in: EASST Review (14/1): 14-19.

Federal Ministry for Economic Affairs and Energy (Ed.) (2019): Testbeds. Easing access for SMEs, in: https://www.plattform-i40.de/PI40/Navigation/EN/InPractice/Testbeds/testbeds.html, last retrieved: 30/05/2019.

Hansen, M.T. (1999): The Search-Transfer Problem: The role of weak ties in sharing knowledge across organization subunits, in: Administrative Science Quarterly (44/1), pp. 82-111.

Hill, L. (2014): How to manage for collective creativity. In: TEDxCambridge (Ed.): Linda Hill at TEDxCambridge. How to manage for collective creativity, in: https://www.ted.com/talks/linda_hill_how_to_manage_for_collective_creativity/up-next, last retrieved: 30/05/2019.

IBM Global Business Services (2010): Capitalizing on Complexity. Insights from the Global Chief Executive Officer Study, last retrieved: 29/05/2019.

IBM Global Business Services (2012): Leading Through Connections. Insights from the Global Chief Executive Officer Study, last retrieved: 29/05/2019.

IMP^{3}rove – European Innovation Management Academy EWIV (Ed.) (sa): Our Story, in: https://www.improve-innovation.eu/about/our-story/, last retrieved: 29/05/2019.

IMP^{3}rove – European Innovation Management Academy EWIV (Ed.) (2014): Evaluation Report – ABC AG, in: https://www.improve-innovation.eu/wp-content/uploads/2015/02/IMP^{3}rove_Assessment-Report-Excerpt-ENG.pdf, last retrieved: 29/05/2019.

Jordan, N.D. & Lemken, T. & Liedtke, C. (2014): Barriers to Resource Efficiency Innovations and Opportunities for Smart Regulations – the Case of Germany. In: *Env. Pol. Gov.* 36 (1).

Keeley, L. et al. (2013): Ten types of innovation. The discipline of building breakthroughs. Hoboken, NJ: John Wiley & Sons Inc., in: http://lib.myilibrary.com/detail.asp?id=487241, last retrieved: 29/05/2019.

KfW Group (Ed.) (2017): KfW SME Innovation Report 2016. Innovation is concentrated in increasingly fewer enterprise.

Kuratko, D. F. & Hornsby, J.S. & Covin, J.G. (2014): Diagnosing a firm's internal environment for corporate entrepreneurship. In: Business Horizons 57 (1), S. 37–47.

Markides C. & Chu W. (2009): Innovation through ambidexterity: how to achieve the ambidextrous organization, in: Handbook of research on strategy and foresight.

McKeown, M. (2015): The Strategy Book. 2nd edition.

Neck, H. M.; Brush, C. G.; Greene, P. G. (2014): Teaching entrepreneurship. A practice-based approach.

Rammer, C. & Kinne, J. (2016): Microgeography of Innovation in the City. Location Patterns of Innovative Firms in Berlin. In: SSRN Journal. DOI: 10.2139/ssrn.2882503.

Preußig, J. (2015): Agiles Projektmanagement. Scrum, User Stories, Timeboxing & Co. Freiburg: Haufe-Lexware GmbH & Co. KG (Haufe TaschenGuide). In: https://www.wiso-net.de/document/HAUF,AHAU__9783648065198236, last retrieved: 29/05/2019.

Ranga, M., Etzkowitz, H. (s.a.): Triple Helix Systems: An Analytical Framework for Innovation Policy and Practice in the Knowledge Society, in: https://triplehelix.stanford.edu/images/Triple_Helix_Systems.pdf, last retrieved: 29/05/2019.

Rogers, E. M. (1983): Diffusion of innovations. 3. ed.

Rössing, S. M. (2006): Technology transfer to China. Conflict of interest within multinational corporations. WHU - Otto Beisheim School of Management, Diss., 2005. 1. ed.

Sheremata, W. A. (2000): Centrifugal and centripetal forces in radical new product development under time pressure. The Academy of Management Review, 25(2), 389-408.

Schumpeter, J. A. (1934): The theory of economic development.

Strobel, N. & Kratzer, J. (2017): Obstacles to innovation for SMEs. Evidence from Germany. In: International Journal of Innovation Management. 21 (03).

STYLE project (Ed.) (2018): STYLE (Sustainability Toolkit for easy-Life-cycle Evaluation) – Outcomes, in: https://www.spire2030.eu/style#edit-group_outcomes, last retrieved: 29/05/2019.

Tello, P. & Weerdmeester, R. (2013): Spire Roadmap. A.SPIRE aisbl.

Thornberry, N. (2001). Corporate entrepreneurship: antidote or oxymoron?

TNS Political & Social Flash (2014): Eurobarometer 394. The role of public support in the commercialisation of innovations on behalf of the European Commission.

Tushman ML, O'Reilly CAO (1996): Organizational Ambidexterity: Past, Present and Future.

Wolcott II, R. C. & Lippitz, M. J. (2009). Grow from Within: Mastering Corporate Entrepreneurship and Innovation.

Zimmermann, V. & Thomä, J. (2016): SMEs face a wide range of barriers to innovation – support policy needs to be broad-based.

Links references in the deliverable text

A.T. Kearney's Best Innovator contest: http://www.best-innovator.com/

Cluster Excellence - https://ec.europa.eu/growth/industry/policy/cluster/excellence_en

Cluster Internationalisation - https://ec.europa.eu/growth/industry/policy/cluster/internationalisation

Clusterportal Baden-Württemberg - https://www.clusterportal-bw.de/clusterdaten/technologiefelder/

European Business and Innovation Centre Network - http://www.ebn.eu/

European Cluster Alliance - http://www.eca-tactics.eu/eca/

European Cluster Collaboration Platform (ECCP) - https://www.clustercollaboration.eu/

European Cluster Observatory - https://ec.europa.eu/growth/industry/policy/cluster/observatory_en

Enterprise Europe Network (EEN) - https://een.ec.europa.eu/

European Industrial Research Management Association - https://www.eirma.org/contact

European IPR Helpdesk - https://www.iprhelpdesk.eu/

Fed4FIRE+ (by Next Generation Internet testbeds) - https://www.fed4fire.eu/

IMP^{3}rove – European Innovation Management Academy EWIV - https://www.improve-innovation.eu/

InnoAudit der Fraunhofer IAO - http://www.iao.fraunhofer.de/geschaeftsfelder/tim/360.html?lang=de

Innovate! austria Assessment der Plattform für Innovationsmgmt. - http://www.innovate-austria.at/

INSPIRE tools - http://www.inspire-eu-project.eu/inspire-tools/

Interreg-projects - www.interregeurope.eu/projects

I4KMU - Contact point by the German Federal Ministry of Education and Research - https://i4kmu.de/

Journal of Technology Transfer – see: https://link.springer.com/journal/10961

Labs Network Industrie 4.0 - https://lni40.de/

OneLab. Platform for Computer Networking Testbeds - https://onelab.eu/

Plattform Industrie 4.0 - https://www.plattform-i40.de/

Smart Specialisation Platform - http://s3platform.jrc.ec.europa.eu/what-is-smart-specialisation /; https://ec.europa.eu/regional_policy/sources/docgener/guides/smart_spec/strength_innov_regions_en.pdf

SME Internationalisation Portal - https://webgate.ec.europa.eu/smeip/

Siemens Digitalization Consulting - https://new.siemens.com/global/de/unternehmen/themenfelder/digital-plant/digitalization-consulting.html

Standardization Council Industry - https://sci40.com/de/

ANNEXES

ANNEX A – Industrial associations working groups

The associations working groups (WGs) could be utilized for cooperation and cross-sectorial, inter-associational innovation transfer, especially since several associations that have the same opinion and aims strengthen their overall position ("one voice rather than shotgun approach").

This list was used for clustering the indicators into the 10 cluster areas (see chapter 4, p. 14).

Most European associations in scope, had WGs related to Climate & Energy, Markets / Products / Trade and Sustainability:

Topic-specific Working Groups				
CEFIC[42]	Climate Change & Energy	HSE, Responsible Care & Supply Chain PC	Industrial Policy	Product Stewardship
CEMBUREAU[43]	Climate & Energy	Health & Safety	Resources & Processes	Markets & Products
CERAME-UNIE[44]	Climate & Energy WG	Environment & Health Committee	Chemical Agents WG	Trade & internal market
EUROFER[45]	Energy & Climate Committee		International Affairs	Specialty Steels
EUROSLAGS	Fertilizers	Dangerous Substances		

Topic-specific Working Groups				
CEFIC	Innovation	Legal Forum	Sustainability Forum	Advocacy Forum
CEMBUREAU				
CERAME-UNIE	Research & Innovation		Construction & Sustainability	BREF Task Force
EUROFER			Environment Committee	
EUROSLAGS				

[42] http://www.cefic.org/About-us/How-Cefic-is-organised/
[43] https://cembureau.eu/media/1485/cembureau_structure.pdf
[44] http://cerameunie.eu/association/structure/
[45] http://www.eurofer.be/About%20us/About%20EUROFER.fhtml

ANNEX B – 2019 HARMONI Summit Minutes

Session 1A "Learning from success - tools and standardization to grow and transfer innovations" - Day 2 (17th January 2019); starting at 9:30am; finished at 12.10pm.

Topic: Enhancing the transferability of solutions across SPIRE sectors

Introduction text and session context

"Dear Participant,
WELCOME to Session 1A "Learning from success - tools and standardisation to grow and transfer innovations". This task is split into two parts:
a) One individual task
b) One group task"

- **Individiual survey – Results** [excluded since relevant for 5.1; see D5.1 for more]

- **Group work as conducted in session 1A**

Group task – A) Role of the industrial association

In your opinion, what's the role of the European and national associations in the context of innovation transfer?

- Identification of common problems within the sector
- Facilitate cooperation between members of the associations (big and small ones)
- Organise consortia / cooperation
- Contribute to solving legal issues, like confidentiality, anti-trust, etc.

- Identify problems to work together / promote collaboration
- [...] major associations + SMEs [...] share resources
--> Collaboration framework (risk: anti-trust)
--> Defining [...]

- Promote collaboration
- Identifying opportunities for collaboration between research institutions and SMEs

- Implement methods to transfer
- Deliver these methods to all members → Problem of budgets
- Need to be trained in Innovation management and transfer (broad understanding for all employees)

- Collaboration area
- Clear procedures concerning innovation rules
- Take part in TC → harmonize standardization strategy
- Associations first internationally [?]

What tools do they need in your perspective to improve their work results with regards to innovation transfer? [...]

Group task – B) Innovation Transfer

How would you preferably transfer innovation including non-technological innovations such as a new business model, new management approaches or a new IT software for your internal monitoring activities? What channels and cooperation partners would you use to transfer innovation and why?

- Transfer innovation → Type dependency → incremental vs. disruptive AND private vs. public
- Type dependency → drivers→ market competence / legislation / why?
- PLATFORMS *life labs*: freedom, trust, openness […]
- HOW?

- Improve collaboration between supplier and customer
- Demonstration platforms
- Incremental vs. disruptive differs
- Open vs. closed environment differs

- Good communication between company and clients when talking about products or services
- Creation of spin-offs

- Depends on the type → ideally a separate unit!
- Good collaboration between supplier and customer
- Good collaboration between similar types of organizations
- Good collaboration between similar types of organization but different applications
- There are two different phases
1. First platforms, e.g. live labs / safe testing environments
2. Later direct collaboration
- *If very competitive → preferably phase 2
- * if legislative driven competition → phase 1
- Need of time to market → more open collaboration (semi-open) like Live Labs

*- Depends on the "why" → what drives the innovation / is there a sense of urgency?
- Most important is a good cooperation between interested customers and the innovation
- Very variable

- Improve collaboration between supplier and customer
- Dependency from market: competition, supplier, customer and partners
- Depending on market competition
  --> very competitive does not allow innovation
  --> regulation can influence competition (s. PNO-consultant)
  --> depending on incremental innovation --> approach customer B2B --> easier
- When DISRUPTIVE you want to approach the broader market
- Depending on steps, having a meeting, bring actors together, make sure that people have innovation mind-set --> living labs incl. academia
  --> platforms, demonstration, facilities
  --> LATER: establish partnerships
- depends on time pressure --> establish trust to need to let go
  --> fear of missing out + sense of urgency
- if you need to speed up, you need to find hybrid solutions like living labs (=ecosystems) --> help via associations or projects if topic not too complicated

- Most important is a good cooperation between interested customers and the innovation supplier
- guarantees good references which is important to reach the market or the partners for other types than product
- same if transfer from one sector to another-partnership
- create start for a business with good showcase
- inspiration and group discussions can drive "want new technologies and services" as complement regulatory demands
- Market opportunities can drive interest

- Open platforms & tools vs. proprietary
  1) open → many work[…] the product or service à high speed to market
  2) proprietary makes business for a few
- Business model generally very important
  --> How finance the innovation (product), sell licenses (like Microsoft & Apple) or through adds (like Facebook & Google)

What are important indicators in your eyes to enable the transfer of copying of innovation from other companies or sectors?

- Trust
- […]
- Demonstrability
- […]

- Openness
- Trust of clients
- Shared problem
- Complementary in strategy

- Trust
- (Semi-) Openness
- Shared problem OR goal
- Complementary in strategic interests
- Demonstration / credibility
of innovation in the new environment

- Trust
- Openness
- Companies position in the value chain
- Complementarity vs. similarity
  --> Shared goal vs. shared problem
- Opportunity / time-to-market
- Credibility of the innovation in new environment

- Trust is most important
- Complementary in strategic interests
- Shared problem OR goal but complementary roles for partners

- Dependency from company type (wide e.g. Facebook) or close (hidden partnerships preferred)
- Dependency from market
- Environment influences decision
- Dependency on innovation type (Schumpeter types; incremental vs. Disruptive; B2B or B2C; urgency, demonstration facilities, …)

ANNEX C – Questions to the A.SPIRE annual survey in the field of innovation management

- *What are barriers that your project is currently facing concerning innovation and innovation transfer? What measures have you already implemented? What other solutions can you in initiate or implement in order to reduce those barriers?*
- *How do you plan to facilitate dialogue about innovation transfer? What can be improved?*
- *Analyse your organizations innovation transferability, e.g. by using our indicators which were already prepared in a survey format. We recommend to apply a five- or seven-level Likert scale with a weighted evaluation according to the relevance of the criteria when doing so. We also recommend to distribute the survey more broadly within the company in order to ensure more objective data rather than very distinct personal results.*
- *Identify the areas of transfer you are already operating in. Do you have business partner working in the same field? Do you know companies with the same problems or objectives in your network? Is there cooperation potential which you can make use of?*