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University-industry communication for economic growth and innovation

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Abstract

University and industry (U-I) are the main sources of knowledge and innovation which are increasingly becoming the main pillar of competitiveness at micro and macro level. Despite potential synergies and benefits for the involved agentes, economies and society, communication between university and industry in the scope of innovation remains limited for decades. While a number of tools exists to stimulate U-I communication for innovation and the recognition for the need to ensure crossfertilising academic and industrial resources is increasing, currently implemented strategies rarely translate into long-term U-I engagement into co-innovation. Literature recognises i/organisational barriers, ii/ lack of adjustments of the strategies to stakeholders needs and local socio-economic conditions, and iii/ lack of tolls and strategic measures modernisation among the main reasons for poor results of the support strategies (Al-Agtash & Al-Fahoum, 2008, Vries et al., 2019). Therefore, better understanding how to address those challenges is needed.

As a reaction to the current state, our study is centred on the main research question – How to build effective strategies for U-I communication for innovation? To contribute to the solution, we are looking at specific tools and measures with potential to enable effective U-I communication for innovation across the barriers and the tools applicability. We approach the issue by means of systematic literature review, multiple regression and structural equation modelling. Within initial systematic review we map the existing knowledge to define which tools could be applied to bridge the main identified U-I communication barriers, such as differences in pourpose, standards and procedures or culture or language gaps. That process allowed us to from one side define which tools can be used to bridge each of the identified gaps and from the other side reviled a broad number of gaps in the current body of knowledge that do not allow decision makers design effective knowledge based strategies.

In our empirical studies we address a limited number of the identified gaps, specifically: i/ lack of clear empirical evidence regarding different impact of policy measures within different economic contexts; ii/ lack of modern studies on information and communication technology (ICT) influence on U-I communication, iii/highly limited amount of quantitative and comparative studies in the scope of U-I communication, iv/ lack of studies regarding international scope of U-I communication for innovation. In the first place, in chapter 3 we analyse how applicability of macro-level tools may differ in countries at different

development levels and whether the impact of U-I communication on economic development differs. Furtherly, in chapters 4 and 5 we analyse applicability of computer mediated communication (CMC) in the scope of cross-organisational communication with engagement of university and industry. We specifically look at the potential of a groupware system to build social capital (that was previously shown to have the ability to bridge U-I communication barriers) and how specific functions can support usefulness of such a tool to enable effective U-I communication for innovation.

Our main findings show empirically that the level of U-I communication is insufficient to significantly stimulate economic development. Countries at all development levels struggle to reach a critical mass of effective U-I communication for innovation and need to adjust their strategies to support U-I communication. Supporting increase in quality of research institutions and private R&D invetments is relevant at all development levels, while staff training related with absorptive capacity is relevant at lower development levels. However, our results suggest that, creating effective strategy for fostering U-I communication requires its adjustment to economic environment as the governmental mechanism can result in both, positive and negative influence on U-I communication. Meanwhile, on cross-organisational level, such a communication and its sustainability may be supported by providing effective means for computer mediated communication at the interface between organisations. To generate such a result, information and communication technology needs to provide social usefulness and mechanisms for building social capital. Functionalities enhancing participatory character and transparency of cross-organisational communication and providing interactivity within computer mediated communication shown enabling character for overcoming cross-organisational barriers.

Keywords

university – industry communication, university – industry collaboration, technology and knowledge transfer, innovation, open innovation, cross-organisational communication, computer mediated communication, policy measures

Resumo alargado

1. Fundamentação e objectivos do estudo

Em 1987, num estudo da comunicação dentro do sistema sueco de inovação Höglund e Persson (1987), baseando-se no estudo da literatura dos últimos 15 anos, mostraram que a comunicação entre a indústria e a universidade (U-I) no âmbito da inovação é extremamente limitada. O nosso estudo dos 32 anos seguintes sobre área sugere claramente que, apesar do crescente do reconhecimento dos potenciais benefícios da comunicação U-I na inovação e das tentativas dos agentes governamentais e sociais para incentivar o envolvimento mútuo das universidades e da indústria na investigação e inovação, o progresso alcançado não foi significativo.

Höglund e Persson (1987), embora reconhecessem a falta de conhecimento sobre a génese do problema, especularam que as possíveis razões para tal estado se encontrariam na relevância limitada da investigação básica com aplicações práticas e na generalizada falta de contacto entre diferentes agentes do sistema de I&D. Desde então, a literatura estudou a questão em detalhe, mostrando que, por um lado, o problema está nas barreiras organizacionais da comunicação U-I (Gera, 2012; Vries et al., 2018) e, por outro, na falta de ferramentas e sistemas adequados para que a comunicação U-I para a inovação ocorra de forma natural e não mediada (Bayne et al., 2016; Suomi et al., 2019). A literatura destaca especialmente que a comunicação U-I é fortemente obstruída por diferenças de objectivos, culturais e linguísticas, lacunas de incentivos ou diferenças de procedimentos e padrões de qualidade (Plewa et al., 2013a; D'Hooghe 2017; Vries et al., 2019). Enquanto isso, postula-se que uma comunicação eficaz na inovação traz benefícios significativos não apenas para os agentes envolvidos, mas também para a economia e para a sociedade (Martins, 2016; Suomi et al., 2019). A importância da comunicação entre universidade e indústria está a aumentar especialmente devido à mudança do mercado global em direção à concorrência baseada no conhecimento e à crescente importância de tecnologias inteligentes e inovação que, devido à sua complexidade, exigem o envolvimento de uma ampla gama de conhecimentos multidisciplinares. Neste ambiente económico, a falta de envolvimento de diferentes agentes com experiência em inovação e em múltiplas disciplinas exclui as economias de competir eficazmente nos principais sectores, gera custos através de oportunidades perdidas e duplicação de esforços, pode levar a uma maior marginalização das regiões menos desenvolvidas (MacLead et al., 1997 ; Sheen & MacBryde, 1995; Hotaling et al., 2012; Kopczynska & Ferreira, 2018). Enquanto isso, a falta de comunicação U-I eficiente no âmbito

da inovação tem sido relatada não apenas em regiões menos desenvolvidas na área da inovação (Hassen, 2018), mas também entre os líderes em inovação (Suomi et al., 2019; Kim & Jang, 2019).

Apesar da popularização recente de conceitos como universidade empreendedora e modelo de hélice tripla ou quádrupla, apesar dos investimentos governamentais significativos em estratégias que incentivam a comunicação U-I ou aumentam o reconhecimento da terceira missão da universidade, o problema da comunicação U-I insuficiente continua a ser um problema global. Embora atualmente o conhecimento sobre as barreiras da comunicação U-I seja extenso, falta entender como usar efetivamente ferramentas e estratégias para as superar (Kim & Jang, 2019). A literatura mostra especialmente que, enquanto países de todo o mundo investem em medidas para apoiar a comunicação e a colaboração U-I (Cooke, 2002; Peng et al., 2017), os seus esforços geralmente levam a resultados altamente limitados e insustentáveis (Lissoni, 2010; Suomi et al., 2019; Kim & Jang, 2019). Isto sugere que a compreensão atual das complexidades relacionadas com as estratégias para promover a comunicação U-I para inovação é limitada e a sua melhoria poderia contribuir para melhores estratégias de suporte e melhor capitalização dos recursos de conhecimento. A literatura enfatiza especialmente que as questões estão relacionadas com i/ a tendência de transferir ingenuamente práticas bem-sucedidas entre países, com diferentes contextos económico e culturais, sem a devida compreensão e / ou adaptação (Macleod et al., 1997; Salem & Amjed, 2008; Sandberg et al. al., 2015; Kim & Jang, 2019), ii / falta de modernização das medidas aplicadas aos desafios e oportunidades atuais (Paslowski et al., 2015; Kim & Jang, 2019), iii / foco na transferência unidirecional de conhecimento, em vez de na comunicação baseada em ciclos de feedback e dialogo para inovação (Kodama, 2002; Peng et al., 2017; Hayden et al., 2018).

Nesse âmbito, o nosso estudo tem como objetivo contribuir para a discussão e a resolução de problemas, analisando, em primeiro lugar, a literatura académica para integrar o corpo de conhecimentos existente a uma abordagem mais holística, procurando entender 1 / como as ferramentas e mecanismos específicos podem contribuir para superar as barreiras existentes entre a comunicação U-I e quais são as aplicações, os fatores de transferência e as condições; e 2 / identificar lacunas e deficiências no corpo de conhecimento que devem ser abordadas para permitir que quem deve tomar decisões e partes interessadas envolvidas gerem estratégias eficazes para maximizar a comunicação U-I para inovação. Além disso, a literatura geralmente sugere que a resolução requer estratégias modernas e a vários níveis, permitindo que a comunicação U-I ao nível macro - o nível relacionado ao sistema de políticas e inovação (Lee & Yoo, 2007; Ranga et al., 2008; D'Hooghe 2017; Hassen, 2018), e micro – o nível organizacional e de ferramentas relacionadas (Ranga et al ., 2008; Korzhenevskaya, 2014; Howarth & Monasterolo, 2016; Martins, 2016). Assim, seguimos com estudos empíricos de estratégias de nível macro e ferramentas facilitadoras de nível micro que permitem a

comunicação U-I. Especificamente, abordamos a questão da necessidade postulada pela literatura de ajustes de estratégias aplicadas às condições socioeconómicas de regiões e nações (Vick & Nagano, 2018; Kim & Jang, 2019), analisando se as diferenças no impacto da comunicação U-I no desenvolvimento económico difere entre países a diferentes níveis de desenvolvimento, e se o potencial de intervenções específicas para estimular a comunicação U-I difere entre países dependendo com o seu desenvolvimento. Por outro lado, abordamos a necessidade de modernização das abordagens atuais, não apenas analisando mais estratégias, mas estratégias direcionadas, também analisando empiricamente o potencial e as condições do uso de soluções de grupos de trabalho (groupware) na comunicação entre organizações para não servir apenas como canal eficaz de comunicação, mas como ferramenta de facilitação para superar as barreiras organizacionais existentes.

Reconhecendo a necessidade da inovação aberta para o modelo bidirecional e não linear de interação da U-I (Butcher & Jeffrey, 2005; Lauder & Atkinson-Grosjean 2011), a tese geral visa contribuir para estratégias de envolvimento dialógico da U-I no âmbito da inovação. A literatura atual concentra-se no problema da questão da comunicação da UI para inovação na fase de envolvimento até o primeiro projeto ser concluído (Plewa et al., 2013a). Enquanto isso, a inovação é um processo complexo que resulta de interações não lineares, processos de aprendizagem e colisões entre diferentes ideias, agentes, visões ou sistemas (Leydesdorff & Etzkowitz, 1998; Fields, 2006; Tidd & Bessant, 2014). Precisa, por um lado, de integrar os produtores de conhecimento e inovação e os proprietários de produtos - indústria e/ou universidade; com agentes responsáveis pelo ambiente e suporte à inovação - agentes de políticas, intermediários e cadeia de suplementos. Por outro lado, precisa de um fluxo constante e não linear de comunicação e interações para alimentar o mecanismo de inovação, considerando que a inovação geralmente acontece como resultado de interações inesperadas (Tidd & Bessant, 2014). Conforme apresentado por Levallois et al. (2019) o caso da criação de um novo campo de pesquisa de programas de neuromarketing, os benefícios postulados das interações U-I aumentam não apenas na comunicação U-I estruturada. Também a comunicação pura do progresso ou feedback básico pode estimular o desenvolvimento nas áreas de pesquisa e inovação. Por outro lado, a comunicação estruturada não pode ocorrer sem sistemas eficazes para estabelecer contactos iniciais e fornecer informações claras sobre os recursos potencialmente disponíveis entre parceiros (Ranga et al., 2008; Venditti et al., 2013). A comunicação tem forte inter-relação com a inovação, influenciando-a em todas as etapas. Desde colisões, convergência e divergência de ideias (Pendergast & Hayne, 1999; Shinn, 2005) até a fase de envolvimento contínuo, resultando em comunicação U-I sustentável para a inovação (Plewa et al., 2013a; Plewa et al., 2013b). Tal demonstra ser de importância crítica para qualquer forma ou estágio de interações inter-organizacionais. O que está a mudar é apenas a forma, formalidade e tópicos trocados (Plewa et al., 2013b).

Embora o conceito de comunicação seja frequentemente mal compreendido, ele abrange o processo de criação, codificação, transmissão, interpretação e retorno de mensagens (Watson & Hill, 2000). Envolve uma ampla gama de mecanismos de comunicação, abrangendo (Scott et al., 2001; Butcher & Jeffrey 2005):

1. Codificação / artefactos - cobrindo a transmissão de ideias, informações e projetos por meio de codificação, ou seja, encapsulados em patentes ou protótipos,

2. Cooperação - troca de informações e recursos relevantes para apoiar os objetivos uns dos outros, que podem assumir uma forma estruturada de joint venture, parceria estratégica ou intercâmbio de pessoal,

3. Contactos - interações formais e informais entre investigadores públicos e seus homólogos nas empresas para construir relacionamentos fortes e comunicação eficaz,

4. Contratos - acordos formais de cooperação.

A comunicação entre organizações serve múltiplos propósitos. Entre outros, oferece a possibilidade de reunir conceitos não relacionados ou imagens mentais para explorar novas conexões e gerar ideias, trocar informações, incentivar a compreensão das capacidades dos parceiros, necessidades de recursos e diferentes maneiras de fazer as coisas para cultivar a inovação e o ambiente colaborativo (Treadaway, 2004; Santoro e Saparito, 2003). Permite criar valor a partir da informação através da sua conversão em conhecimento, por absorção e socialização (Neumann & Prusak, 2007). A literatura mostra claramente que, para responder aos desafios modernos, as estratégias que apoiam as interações U-I precisam de abraçar oportunidades de interações U-I de maneira compreensiva. Atualmente, o responsável pela maioria da comunicação U-I para a inovação são os projetos financiados por fundos públicos, sem cultura, competências, mecanismos de comunicação e estratégias de suporte adequados, que estão a levar a resultados pobres sem impacto reportado sobre a sustentabilidade da comunicação na U-I (Lissoni, 2010) e com potenciais efeitos negativos relacionados com a criação e financiamento de projetos superficiais sem potencial ou intensões de exploração comercial ou social (Suomi et al., 2019). Portanto, nossa abordagem procura adotar um âmbito mais alargado da comunicação U-I para a inovação e do seu papel na promoção do diálogo não linear da U-I neste mesmo âmbito para fornecer uma abordagem mais compreensível com aplicação no processo de tomada de decisão relacionado com as estratégias de suporte à comunicação da U-I no âmbito da inovação.

Como estamos a analisar especificamente o âmbito da comunicação U-I, como as principais esferas que contribuem para a produção e inovação do conhecimento, libertar todo o seu

potencial de inovação requer comunicação entre os atores fora de suas arenas tradicionais (Leydesdorff & Etzkowitz, 1998).

Para alcançar os objetivos do estudo estabelecidos após a introdução, o nosso estudo é composto por quatro capítulos principais, que com seus objetivos específicos visam fornecer ideias sobre como criar estratégias eficazes para a comunicação universidade-indústria (U-I) no âmbito da inovação. Nesse âmbito, focamo-nos especificamente nas ferramentas para apoiar a comunicação U-I no âmbito da inovação e a sua aplicação no contexto de barreiras comuns. Após a revisão sistemática da literatura no capítulo 1, identificamos duas lacunas específicas na compreensão das ferramentas para apoiar a comunicação U-I eficaz para a inovação a ser abordada empiricamente. Em primeiro lugar, no capítulo 3, analisamos como a aplicação das ferramentas a nível macro pode ser diferente em países com diferentes níveis de desenvolvimento. Além disso, nos capítulos 4 e 5, analisamos a aplicação da comunicação mediada por computador (CMC) no âmbito da comunicação inter-organizacional com o envolvimento da universidade e da indústria. O design geral da tese é focado na questão central: "Como criar estratégias eficazes para apoiar a comunicação U-I no âmbito da inovação?". Cada um dos capítulos contribui com conclusões específicas sobre a aplicação de ferramentas no nível micro ou / e macro para superar barreiras na comunicação U-I.

2. Metodologia

A investigação é um processo de evolução do conhecimento para promover o progresso e permitir um relacionamento mais eficaz entre o Homem e o seu contexto por forma a alcançar os seus propósitos e solucionar os seus conflitos (Singh, 2006, p. 1). O nosso estudo está fortemente orientado para este objetivo, no âmbito do seu objetivo geral de avançar o conhecimento sobre como construir estratégias eficazes para a comunicação universidade – indústria (U-I). Na sequência deste objetivo, o nosso estudo segue uma lógica de investigação explicativa para compreender a influência de mecanismos e alterações específicos no contexto socioeconómico da comunicação U-I para a inovação.

Para alcançar uma solução dependente para o problema definido e disponibilizar um contributo de relevo, o nosso desenho da investigação é baseado num processo iterativo, no qual os objetivos específicos para estudos empíricos provieram de resultados de resultado(s) anterior(es) (Singh, 2006).

O processo iterativo fundamentou o enfoque e objetivos específicos para cada um dos capítulos. Para além disso, a escolha de uma abordagem quantitativa no âmbito dos nossos capítulos empíricos (3, 4 e 5) foi parcialmente motivada pela identificação, na revisão sistemática de literatura, da falta significativa de investigação quantitativa no âmbito da comunicação U-I. Apesar do reconhecimento da necessidade tanto de investigação quantitativa como qualitativa para a reavaliação de estudos de inovação de apoio à

colaboração entre as duas esferas (Kim & Jang, 2019), a quantidade e variedade de estudos quantitativos no corpo da literatura é altamente limitado, por contrapartida de uma base de conhecimento assente em estudos qualitativos – estudos de caso da Europa (com um único estudo Europeu baseado em investigação quantitativa) encontrada na revisão sistemática da literatura. A aplicação de um método de investigação quantitativo específico para cada capítulo é uma resposta direta ao seu enfoque de estudo e características de medição. Assim:

1. No âmbito do Capítulo 3 – 'A relação bilateral entre comunicação universidade – indústria e órgãos de governação – o nível de desenvolvimento importa?', onde se testam diferenças no potencial de medidas de governação específicas relacionadas com o ambiente de comunicação U-I para apoiar a comunicação U-I e o potencial da comunicação U-I para a inovação para estimular o crescimento económico, aplicámos modelos de regressão múltipla. Como em cada caso independente nos interessava a previsão de alterações numa única variável dependente com base num conjunto de preditores independentes, a regressão múltipla correspondia aos nossos objetivos e desenho do modelo de investigação (Hair et al., 2010).

2. No âmbito do Capítulo 4 – 'Utilidade de social de plataformas de trabalho de grupo (groupware) como ferramentas de superação de barreiras à comunicação entre organizações – o caso do ambiente AdminProject', visamos estudar se o apoio dos grupos de trabalho (groupware) para comunicação mediada por computador (CMC) através de mecanismos de comunicação orientados podem reduzir as barreiras à comunicação entre organizações e fomentar a comunicação U-I. Especificamente, procuramos compreender se a utilidade social dos grupos de trabalho relacionada com a construção de confiança (Bacon et al., 1994; Ju et al., 2016), reforço de relações (Suomi et al., 2019) e entendimento mútuo (D'Hooghe, 2017; Martins, 2016) pode facilitar a comunicação entre organizações para além das barreiras e estimular uma atitude positiva para a sua continuidade. Na medida em que o carácter do fenómeno analisado exigiu a utilização de variáveis latentes, e os objetivos de estudo exigiram análises confirmatórias das relações entre os construtos ao nível do sistema, foi aplicada um modelo de equações estruturais (Hair et al., 2010).

3. No âmbito do Capítulo 5 - 'Compreender o potencial de soluções de trabalho de grupo (groupware) para o reforço da comunicação entre organizações para a inovação – estabelecer a ponte entre o carácter das funcionalidades do sistema' visámos olhar para como os aspetos de funcionalidades especificas podem contribuir para a utilidade do sistema para a comunicação entre organizações e influenciar positivamente as reações emocionais relacionadas com o processo. Foi necessária a utilização de variáveis latentes para refletir as variáveis não observáveis que visámos estudar. Para além disso, os objetivos de estudo exigiram uma análise confirmatória das relações entre construtos ao nível do sistema. Consequentemente, um modelo de equações estruturais foi aplicado (Hair et al., 2010).

3. Conclusões gerais e principais resultados de investigação

No âmbito da dissertação e ainda que, realisticamente, não esperemos encontrar um martelo mágico e derrubar muros estabelecidos entre universidades e indústria que obstruem a comunicação para a inovação entre organizações, nem fornecer uma resposta universal sobre como as estratégias para a promoção da comunicação U-I devem ser especificamente, procuramos formas eficazes para a poiar a comunicação U-I para a inovação. Contribuímos para a discussão, em primeiro lugar, através do desenvolvimento do corpo de conhecimento existente, focando-nos na aplicabilidade de ferramentas específicas e medidas no âmbito de barreiras especificas à comunicação U-I identificadas e os seus fatores. Além disso, no âmbito da nossa investigação empírica, endereçamos um número de lacunas relacionadas com i/ falta de evidências empíricas claras acerca dos diferentes impactos de medidas de política dentro de diferentes contextos económicos; ii/ falta de estudos atuais acerca da influência das tecnologias de informação e comunicação (TIC) na comunicação U-I, iii/ quantidade altamente limitada de estudos quantitativos e comparativos no âmbito da comunicação U-I, iv/ falta de estudos relacionados com o âmbito internacional da comunicação U-I para a inovação.

A dissertação estuda os métodos de apoio à comunicação para a inovação entre universidade – indústria (U-I). A revisão sistemática da literatura inicial (Capítulo 2) resulta na análise dos estudos na literatura sobre ferramentas de comunicação e sua aplicação ou requisitos para superação das barreiras existentes à comunicação U-I. A revisão mostrou não só uma forte necessidade de melhoria dos canais e medidas de apoio à comunicação U-I, mas também falhas significativas no conhecimento sobre como a comunicação pode efetivamente criar pontes entre a universidade e a indústria. O estudo mostra que existem falhas significativas na compreensão sobre como capacitar e fomentar a comunicação U-I para a inovação tanto ao nível micro como macro. Contudo, esta sugere que apenas uma integração adequada de ferramentas e medidas complementares pode gerar benefícios ótimos do investimento em investigação e desenvolvimento a nível global. Assim, como para o encontro de soluções sustentáveis no longo prazo ao nível da comunicação U-I são necessárias intervenções eficazes em ambos os níveis, prosseguimos analisando, dentro da componente empírica do estudo, em primeiro lugar como os órgãos de governação podem apoiar a comunicação U-I na geração de crescimento económico e inovação, seguido de uma análise sobre como tal comunicação pode ser facilitada eficazmente num ambiente TIC.

O nosso estudo do impacto da comunicação U-I sobre o crescimento económico no Capítulo 3, mostra que apesar do postulado impacto da comunicação U-I sobre o crescimento económico não existem evidências empíricas de tais benefícios a nível macro, em nenhum nível de desenvolvimento. Assim, apesar do significante investimento em ferramentas de política para apoio à comunicação U-I para a inovação em muitas economias, os resultados permanecem

insignificantes. Este mostra que as metodologias aplicadas atualmente são ineficientes e existe uma forte necessidade de encontrar soluções melhores que tornem a comunicação U-I para a inovação mais relevante e eficaz. A investigação mostra empiricamente que a facilitação a nível macro incluindo, entre outros, medidas de política que visem o crescimento da qualidade das instituições de investigação ou o nível de investimento privado em I&D são necessários, mas deverão ser cuidadosamente desenhados de acordo com as necessidades específicas da região em vez de transferidos de contextos diferentes. Além disso, enquanto que as políticas que incentivam a melhoria na qualidade percebida das instituições de investigação e os investimentos privados em I&D têm importância através dos níveis de desenvolvimento, para níveis de desenvolvimento mais baixos a formação de recursos humanos em matérias relacionadas com a capacidade de absorção é relevante. Os nossos resultados evidenciam, também, o papel dos sistemas de inovação adequados implementados os quais, dependendo do seu desenho, podem ter tanto um impacto potenciador com inibidor sobre a comunicação U-I. Assim, o apoio à comunicação U-I irá exigir uma construção de políticas inteligente. Entretanto, enquanto que os resultados, no seu estado atual, não são conclusivos, os resultados empíricos do estudo sugerem que a comunicação U-I poderá servir como uma estratégia de relevo para reduzir os impactos negativos de uma recessão económica. Tal iria aumentar ainda mais os possíveis benefícios de tornar a eficaz comunicação U-I para a inovação num objetivo estratégico ao nível de toda a economia.

Enquanto que uma mudança sistémica visando a eliminação de barreiras, a nível macro, à comunicação U-I seria um mecanismos significativo para aumentar a comunicação U-I para a inovação, não existem sinais de que os Governos se encontrem a trabalhar, atualmente, em mudanças radicais nessa matéria (i.e mudança de um sistema de avaliação de desempenho de académicos e investigadores centrado em publicações académicas para um sistema centrado na comunicação ciência-para-indústria). Neste âmbito, os stakeholders envolvidos deverão concentra-se em procurar ferramentas e medidas alternativas/complementares à sua disposição para ultrapassar os obstáculos existentes à comunicação U-I e progressivamente construírem um sistema e uma cultura para a comunicação U-I. O corpo de literatura analisado sugere que fatores sociais e comportamentais em especial, mostram um potencial transversal para colmatar as lacunas na comunicação U-I. Em especial os mecanismos orientados para a construção de relações são comumente associados a um efeito de mediação na lacuna de comunicação U-I. Da base da literatura existente podem retirar-se conclusões de alto nível que sugerem que para se obterem os vários benefícios da comunicação U-I para a inovação, postulados na literatura, os mecanismos de comunicação devem ser desenhados de forma a que:

- Permitam uma comunicação aberta e profissional que promova uma cultura de colaboração e a procura por consenso,

- Sejam estritamente adaptados às necessidades específicas dos stakeholders envolvidos na comunicação,

- Integrem soluções de comunicação complementares ou forneçam as suas características para colmatar barreiras à comunicação existentes.

Com base na revisão sistemática da literatura, a maioria dos mecanismos propostos refere-se a ferramentas baseadas em interações pessoais como os mecanismos de maior importância para colmatar as lacunas na comunicação U-I e melhorar a comunicação U-I para a inovação. Contudo, novos desafios pedem a inclusão de meios mais complexos capazes de dar resposta a desafios e oportunidades atuais. Entre outros, o rápido desenvolvimento das tecnologias TIC resultaram numa crescente dispersão de conhecimento e crescente capacidade para o aceder, consequentemente, a tirar o máximo partido do vasto conhecimento existente. Assim, limitar as estratégias de comunicação U-I às redes locais e clusters normalmente estudados no âmbito da literatura sobre comunicação U-I, pode ser contraprodutivo uma vez que valiosos recursos de inovação podem ser acedidos fora destes limites, permitindo significativo aumento no acesso a recursos de conhecimento.

Contudo, não foram identificados estudos recentes dedicados a analisar comunicação de longa distância U-I para a inovação. Assim, no seguimento da análise empírica de ferramentas de nível macro, analisámos a possibilidade de comunicações mediadas por computador (CMC) não só permitirem a comunicação U-I de longa distância como também facilitarem a superação de barreiras à comunicação U-I através de meios similares às interações pessoais. Com base nas hipóteses desenhadas a partir da revisão sistemática da literatura, identificámos uma solução de trabalho de grupo (groupware) específica especialmente desenhada à medida das necessidades dos stakeholders envolvidos em comunicação entre organizações para a inovação no âmbito do programa Erasmus+ Parcerias Estratégicas. A análise desta solução permitiu-nos verificar se soluções especificas de trabalho de grupo (groupware) podem complementar ferramentas macro ao apoiar a comunicação profissional, a cultura de colaboração e a procura de consenso e disponibilizando características que irão ajudar a superar barreiras comunicacionais existentes. No processo mostramos que soluções específicas de grupos de trabalho (groupware) podem ter um impacto positivo na comunicação entre organizações ao nível das barreiras tanto organizacionais como geográficas, ao disponibilizar não só utilidade técnica como social (Capítulo 4).

Enquanto que a capacidade específica do sistema para melhorar as relações não foi confirmada, a utilidade social foi relacionada com a sua capacidade para estabelecer relações em primeiro lugar através da construção de consciência e familiaridade entre parceiros. O estudo mostra que apesar do sistema analisado não se concentrar diretamente na comunicação, o Sistema inclui características de mecanismos sociais que são relevantes para fomentar intensões de comportamentos positivos para a comunicação entre organizações.

Assim, como os resultados iniciais do estudo revelam o potencial das soluções de grupo de trabalho (groupware) para o decréscimo das barreiras à comunicação entre organizações para a inovação e a promoção de atitudes positivas face a tal comunicação e colaboração, o estudo foi seguido pela análise de mecanismos específicos do sistema que seriam relevantes no processo (Capítulo 5). Seguindo o postulado na literatura das características, descobrimos que mecanismos de apoio à transparência, comunicação participativa e interatividade podem influenciar positivamente a comunicação através das fronteiras da organização estimulando reações emocionais positivas entre os utilizadores. No conjunto, mostra empiricamente que, se desenhado especificamente para as necessidades de colaboração entre organizações, a CMC pode disponibilizar não só espaço para comunicação como também um ambiente social no qual os indivíduos envolvidos podem, de forma profissional, imbuir-se numa procura pelo consenso. Enquanto que, no seguimento dos resultados, tal ambiente pode disponibilizar meios de facilitação para a superação de barreiras à comunicação entre organizações, as competências relacionais dos indivíduos (como postulado na literatura de forma mais simplificada (Pendergast & Hayne 1999; Santoro & Saparito, 2003), permanecerão com elevada relevância na comunicação eficaz.

No conjunto, o estudo mostra que uma estratégia complexa com envolvimento a múltiplos níveis é necessária para alcançar níveis de comunicação U-I relevantes para o crescimento económico e inovação. A capitalização ótima do potencial de inovação no âmbito da universidade e setor industrial irá exigir não só o envolvimento ativo dos agentes daquelas esferas como também o de outros stakeholders do ambiente de inovação tais como órgãos de governação, e tecnologias facilitadoras. Enquanto que a universidade e a indústria são os principais agentes responsáveis pela geração de conhecimento e inovação, a compreensão do contexto alargado (incluindo órgãos de governação, organizações de apoio bem como fatores ambientais tais como tecnologia existente) é necessária para a definição de estratégias ótimas para a otimização da comunicação U-I para a inovação.

Palavras - chave

Comunicação universidade - indústria, colaboração universidade - indústria, transferência de tecnologia e conhecimento, inovação, inovação aberta, comunicação entre organizações, comunicação mediada por computador

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Chapter 1

Introduction

Rationale and study objectives

In 1987, in the study of communication within the Swedish innovation system, Höglund and Persson (1987) basing on their study of literature of proceeding 15 years shown that the communication between industry and university (U-I) in the scope of innovation is highly limited. Our study, covering the following 32 years of studies in the area clearly suggests that, despite increased recognition for potential benefits of U-I communication for innovation and attempts of governmental and social agents to encourage mutual engagement between university and industry in research and innovation, progress has been not significant.

Höglund and Persson (1987), while recognised the lack of knowledge regarding genesis of the problem, speculated that the possible reasons for such a state lied in limited relevance of basic research for practical applications and a general lack of contact between different agents within the R&D system. Since then literature studied the issue in details showing that from one side the problem lies in organisational barriers to U-I communication (Gera, 2012; Vries et al., 2018) and from the other in lack of proper tools and systems in place for U-I communication for innovation to occur in a natural unmediated way (Bayne et al., 2016; Suomi et al., 2019). Literature especially underlines that the U-I communication is strongly obstructed by purpose, cultural and language differences, incentive gaps or differences in procedures and quality standards (Plewa et al., 2013a; D'Hooghe 2017; Vries et al., 2019). Meanwhile, it postulates that effective communication for innovation brings significant benefits not only for the involved agents, but also for economy and society (Martins, 2016; Suomi et al., 2019). The importance of communication between university and industry is especially increasing with shift of global market towards knowledge-based competition and increased importance of smart technologies and innovations which due to their complexity require engagement of broad range of multidisciplinary knowledge. Within such economic environment, lack of engagement of different agents with expertise in innovation across disciplines excludes economies from competing effectively in headline industries, generates costs of lost opportunities and duplication of efforts (MacLead et al., 1997; Sheen & MacBryde, 1995; Hotaling et al., 2012; Kopczynska & Ferreira, 2018). It can lead to further

marginalisation of lagging regions. Meanwhile, lack of efficient U-I communication in the scope of innovation has been reported not only in regions lagging on innovation (Hassen, 2018), but also among innovation leaders (Suomi et al., 2019; Kim & Jang, 2019).

Despite recent popularisation of concepts such as entrepreneurial university and Triple or Quadruple Helix Model, despite significant governmental investments into strategies encouraging U-I communication or increasing recognition for universities third mission, the problem of insufficient U-I communication remains a global issue. While currently the knowledge regarding the barriers to U-I communication is extensive, the understanding how to effectively use tools and strategies to bridge them is lacking (Kim & Jang, 2019). Literature shows especially that while countries across the world invest in measures to support U-I communication and collaboration (Cooke, 2002; Peng et al., 2017), their efforts commonly lead to highly limited and unsustainable results (Lissoni, 2010; Suomi et al., 2019; Kim & Jang, 2019). It suggests that current understanding of complexities related with strategies for fostering U-I communication for innovation is limited and its enhancing could contribute to better support strategies and improved capitalisation on knowledge resources. The literature especially underlines that issues are related with i/ tendency to naively transfer successful practices between countries with different economic and cultural context, without its proper understanding and/ or adaptation (Macleod et al., 1997; Salem & Amjed, 2008; Sandberg et al., 2015; Kim & Jang, 2019), ii/ lack of modernisation of applied measures to current challenges and opportunities (Paslowski et al., 2015; Kim & Jang, 2019), iii/ focus on unidirectional knowledge transfer, rather than on dialogic feedback loops based communication for innovation (Kodama, 2002; Peng et al., 2017; Hayden et al., 2018).

In that scope, our research aims to contribute to the discussion and the issues resolution by, in the first place, analysing academic literature to integrate the existing body of knowledge into more holistic approach looking to 1/ understand how specific tools and mechanisms may contribute to overcoming the existing barriers to U-I communication and what are their applicability and transferability factors and conditions; and 2/ identify gaps and shortcomings in the body of knowledge that should be addressed to enable decision makers and involved stakeholders to generate effective strategies to maximise U-I communication for innovation. Further, the literature commonly suggests that the resolution requires multilevel modern strategies enabling U-I communication at macro – the policy and innovation system related level (Lee & Yoo, 2007; Ranga et al., 2008; D'Hooghe 2017; Hassen, 2018), and micro- the organisational and tools related level (Ranga et al., 2008; Korzhenevskaya, 2014; Howarth & Monasterolo, 2016; Martins, 2016). Therefore, we follow with empirical studies of macro-level strategies and micro-level tools enabling U-I communication. Specifically, we address the issue of postulated by the literature need for adjustments of applied strategies to socio-economic conditions of regions and nations (Vick & Nagano, 2018; Kim & Jang, 2019), by analysing whether differences in the impact of U-I communication on economic development

differ between countries at different development level, and whether the potential of specific interventions to stimulate U-I communication differs among countries, depending on their development. From the other side, we address the need for modernisation of current approaches not only looking into more needs targeted macro-strategies, but also by empirically analysing the potential and conditions for using groupware solutions within cross-organisational communication to not only to serve as effective communication channel, but as facilitation tool to overcome the existing organisational barriers.

In recognition of the open innovation need for bi-directional and non-linear model of U-I interaction (Butcher & Jeffrey, 2005; Lauder & Atkinson-Grosjean 2011), the overall thesis is aiming at contributing to strategies for dialogic U-I engagement in the scope of innovation. Current literature focuses the understanding of the U-I communication for innovation issue on the engagement phase of U-I cooperation in which the first project is concluded (Plewa et al., 2013a). Meanwhile, innovation is a complex process resulting from non-linear interactions, learning process and collisions between different ideas, agents, visions or systems (Leydesdorff & Etzkowitz, 1998; Fields, 2006; Tidd & Bessant, 2014). It needs from one side to integrate the knowledge and innovation producers and product owners – industry and/or university; with agents responsible for innovation environment and support– policy agents, intermediaries and supply chain. From the other side, it needs a constant and non-linear flow of communication and interactions to feed the innovation engine, as innovation commonly happens as a result of unexpected interactions (Tidd & Bessant, 2014). As presented by Levallois et al. (2019) case of creation of new research field of neuromarketing shows, postulated benefits from U-I interactions raise not only from structured U-I communication. Also pure communication of progress or basic feedback can stimulate developments in the areas of research and innovation. From the other side, the structured communication cannot occur without effective systems for establishing initial contacts and providing clear information about potentially available resources between partners (Ranga et al., 2008; Venditti et al., 2013). Communication has strong interrelation with innovation influencing it at every stage. From collisions, convergence and divergence of ideas (Pendergast & Hayne, 1999; Shinn, 2005) to the continuing engagement phase resulting in sustainable U-I communication for innovation (Plewa et al., 2013a; Plewa et al., 2013b). It proves to be of critical importance for any form or stage of cross-organisational interactions. What is changing is just the form, formality, and topics exchanged (Plewa et al., 2013b).

While the concept of communication is often misunderstood, it covers a comprehensive process of creating, encoding, transmitting, interpreting and returning messages (Watson & Hill, 2000). It involves a broad range of communication mechanisms covering (Scott et al., 2001; Butcher & Jeffrey 2005):

1. Codification/ artifacts – covering transmission of ideas, information and designs by means of codification, i.e. encapsulated into patents or prototypes,

2. Cooperation – exchanging relevant information and resources in support of each other's goal, which can take a structured form of joint venture, strategic partnership or personnel exchange,

3. Contacts – formal and informal interactions between public researchers and their counterparts in firms to build strong relationships and effective communication,

4. Contracts – formal agreements for cooperation.

Communication across organisations serves multiple purposes. Among others, it provides possibility to bring together unrelated concepts or mental images to explore new connections and generate ideas. It enables exchanging information, encourages understanding of partner capabilities, resource needs and different ways of doing things to cultivate innovation and collaborative environment (Treadaway, 2004; Santoro & Saparito, 2003). It allows to create a value from information by its conversion into knowledge, by absorption and socialisation (Neumann & Prusak, 2007). The literature clearly shows that to respond to modern challenges, strategies supporting U-I interactions need to embrace opportunities for U-I interactions in a comprehensive way. Currently responsible for majority of U-I communication for innovation publically funded projects, without proper culture, skills, communication mechanisms and support strategies, are leading to poor results with no reported impact on sustainability of U-I communication (Lissoni, 2010) and with their potentially negative effect related with creating and funding superficial projects with no potential or intention for commercial or social exploration (Suomi et al., 2019). Therefore, we adopt an approach focused on a broad scope of U-I communication for innovation and its role in fostering non-linear dialogic U-I communication. In this way we aim to provide more comprehensive approach with applicability into decision making process related with creating strategies supporting U-I communication in the scope of innovation.

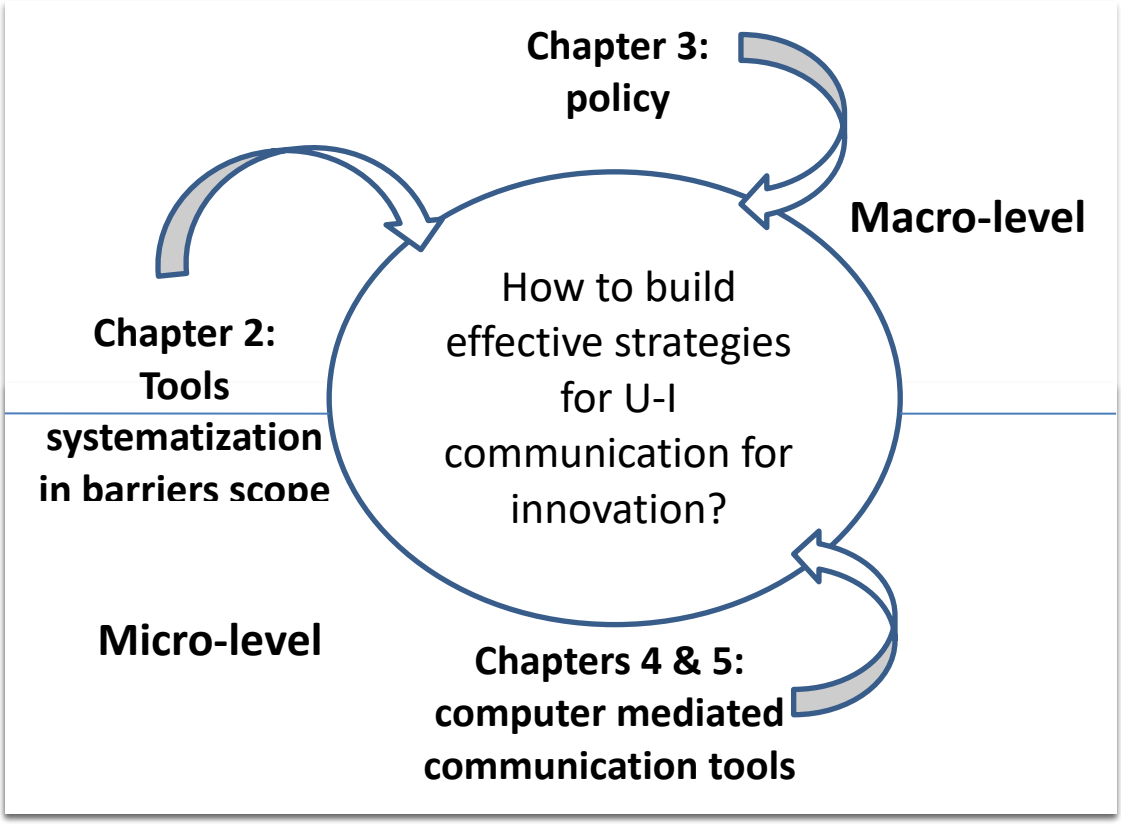
As we are specifically looking into U-I communication scope as covering the main agents contributing to knowledge production and innovation, unlocking the full innovation potential requires communication between actors outside of their traditional arenas (Leydesdorff & Etzkowitz, 1998). Therefore, we approached the topic by analysing it from a realistic perspective including surrounding environment where necessary (Suomi et al., 2019).

Study structure and conceptual model

To reach established study objectives following the introduction, our study contains four core chapters, which with their specific objectives all aim at providing insights on how to build effective strategies for university – industry (U-I) communication in the scope of innovation. In that scope, we specifically focus on tools for supporting U-I communication in the scope of innovation and their applicability in the context of common barriers. Following the systematic

literature review in chapter 2, we selected two specific gaps in understanding of tools for supporting effective U-I communication for innovation to be empirically addressed. In the first place, in chapter 3 we analyse how applicability of macro-level tools may differ in countries at different development level. Further, in chapters 4 and 5 we analyse applicability of computer mediated communication (CMC) in the scope of cross-organisational communication with engagement of university and industry. The overall thesis design is focused on the central question – 'How to build effective strategies to support U-I communication in the scope of innovation'. Each of the chapters contributes with specific conclusions regarding application of tools at micro- or/and macro-level to overcome barriers to U-I communication (See Figure 1.1).

Figure 1.1. Thesis research model



Methodology

Research is a process of advancing knowledge for promoting progress and enable man to relate more effectively to his environment to accomplish his purpose and resolve his conflicts' (Singh, 2006, p. 1). Our study is strongly aiming at this objective within its general objective of looking for knowledge on how to build effective strategies for university – industry (U-I) communication. Following that objective, the study follows explanatory

research logic to understand the influence of specific mechanisms and changes on the socio-economic context of U-I communication for innovation.

To arrive at a dependable solution to the defined problem and provide contributions of relevance, our research design is based on an iterative process, where specific objectives for empirical studies were derived from previous output(s) (Singh, 2006). The process of translating the research objective into research questions is presented in the figure 1.2.

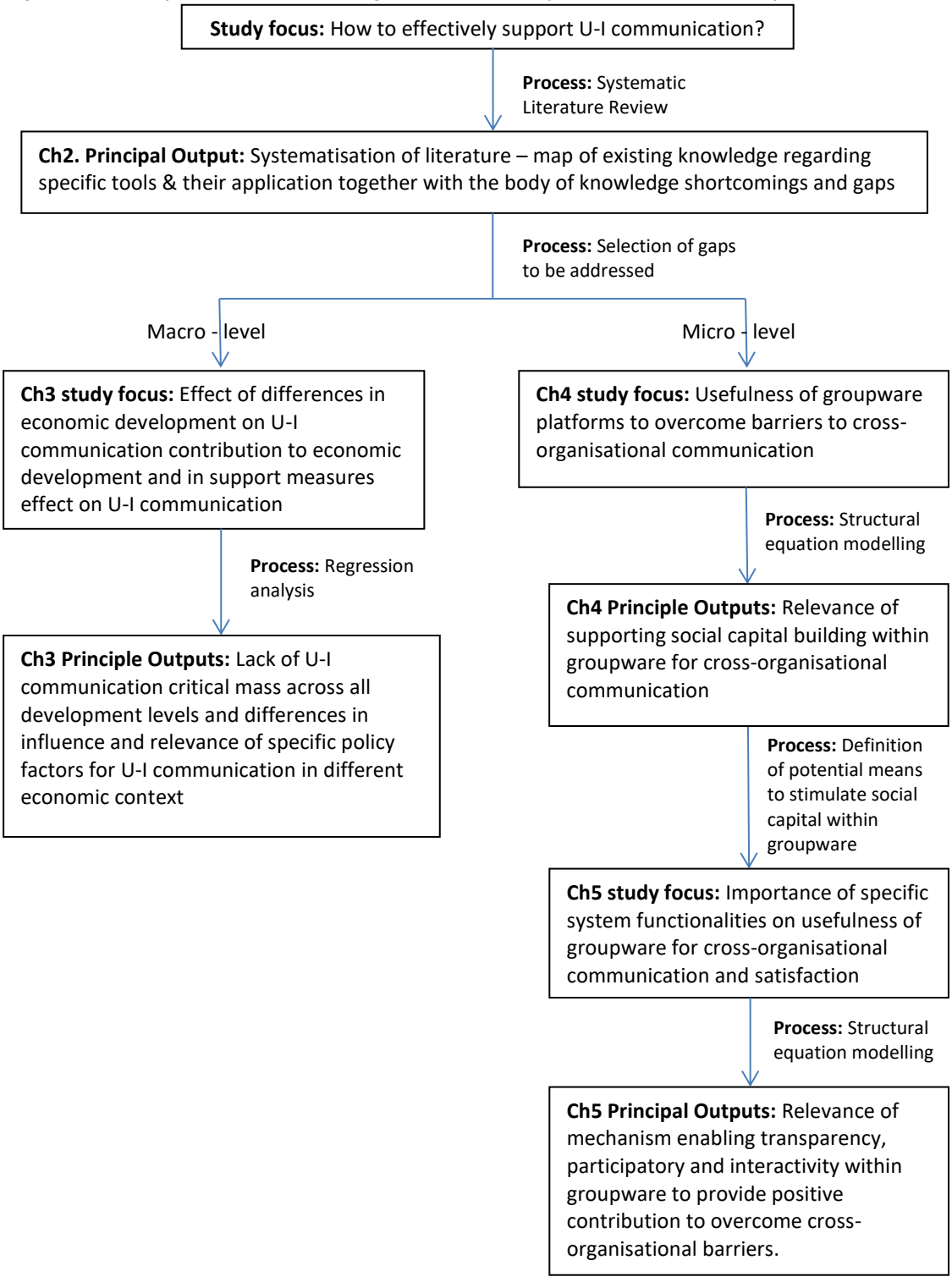
The iterative process informed specific focus and objectives for each of the chapters. Moreover, the choice of quantitative approach within our empirical chapters (3, 4 and 5) was partially motivated by defined within the systematic literature review significant lack of quantitative research in that scope of U-I communication. Despite recognition for the need of both quantitative and qualitative research to reassess innovation studies for support of inter-sphere collaboration (Kim & Jang, 2019), the amount and range of quantitative studies within the systematic literature review is highly limited.Especially in Europe the existing knowledge base is strongly qualitative, and specifically case study driven (with a single Europe based quantitative study). The application of specific quantitative method for each chapter was a direct response to its study focus and measurements characteristics. Therefore:

1. Within Chapter 3 – 'The bilateral relation between university – industry communication and government - does development level matter?', testing differences in potential of specific governmental measures related with U-I communication environment to support U-I communication and the potential of U-I communication for innovation to stimulate economic growth, we applied multiple regression modelling. As in each independent case we were interested in predicting changes in a single dependant variable based on a set of independent predictors, multiple regression corresponded to our objectives and research model design (Hair et al., 2010).

2. Within Chapter 4 – 'Social usefulness of groupware platforms as tools to overcome barriers to cross-organisational communication – case of AdminProject environment', we aim to study whether the groupware support for computer mediated communication (CMC) through a targeted communication mechanism can decrease barriers to cross-organisational communication and foster U-I communication. Specifically, we aim to understand whether the groupware social usefulness related with trust building (Bacon et al., 1994; Ju et al., 2016), relation enhancement (Suomi et al., 2019) and mutual understanding (D'Hooghe, 2017; Martins, 2016) can facilitate cross-organisational communication across barriers and stimulate positive attitude toward its continuance. While the character of analysed phenomenon required usage of latent variables, and the study objectives required confirmatory analysis of the relations between the constructs at the system level, a structural equation modelling has been applied (Hair et al., 2010).

3. Within Chapter 5 - ‘Understanding potential of groupware solutions for enhancing cross-organisational communication for innovation – bridging character of system functionalities’ our objectives looked into how specific functionalities can contribute to usefulness of the system for cross-organisational communication and how they may positively influence the emotional reactions related with the process. Use of latent variable was required to reflect the unobservable variables we aimed to study. Further, the study objectives required confirmatory analysis of the relations between the constructs at the system level. Hence, a structural equation modelling has been applied (Hair et al., 2010).

Figure 1.2. The process of translating the research objective into research questions.



Chapter 2

How to bridge the gap between university and industry? – A Review of Tools supporting university-industry communication

2.1. Introduction

For decades the need for a close collaboration between university and industry in the area of innovation is broadly recognised. Despite the common agreement between university, industry and administration that the collaboration is relevant for knowledge-based sustainable development, evidence shows that in practice it is highly limited. While collaboration research was the original format of science, after the 'industrialisation' of higher education in the 19th century, universities and industry struggle to align their objectives, effectively communicate and establish fruitful collaboration (Etzkowitz & Leydesdorff, 2000). Meanwhile, recent boom in technological development and increasing complexity of technology make the ability to collaborate a requirement to develop meaningful innovation and remain competitive on micro, meso and macro scale.

In that scope the role of a broadly understood as the process of creating, encoding, transmitting, interpreting and returning messages (Watson & Hill, 2000) effective communication between university and industry is broadly pointed out. Communication inefficiencies effects are reaching much beyond limited R&D performance and competitiveness of organisations. They block transfer of tacit knowledge, decrease the productivity of resources on regional scale and overall attractiveness of regions. Its comprehensive impact on every stage of collaboration and innovation should make improvement of communication a top priority for university and industry leaders, but also, due to the postulated influence on economic development, for regions and nations.

Despite the common recognition of communication as a precondition of collaboration and its key success factor, studies focusing on university- industry (U-I) communication are limited and strongly centred on the recognition of ineffective communication as a barrier for

collaboration and knowledge transfer. The current body of literature provides i/ a list of arguments regarding importance of communication between universities and industry to those organisations, administration and individuals (Howarth & Monasterolo, 2016; Pablo-Hernando, 2015; Vick & Nagano, 2018), ii/ a range of studies defining barriers obstructing the communication (Pablo-Hernando, 2015; Rad et al., 2015; Ranga et al., 2008), as well as iii/ numerous case studies regarding tools and approaches that may facilitate the process (Alshehri et al., 2016; Martins, 2016; Pablo-Hernando, 2015). However, the existing literature is highly fragmented and leaves a significant number of gaps that need to be filled to address the practical implications of the knowledge. Some gaps, such as the lack of studies of stakeholders adapted and optimized communication, were already identified in previous studies (Fiehe et al., 2014). Our synthesis identifies a number of additional gaps, such as i.e. the need for better understanding of the effectiveness of tools in specific context or the need to better understand the modern ICT tools impact on long-distance U-I communication. The current study specifically addresses lack of comprehensive summary of the current state of the art that could i) support decision makers in developing strategy for communication between university and industry; and ii) allow to identify specific needs for further developments of knowledge in the area.

The study provides practically oriented systematisation of scientific literature structuring the knowledge in the form of practical recommendations for use of existing tools for enhancing U-I communication for innovation despite existing barriers and list of existing gaps. By integrating knowledge about identified barriers directly with possible solutions and their applicability, it brings a better understanding of the practical usefulness of the existing knowledge and its shortcomings.

The study suggests how to improve communication between university and industry in the scope of innovation based on three main outcomes: 1) systematisation and categorisation of tools supporting communication and barriers, 2) roadmap for practitioners how to overcome the barriers encountered in establishing U-I communication, and 3) identification of gaps and limitations of existing literature requiring attention, as i.e. its strong single-tracked orientation towards practices for universities, with neglected studies on how industry can contribute into improvement of the communication.

2.2. Research design

To meet the objectives of the study a systematic literature review on U-I communication in the scope of innovation was conducted to answer the research question. The review followed the methodology proposed by Tranfield et al. (2003) and was based on search results from July 2019 within articles indexed in Scopus and Web of Science databases. We established the quality conditions of the database as sufficient quality condition for inclusion of articles in

our study. In the modern world innovation is often multidisciplinary. Therefore, we did not limit the areas of search. An initial search cross-referencing ‘communication’, ‘university and industry’ or ’academia and industry’ and ‘innovation’ or ‘knowledge transfer’ returned 134 articles in English on Scopus and 141 articles in English on the Web of Science. Removing duplicates and screening of titles and abstracts of the articles for those related with U-I communication in the scope of innovation led to identifying 96 articles related to the scope of the topic. As the articles focussing on communication in the context are very scarce, within the screening process, the researchers looked also for a broad inclusion of articles providing references to communication aspects of U-I collaboration to gain deep understanding of the development in the field based on the fragmented and dispersed knowledge and meet the study objectives.

To reach the objective titles and abstracts were screened according to the selection questions:

i) Does the article discuss U-I communication?

ii) Does the article discuss any barriers to communication?

iii) Does the article discuss any tools that can support communication?

iv) Does the article discuss importance of communication in the scope of U-I relations?

v) Does the article discuss impact of communication on any aspect of U-I relations?

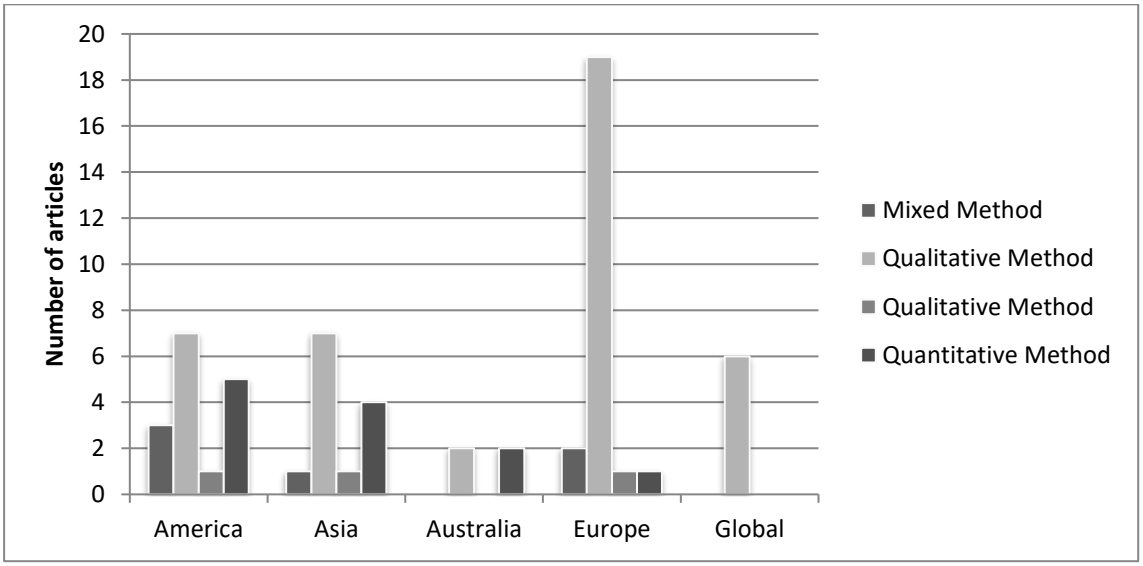
To ensure that a broad spectrum of knowledge regarding U-I communication is included; all articles with positive answer to any of the questions were included in further research. Furthermore, in case of any doubt regarding the answer to above questions the article was kept within the sample to avoid potential loss of valuable information. Out of the obtained selection, 88 articles summarised in the Table 2.4 (in appendixes) available to the researchers were studied in details and summarized into data-extraction forms. This base for a comprehensive research synthesis in a form of content analysis allowed providing relevant results and conclusions according to the established research questions.

Based on the content analysis we identified three main groups of information of practical relevance in the scope of the research objective: 1) barriers to communication; 2) tools and approaches for effective communication; and 3) success factors. To reach the objective of the study and provide the roadmap to effective U-I communication with practical relevance, the information was mapped to match possible solutions (approaches, tools and specific factors) with defined in the literature problems (barriers to communication).

2.3. Sample analysis

The identified articles show a strong focus of researchers on qualitative studies in the area. 44 out of 62 empirical studies apply qualitative methods, with a significant majority of the studies - 34, applying a case study methodology. Only 12 studied articles applied quantitative methodology and six a mixed one. Interestingly, a strong regional tendency in the methodology used can be identified. While case studies were conducted across continents, with the exception of Australia and Oceania, only one quantitative and two mixed studies in the sample were performed in Europe (see Figure 2.1). The quantitative and mixed studies appear in the sample (with one exception) starting from 2008. That may suggest that up to the point the communication between university and industry was not significant for quantitative methods to be meaningful.

Figure 2.1. Distribution of articles by method and geographic coverage



The broadest empirical article group presents a cross-industrial or industry independent approach to the topic (27 articles). A broad range of industries from hi-tech engineering through agriculture to creative industries has been studied. However, Medicine and Biotechnology (9 articles) and ICT (9 articles) are the industries most represented in the sample. The literature shows not only the importance of the topic across industries and countries, but also its transversal character. While in the sample communication oriented studies were relatively scarce (23/88, see Table 2.4 in Appendixes), a range of articles related with diversified U-I collaboration, regional and national development and management strategy were identified as providing significant insights in the area. In the sample, 39 of the articles discussed the benefits of U-I communication for universities, industry or economy; 45 mentioned barriers to U-I communication; out of 88 articles 85

referred to at least one communication tool and 63 referred to factors facilitating communication.

Despite postulated in the literature important role of ICT tools for facilitating U-I communication, collaboration and knowledge transfer (Lan, 2004; Neumann & Prusak, 2007; Treadaway, 2004), only 12 articles focused on those tools as a study topic. Seven of those studied the early impact of raise of ICT mediated connectivity at its early stage. In the sample only two studies regarding ICT were conducted within the European context, with lack of quantitative studies.

2.4. Content analysis

In 1987 in their study of communication within Swedish R&D system, Hoglund and Persson (1987) showed based on proceeding 15 years of previous studies that universities and research institutes supply industry with innovative ideas to a highly limited degree. Our analysis of publications across more than 30 years following the study (1987-2019) shows that, despite increasing attention to the importance of collaboration and rise of concepts such as open innovation or triple or quadruple helix model, progress in the area is not significant. While positive examples of collaboration can be pointed out, in general, modern economies still struggle with general lack of efficient communication between different agents within R&D systems (Bayne et al., 2016; Venditti et al., 2013; Vick & Nagano, 2018).

To meet its objectives, the content analysis in the first place summarises in the following sections the academic discussion regarding: i/the role of communication, ii/benefits for stakeholders, and especially focusing on iii/ barriers and iv/ tools to U-I communication. Those are further synthesised into practically oriented systematisation of the tools in the scope of the identified barriers in the result discussion section followed by identification of significant gaps in understanding the measures for supporting U-I communication for innovation in the final section.

The role of communication in the scope of innovation

While some causal relations are still not clear in the literature, academics are broadly underlying the crucial impact of communication on modern innovation. In the analysed sample, 42 articles discussed the role of communication in the scope of innovation. The academic discussion strongly highlights the direct benefits of U-I communication coming from fuelling innovation with new ideas and knowledge.

Due to the increasing complexity of science, effective communication is nowadays a formal requirement of developing scientific capability and absorptive capacity required for knowledge transfer (Yuthavong et al., 1993; Martins, 2016). As the complexity of innovation

increases, communication between not only different organisations from university and industry sectors was pointed as crucial. Enabling broader multidisciplinary U-I communication is what is suggested as a key to generating complex and quality innovation. Increase in innovation-based competition requires taking advantage of synergies rather than investing in developing a broad portfolio of innovation related knowledge and capabilities within a single organisation (Petroni et al., 2011). Complex smart innovation requires collision of ideas and visions, iterative combination and recombination of knowledge, ideas and resources across organisational and sectorial boarders. Communication allows not only transfer of knowledge, but also crucial for innovation collisions, convergence and divergence of ideas. Therefore, modern innovation is communication dependant (Pendergast & Hayne, 1999; Shinn, 2005). In current highly competitive environment, organisations need to establish effective communication not only to access external resources, capabilities and stimuli, but also to avoid duplication of efforts leading to significant misuse of resources on a global scale (Parker & Hine, 2014). In that scope, innovation agents should aim at broad exchange and open dialog involved in bilateral or multilateral process of communication, rather than limiting their focus to knowledge transfer often tied to limited one-way communication (Hayden et al., 2018).

The meaning and importance of broad approach to communication has grown in times when smart technologies are leading the stream of innovation. Highly dependent on multidisciplinary input and cross-fertilisation of ideas between disciplines, involvement in smart technologies development require high level communication skills on individual and organisational level, and high literacy of communication strategies to support innovation oriented communication across organisations, as well as disciplines (Langford et al., 1997; Kim, 2011). Communication is a key to effective generation, access, transfer and absorption of codified knowledge. But it is a requisite for effective generation and transfer of tacit one (Sherwood & Covin, 2008; Runiewicz-Wardyn, 2014) which is the key to gaining high level competitiveness of smart technologies and generating sustainable development in modern economy (Martins, 2016; Vick & Nagano, 2018). The literature shows that with the raise in complexity of innovation the dependence of both university and industry on mutual communication is increasing for remaining relevant. Currently the dependence level varies across industries and topics. But its impact is especially well visible in such industries as pharmaceuticals and biotechnology and multidisciplinary scope of life sciences. In those fields the well documented examples and within the long tradition of effective U-I communication between academics and practitioners translates into effective collaboration for innovation (Kim, 2011; Sterckx, 2011). Nevertheless, even in the case of established collaborations, effective mutual communication is still reported to be highly limited (Vick & Nagano, 2018).

Absorptive capacity literature shows though that cross-organisational communication, even when collaboration has been established, does not necessarily translate into innovation. Cases of collaborative innovation reveal patterns of both, collaboration as well as conflict. That

requires highly effective and clear communication to ensure negotiations and mediations (Fields, 2006). Even seemingly straightforward relationships which do not involve strong organisational barriers commonly involve confusion and conflict regarding technological development and gaps in organisations internal well-established processes for innovation. That often obstructs collaboration and places it in doubt (Davis & Eisenhardt, 2011). It is strong communication that allows recognition of needs and alignment of objectives, but also brings correct understanding of strengths and weaknesses of engaged in collaboration agents (Leydesdorff & Etzkowitz, 1998). That allows exploiting existing synergies and fully capitalise on the partnership capabilities. From the other side, when effective communication is lacking, managers often refuse to adjust objectives and incorporate partners' perspectives. As a result, they often fail to explore alternatives within the technology space and ultimately to innovate (Davis & Eisenhardt, 2011). Importance of communication increases even further in case of collaborations where sensitive information is involved. The difficulty of negotiations highly increases with the need for confidentiality agreements. Communication not only facilitates the negotiation process, but, as mechanism to build strong relationship and trust, it can decrease costs of collaboration for both sides and helps circumvent bureaucracy often involved in ventures, especially with public sector (Bergha & Guild, 2008; Papagiannidis et al., 2009; Davis & Eisenhardt, 2011).

Communication is shown as having a significant direct and indirect impact on innovation. The body of literature focused on factors of U-I collaboration success commonly points communication among the Critical Success Factors (CSFs). Besides the direct impact, communication influences indirectly other aspects of collaboration. Communication is a consistent predictor of U-I collaboration success as it associates with trust, understanding, commitment and quality of decision making (Alsehru et al., 2016; Salimi et al., 2016). Among others, it provides timely information, facilitates understanding of partner capabilities and resource needs and encourages understanding of procedures. Effective communication can lead to emotional attachment and facilitate the formation of trust. It is decisive for establishing strong relationship between transferor and recipient and advancing all relational success factors across all phases of collaboration (Plewa et al., 2013a; Ju et al., 2016). That may reduce transactional costs and ease knowledge transfer (Plewa et al., 2013b). Communication is a factor optimising the time of decision making and the quality of decisions taken.

Often the causality between communication and the aspects listed above is not clear (Plewa et al., 2013a). However, inefficient communication was pointed out as the most common reason for U-I collaboration failure showing its crucial character for collaboration (Salimi et al., 2016; Peng et al., 2017). However, communication is not only crucial for success of collaborative innovation processes. Innovation often occurs in unpredictable ways and effective communication between diversified and often contrasting organisations is also

essential for generating knowledge from data and information, knowledge transfer and retention (Ajjan et al., 2014; Parker & Hine, 2014; Sandbrg et al., 2014). Communication is crucial at every stage of innovation development. On one end, it allows generating better quality ideas through their collisions, convergence and divergence (Pendergast & Hayne, 1999; Shinn, 2005). On the opposite end, continues dialogue with industrial partners allows better understanding of market readiness and recognition. It allows generating quality user oriented innovation that will protect the innovation from extinction and increase value of innovation (Sheen, 1995; Al-Agtash & Al-Fahoum, 2008).

Howarth and Monasterolo (2016) suggest that especially in areas facing societal needs, such as post-catastrophic management or medicine, mutual communication is crucial to face complex and often time sensitive character of required decision making. In those cases, cross-organisational communication has not only impact on quality of decisions and collaboration to solve the problems, but will strongly impact the trust in the decision making process and decisions itself. Levallois et al. (2019) based on the study of the emergence of neuromarketing as a new research field as well as industry show that even simple exposure of academics to practical developments and vice versa can lead to rise of new concepts, knowledge and innovation. It suggests that importance of U-I communication goes beyond simply constituting a success factor of U-I collaboration and knowledge transfer.

Social and economic importance of U-I communication was further underlined in the context of developing regions. Effective communication based on effective and target oriented communication means was pointed as crucial especially in low-development regions where a gap in knowledge between universities and the general population is especially significant. Universities in those areas are suggested to be socially responsible to provide support for regional development in the form of knowledge promotion, consultation to industry and increasing awareness of possible for entrepreneurs' improvements. Authors suggested that in those countries where SMEs (which represent the majority of industry) have specifically low access to resources, engagement of university in U-I communication should be especially pro-active (Yuthavong et al., 1993; MacLead et al., 1997). It should cover not only communication of knowledge and technology, but also aim at overcoming SMEs fears of new technologies and adaptation of knowledge, and direct involvement in development oriented support, up to the point of direct capital investments of university in industry to enable development and technology diffusion (Yuthavong et al., 1993; MacLead et al., 1997). The authors argue that especially in developing regions lack of efficient, target oriented communication leads to limited benefits to final users or even to lack of acceptance of innovation (Yuthavong et al., 1993; MacLead et al., 1997). That hampers chances of the region for growth and development, marginalising further those regions and opportunities for located there organisations. Vanditti et al. (2013) and Runiewicz-Wardyn (2014) show that that lack of efficient U-I communication leads to an untapped pool of socially relevant resources,

knowledge and expertise in economies, while establishing effective U-I communication creates the critical mass for tacit and codified knowledge transfer.

The fast technological development of the last three decades brought significant changes in the area of communication. Literature underlines the opportunities coming from new communication tools allowing long-distant communication and enhancing connectivity (Neumann & Prusak, 2007). It also shows that together with new possibilities the changes impacted many aspects of the working environment. New means of communication allowed long-distance collaboration, provided new ways of generating and sharing knowledge and ideas and facilitated the process of cross-oganisational communication (Graham, 1996; Lan, 2004). From the other side the body of literature underlines that it also brought challenges with reorientation of systems, organisational structures and need for additional knowledge and technical and relational skills (Fields, 2006). However, not much attention has been devoted within the literature to the technological aspects and challenges in the scope of U-I communication for innovation.

Benefits for stakeholders

The academic discussion strongly underlines the importance of communication in the context of university-industry relations for the organisational benefit of both sides, as well as gains for regions and societies. The literature summarised in Table 2.1 shows a number of benefits of U-I communication for industrial partners. In the first place, improved U-I communication provides companies access to knowledge and scientific resources often out of reach within their internal resources and capabilities, improved productivity and improvement in the internal skills and capabilities. U-I communication enables not only improving industrial production, but allows smaller companies to compete with large corporations, by accessing and applying external base of knowledge and expertise. Beyond new products development, companies along U-I communication develop their internal knowledge base, skills and capabilities leading to improved productivity. Effective U-I communication allows better understanding of available knowledge and its applicability in a particular context. It may furthermore generate significant learning about interacting with public sector researchers, making the access and acquisition of knowledge more effective (Lockett et al., 2008; Bjerregaard, 2010; Pablo-Hernando, 2015). The U-I communication not only increases innovative capacity of the company, but by positive impact on absorptive capacity allows to extract and apply knowledge significantly beyond the organisational capacity to gain competitive advantage (Martins, 2016). Empirical studies show that as a result, firms that collaborate with universities are generally those who introduce more original innovations (Cassanelli et al., 2017).

From the other side, while the access to external funding and equipment is a common motivation for universities to engage in U-I communication, the study shows that access to applied knowledge, new skills and cutting edge equipment is equally or even more important for academic research. The literature broadly recognises the benefit of obtaining industry perspective for stimulating the generation of valuable research findings, or even for establishment of new academic research fields (Sandberg et al., 2014; Mehdi et al., 2014; Levallois et al., 2019).

Through improvement of communication with industry, universities can gain not only new scientific information, instruments and methodologies, but also improvement of tacit knowledge and skills and fastest development of knowledge (Chen et al., 2013). By working with application related industrial technologies researchers boost their productivity and build their social capital which further improves their scientific performance (Chakrabarti & Santoro, 2004; Welsh et al., 2008). Contributions to industrial development give universities a stronger negotiation position as a knowledge and research provider. It also brings significant advantages for students which may benefit from more market oriented education, opportunities to gain practical experience along the educational path, access to cutting edge technologies and improved employability at the point of graduation.

Table 2.1. Benefits of U-I communication in the scope of innovation for its stakeholders

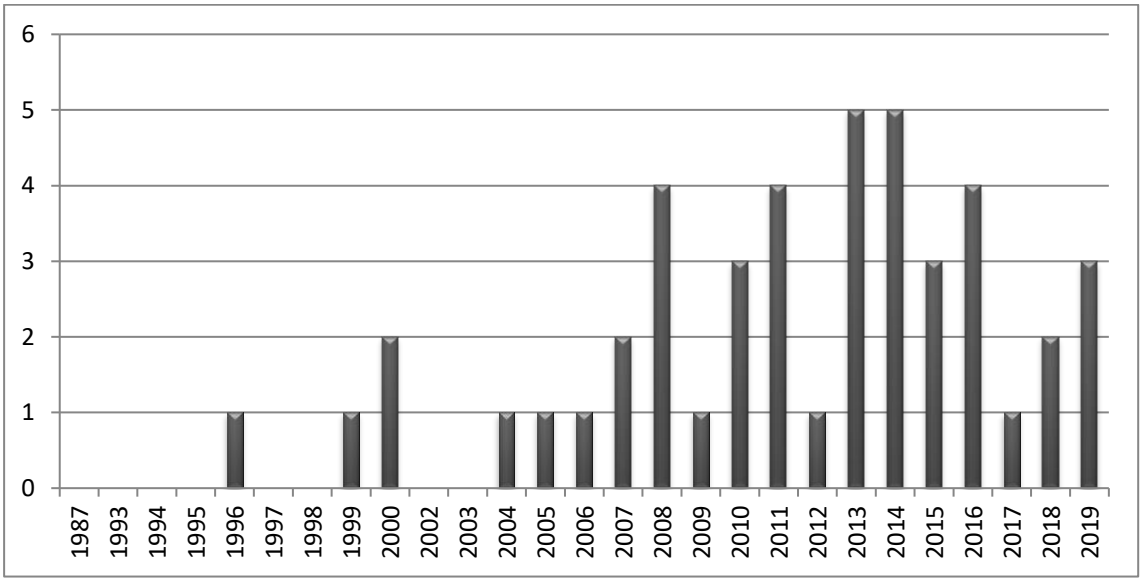
	(Höglund & Persson, 1987)	(Yuthayong et al., 1993)	(Sheen & MacBryde 1995)	(Macleod et al., 1997)	(Frantz, 1998)	(Levdesdorff & Etzkowitz, 1998)	(Santoro & Saparito, 2003)	(Chakrabarti & Santoro, 2004)	(Lan, 2004)	(Grimaldi & Grandi, 2005)	(Butcher & Jeffrey, 2005)	(Fields, 2006)	(Sherwood & Covin, 2008)	(Salem & Amied, 2008)	(Lockett et al., 2008)	(Welsh et al., 2008)	(Ranga et al., 2008)	(Papagiannidis et al., 2009)	(Lissoni, 2010)	(Hong & Olander, 2010)	(Bierregaard, 2010)	(Kim, 2011)	(Plewa,et al., 2013a)	Chen et al., 2013)	(Sandberg et al., 2015)	(Rad et al., 2015)	(Paslawski, et al. 2015)	(Pablo-Hernando, 2015)	(Bayne et al., 2016)	(Allen et al., 2016)	(Alshehri et al., 2016)	(Martins, 2016)	(Cassanelli et al., 2017)	(Peng S., et al., 2017)	(D' Hooghe, 2017)	(Hayden, M., et al. 2018)	(Kim L., Jang D., 2019)	(Levallois et al. 2019)	(Vries, et al., 2019)
University																																						
Knowledge of industrial environment	x										x			x	x											x									x		x	x
New networks											x					x			x					x								x						
Recognition/reputation			x												x										x													
IPR rights			x											x																								
Tacit knowledge			x																																			
External funding							x	x							x	x			x						x	x								x	x			x
Access to applied knowledge and new skills							x		x	x	x	x	x	x		x						x	x	x		x	x		x			x			x			x
Access to external resources								x								x										x										x		
Benefits for students							x	x			x			x		x									x	x				x							
Faster pace of product development																x								x					x								
Entrepreneurial culture/acceptance for commercialisation										x					x																							
Improved performance of researchers							x	x			x			x		x			x			x			x		x			x								
Industry																																							
Access to university knowledge and resources		x				x	x	x		x		x	x			x		x		x					x				x		x	x		x	x		
Tacit knowledge			x																																			
Access to university networks										x								x																				
Improved reputation								x		x					x					x	x																	
Improved internal skills and capacities															x					x	x		x	x			x		x								
IPR rights/ new products			x											x	x																x						
Improved productivity				x																				x	x				x	x			x	x			
Costs reduction														x										x	x										x		
Better access to qualified staff					x																					x											
Region																																						
Economic growth		x		x								x			x		x						x		x			x				x					x

The literature suggests that through supporting the growth of both industry and university, U-I communication significantly impacts development, innovativeness and competitiveness of regions. From the other side, in the knowledge-based economy success of both university and industry depends on attracting quality human resources, students and employees. That requires regional environment providing high life quality with access to great education and job opportunities. Neither universities, nor industry can nowadays remain successful without coexistence with one another. Therefore, constant communication allowing collaboration to ensure sustainable growth of the region is an important factor of competitiveness for universities and industries, as well as regions (Porter, 1998).

Barriers to U-I communication

Some causal relations are still not clear in the literature. However, academics are broadly emphasising the crucial impact of communication on modern innovation. While already early literature regarding U-I communication commonly underlines the need for U-I communication to enable complex innovation and optimal use of resources within modern economies (Porter, 1998; Sheen & Macbryde, 1995), the beginning of 21st century marks development of broader discussion regarding the barriers obstructing U-I communication (see Figure 2.2).

Figure 2.2. Distribution of discussion regarding barriers to U-I communication in in time: number of articles related to the topic)



Across the analysed period, the cultural and language and understanding gaps together with differences in procedures and standards were pointed as the main barriers. Meanwhile, commonly underlined differences in purpose (Fujigaki & Leydesdorff, 2000; Bjerregaard, 2010) after 2013 were rarely mentioned, suggesting decreasing impact of this barrier on

limited U-I communication in the scope of innovation together with broader discussion and acknowledgement of university 3rd mission (Hayden et al., 2018; Suomi et al., 2019)(see Table 2.2).

Table 2.2 Discussion regarding barriers to U-I communication

	cultural gap	language and understanding gap	differences in procedures and quality standards	purpose differences	incentives systems	disconnection of science from market	different perception of time	different focus/ interests	confidentiality issues	IPR issues	access issues	negative reputation of university	restrictions on publications and communication with other scientists	external pressures on traditional role of the university	lack of industry oriented communication mechanism	negative reputation of industry	authority conflict	low credibility of academics	resistance to commercialisation	costs of R&D transfer	unrealistic expectations
(Graham, 1996)		x																			
(Pendergast & Hayne, 1999)		x																			
(Fujigaki & Leydesdorff, 2000)	x		x	x																	
(Etzkowitz & Leydesdorff, 2000)			x																		
(Chakrabarti & Santoro, 2004)	x	x		x						x	x				x						
(Butcher & Jeffrey, 2005),	x		x	x	x																
(Marques et al., 2006)			x																		
(Teubner, 2007)		x			x													x			
(Neumann & Prusak, 2007)				x																	
(van den Berghe & Guild, 2008)									x												
(Lockett et al., 2008)	x		x		x		x			x		x				x					
(Welsh et al., 2008)	x												x								
(Ranga et al., 2008)	x	x	x				x				x								x		
(Higginbotham et al., 2009)			x	x		x	x														
(Lissoni, 2010)		x																			
(Hong & Olander, 2010)	x								x	x											
(Bjerregaard, 2010)	x		x	x	x		x	x			x		x								
(Huang & Yu, 2011)									x												

(Davis & Eisenhardt, 2011)			x														x					
(Lander & Atkinson-Grosjean, 2011)	x	x																				
(Sterckx, 2011)				x						x			x									
(Gera, 2012)	x	x		x	x		x															
(Plewa et al., 2013a)	x		x	x																		
(Plewa et al., 2013b)	x							x	x													
(Chen et al., 2013)						x					x										x	
(Doloswala et al., 2013)						x																
(Leydesdorff & Ivanova, 2014)		x																				
(Buser, 2013)	x					x											x					
(Korzhenevskaya, 2014)	x													x								
(Ivanova & Leydesdorff, 2014)		x																				
(Ajjan et al., 2014)	x																					
(Fiehe et al., 2014)		x	x			x		x														
(Sandberg et al., 2015)	x	x		x	x																	
(Rad et al., 2015)	x				x	x	x	x				x										
(Pablo-Hernando, 2015)	x				x	x						x		x								
(Bayne et al., 2016)		x																				
(Howarth & Monasterolo, 2016)		x																				
(Alshehri et al., 2016)	x								x													
(Ju et al., 2016)	x			x	x																	
(Cassanelli et al., 2017)						x			x													x
(Vick & Nagano, 2018)	x	x						x														
(Hassen 2018)	x					x				x												
(Suomi et al. 2019)	x		x		x	x	x					x			x							
(Kim and Jang, 2019)			x		x		x	x														
(Vries et al., 2019)	x	x	x	x	x	x	x	x		x						x						
Count	24	16	14	12	12	11	9	7	6	6	4	4	3	3	2	2	2	1	1	1	1	

The literature broadly recognises a significant gap in culture and language as a crucial issue. A number of studies confirms empirically that university and industry not only tend to use different lexicons (Teubner, 2007; Vick & Nagano, 2018). The body of literature shows that academics and practitioners often struggle with different understanding of technical terms used in both spheres. The gap can be a significant obstacle for mutual understanding and communication by bringing uncertainty, confusion and limiting trust within U-I relations (Bjerregaard, 2010; Gera, 2012). Using different codes leads to redundancies resulting in miscommunications and misinterpretations that increase uncertainty which is already especially excessive within innovation scope (Leydesdorff & Ivanova, 2014).

Significant cultural differences between university and industry generate differences in tacit epistemologies and the nature of cognitive processes. The effect is commonly associated with the 'ivory tower' culture of universities. By attachment to traditional modes of scientific production, university researchers often are not just applying lexical conventions not adapted to the needs of external users, but may stand as gate keepers of knowledge (Gera, 2012; Lissoni, 2010; Pablo-Hernando, 2015). The egalitarian approach, represented by the creation of idiosyncratic language and knowledge base by highly competent individuals often aims at improvement of communication within a limited group of internal specialists. Meanwhile, it limits understanding of external actors (Lissoni, 2010).

The language gaps were reported to obstruct not only U-I communication. The current academic culture supports the creation of 'academic tribes' with internal language limited to a specific discipline or internal group. That leads to communication difficulties also within academia (Fiehe et al., 2014; Pablo-Hernando, 2015). In example, a study of knowledge transfer in Austria shows that many scientists in area of social sciences associate knowledge transfer with a science-to-science process, while in other fields the terminology understanding more commonly includes transfer to external agents (Hayden et al. 2018). Such gaps translate to further increase in difficulty in creation and management of cross organisational multidisciplinary teams required to generate high quality knowledge and smart technologies. When groups are attached to different paradigms, they in fact cannot communicate at all (Shinn, 2005). Meanwhile empirical studies show that even in case of projects funded to respond to practical issues, academic research language tends to focus on domain terms and pull strongly toward basic research (Vick & Nagano, 2018).

The language and cultural differences fuelled by publication-oriented incentive system within universities together with limited recognition, acceptance and/or understanding for university 'third mission' impair U-I communication and undercut potential development of both, universities and industry (Alshehri et al., 2016; Howarth & Monasterolo, 2016; Hayden et al., 2018). The strongly publication-oriented incentive system at universities raises obstacles on both ends. Academic researchers are often discouraged to establish relations

with industry due to possible restrictions on publications and lack of recognition for contributions into knowledge transfer (Chakrabarti & Santoro, 2004; Welsh et al., 2008; Hayden et al., 2018). Meanwhile, industrial partners tend to avoid the risk of leaking important information through publications and scientific communication (van den Berghe & Guild, 2008).

The early literature strongly underlines the impact of different objectives and organisational logics on limited U-I communication. In the process cross organisational teams need to struggle to negotiate and balance tensions between the academic norms of knowledge dissemination and the scientific rigor and market applicability and competitiveness (Bjerregaard, 2010). It raises issues with conflicting quality requirements, approach to R&D pace and potential conflicts regarding communication of the research. Some authors point that not only a possible culture, understanding and perception issues can be strong barriers. Some more tangible barriers are a result of lack of industry required quality standards within research facilities which are a serious barrier for commercial applicability in many sectors. For industrial partners a test based track of applicability, rather than research methodology are the required measure of quality (Bjerregaard, 2010; Lockett et al., 2008). Lack of feeling of urgency, tying projects to academic year, small awareness of market environment and high bureaucracy at universities may further discourage industrial partners to face the challenging barriers to U-I communication (Lockett et al., 2008; Ranga et al., 2008). Altogether, those aspects contribute to negative reputation of universities related to their potential to provide meaninful for innovation contributions (Suomi et al., 2019).

The cultural gap is especially strongly impacting university communication with SMEs. While SMEs with their limited resources could especially benefit from university knowledge and resources, cultural bias leads to university preference to collaborate with big highly recognised companies (Lockett et al., 2008; Ranga et al., 2008). SMEs contact with universities is especially obstructed if no public information regarding the university competences and contact people are easily available (Chakrabarti & Santoro, 2004; Ranga et al., 2008).

While a number of different barriers were suggested as obstacles to U-I communication (see Table 2.1), Chen et al. (2013) show that it is the lack of efficient communication channel to the R&D achievements of academic research (60,2%) from one side, and lack of communication channels to SMEs (62,3%) from the other that is obstructing the communication in the scope of open innovation in the first place (Chen et al., 2013; Ranga et al., 2008). Those are followed by unreasonable transfer costs of R&D achievements (Chen et al., 2013). Those barriers not only make the communication more difficult, but prevent it effective occurrence in the first place. That increases the role of tools to overcome the barriers.

Tools and factors

Along the analysed period authors were broadly discussing not only the importance of the U-I communication, its benefits and barriers, but also, presented tolls with potential to support it and factors impacting their effectiveness. In the scope of U-I communication, the literature summarised in the Table 2.5 in appendixes names a broad number of communication channels within three categories: i) publishing and printed media; ii) information and communication technology mediated channels; and iii) personal interaction channels.

While a broad range of case studies of communication channels, supporting organisations and mechanisms exist, not much is known about their specific efficiency. This section, analysing the presented in the body of literature tools for U-I communication, aims to identify approaches with potential to effectively enable and facilitate U-I communication in the scope of innovation and their requirements. It specifically looks to identify tools with potential to overcome identified in the scope of this study barriers to U-I communication.

i) Publishing and printed media

While publishing is the communication means most commonly applied by the academic community, literature broadly recognises its limited applicability in the contexts of U-I communication (Gera, 2012; Teubner, 2007; Yuthavonget et al., 1993). The linear model of innovation assuming that the knowledge published in academic literature is analysed by industry and further developed into practical applications is not commonly executed (Lander et al., 2011). Empirical studies show that practitioners tend to ignore academic literature (Teubner, 2007). It is due to specific academic writing conventions that require high level absorptive capacity for sense making and translation into practical applications (Gera, 2012), ignoring the 'red tape' issues and assuming a system of reference that requires specific mechanisms to integrate it within market applications (Etzkowitz & Leydesdorff, 2000; Teubner, 2007). But also due to the fact that such literature is commonly accessible just to university personnel and students due to vast number of international scientific journals in each field and expense of each subscription (Suomi et al., 2019).

While the academic literature is considered a possible mean of communication in highly specialised areas, such as space or semiconductor industry (Runiewicz-Wardyn, 2014), gaps and lack of trust in methodologies behind academic publications make it a specific tool for academic communication rather than an effective communication tool for science-to-industry communication (Etzkowitz & Leydesdorff, 2000; Fujigaki & Leydesdorff, 2000; Sterckx, 2011). It was suggested that practical recommendations could be the tool to increase the usability of academic literature for practitioners. That would require a strong focus of academics on

delivering industry relevant and applicable conclusions taking into account external and internal contexts of the specific subject (Teubner, 2007). While the method could potentially increase the value of publications in the scope of multidisciplinary research, its potential to overcome barriers to U-I communication seems limited. Low recognition of academic literature in the industry suggests that academic literature to become a significant U-I communication tool in the scope of innovation would require not only significant changes to academic writing conventions and methodologies, but also re-education of both academics and practitioners to recognise and adapt to the evolution. From the other side, as the respondents in the study by Hayden et al. (2018) pointed, informing the public about the research that is conducted is a part of university duties and for that effect the findings should be translated into everyday language already for the basic mission of science-to-public communication (Hayden et al., 2018). In that scope though not only the specific academic language could be an issue. Suomi et al. (2019) suggest that English rather than national language being the general language of publications can be a barrier for the stakeholders to access it as a knowledge source (Suomi et al., 2019).

From the other side, the involvement of industrial experts in academic publications can be an important mean for communication from industry to academia. Suomi et al. (2019) suggested that co-involvement of academics and practitioners in systematic review of knowledge could be a good beginning to co-create knowledge. However, that requires decreasing association of industrial authors with biased inputs among academic reviewers and increasing their openness to external perspectives (D'Hooghe, 2017).

While reports, grey literature and other published media can provide an opportunity to communicate between university and industry in specific situations, they shown highly limited impact at establishing innovation oriented U-I communication (Bayne et al., 2016; Shinn, 2005; Yuthavong et al., 1993). Contributions to popular media, especially writing commentaries in newspapers and magazines, but also attendance of science related TV programs can be though relevant for overcoming the image of universities as gatekeepers of knowledge (Haynes et al. 2018).

ii) Direct interaction communication tools

The channel for U-I communication that is recognised as the most commonly bringing university and industry together are formal and informal personal interactions. Traditionally those are taking place through such channels as meetings, conferences or social networks (see table 2.5 in appendixes).

Many academics argue that unmediated contact through well informed and networked external individuals is needed to bring academia and industry together (Lockett et al., 2008; Plewa et al., 2013a). The role of individuals is especially strong within university

environments that do not favour university engagement in commercialisation activities (Rad et al., 2015). Personal interactions are not only the main channel to communicate tacit knowledge and increase the effectiveness of transmitting technical information (Gera, 2012; Vick & Nagano, 2018; Yuthavong et al., 1993), but also can allow overcoming a number of barriers to U-I communication. It is individuals who drive cultural evolution by making conscious decisions to implement specific behaviour and bridge institutional gaps (Bjerregaard, 2010; Etzkowitz & Leydesdorff, 2000). Individuals' social capital and communicational skills may facilitate complex negotiations and help to circumvent organisational bureaucracy (Papagiannidis, Li, Etzkowitz, & Clouser, 2009; Sandberg et al., 2015).

Individuals play a key role when trust between organisations is limited. They are required communication channel in relation-oriented cultures, such as China (Bjerregaard, 2010; Hong & Olander, 2010; Santoro & Saparito, 2003). Using more personal informal communication mechanisms, such as social networks, helps mediate lack of trust through better monitoring of interactions and recognition of an individual as 'honest broker' that helps mediate organisational and cultural differences (Bjerregaard, 2010; Papagiannidis et al., 2009; Santoro & Saparito, 2003). To effectively mediate U-I communication and move relations beyond the initial phase into deeper exchange required in scope of innovation, individuals need to have social capital that will allow them to contribute to establishment of U-I communication, as well as very strong relational and translational skills (Bayne et al., 2016; Vick & Nagano, 2018). Personal relations will be only valuable for continuance of U-I communication if the relevant skills and interests are in place (Plewa et al., 2013a). Studies show that social recognition and being known for specific knowledge or resources translate to more frequent inclusion in building collective intelligence and new knowledge (Allen et al., 2016). Literature suggests that, due to the strong effectiveness of competent individuals in overcoming barriers to U-I communication and their support for creating innovation networks, increasing personal communication channels between academics and practitioners should be the main way to facilitate U-I communication in the scope of innovation (Allen et al., 2016; Butcher & Jeffrey, 2005). The most common traditional channels for personal U-I communication cover meetings, conferences and seminars, consulting, exhibitions, committees and advisory boards, covering both formal and informal communication channels (See table 2.4).

The range of available tools widened with the recent fast development of information and communication technologies (ICT). Development of online communication channels allowed establishing personal interactions and relation building across distant locations. World Wide Web provides connectivity enabling instantaneous, long distance connections between university and industry increasingly becoming the main medium for social and knowledge networks and innovation (Neumann & Prusak, 2007). The computer mediated communication (CMC) tools and channels vary strongly regarding their application and complexity. Basic tools

such as phone or email were with time complemented with more sophisticated solutions as video transmissions, file sharing systems or collaborative platforms (See table 2.5 in appendixes). It brought new opportunities to U-I communication. From the other side, they demand adaptations due to requirements for new managing and operational rules and toolkits (Christiansson, 1993; Fields, 2006; Lan, 2004), new skills (Ajjan et al., 2014; Neumann & Prusak, 2007) and adaption of communication language and culture (Howarth & Monasterolo, 2016; Neumann & Prusak, 2007; Treadaway, 2004).

Modern ICT communication tools allow overcoming location barriers and creating group familiarity and personal relations without the need for face to face interactions (Graham, 1996; Pendergast & Hayne, 1999). The possibility to participate in long distant meetings was considered crucial. The video technology embedded in remote meeting tools allows building a sense of presence, group awareness and familiarity with daily working habits (Graham, 1996). However, to function properly, CMC requires from leaders ensuring tools literacy, understanding the group culture among participants and especially, ensuring that participants understand the expectations of participation (Graham, 1996). Literature argues that for CMC to be efficient, interactions need to be managed within specific meeting protocol and structure established within the participating in the communication group, rather than those applying in a specific organisation (Graham, 1996; Pendergast & Hayne, 1999).

CMC can also contribute to ambiguity problems, due to different local interpretations. Facilitating sense making should be obtained by creating a culture based on a simple representation of ideas, including graphics and drawings that will facilitate sense making across locations and organisations (Graham, 1996; Pendergast & Hayne, 1999). From the other side, CMC can help to overcome a number of barriers to establishing relationships. It decreases the role of sociability in forming relationship (Pendergast & Hayne, 1999). CMC can facilitate overcoming racial, ethnical or age bias (Santoro & Saparito, 2003) and decrease language barriers (Treadaway, 2004). More importantly, ICT based environments, such as groupware, provide platform to communicate knowledge and information in a non-linear interactive way on global scale. It allows to share and recombine knowledge and ideas to enable e-innovation (Lan, 2004; Neumann & Prusak, 2007; Treadaway, 2004).

While collaborative innovation is increasingly taking digital form, organisations can proactively respond to changes in social dynamics and systems. Specific tools can facilitate U-I communication at every stage:

- Establishment – communication of research and contact channels – websites and communication platforms, blogs, Twitter, social media,

- Development – email, media platforms, online meetings, instant messaging,

- Maturity - relational informal channels – communities of practice, instant messaging, networks.

Specific tools are characterised by different level of richness of communication. On one end, unilateral communication can be provided by websites. On the opposite end, concurrent interactive communication may take place via instant messaging with video transmission. To build positive relations, any CMC tool, needs to be based on easy interface, dialogic loops, meaningful contents and reputation of the source (Howarth & Monasterolo, 2016; Kim & Park, 2014; Treadaway, 2004). To enable it, in knowledge based organizations, knowledge workers need to possess the ability to navigate, utilize and provide relevant contributions to CMC (Neumann & Prusak, 2007). But in the first place the adaptation to the quickly changing knowledge environment organisational leadership needs to ensure the creation of culture motivating the required organisational and individual adjustments (Kim & Jang, 2019).

While it has been postulated that CMC provides specific mechanisms for relation building and breaking barriers to cross-organisational and international collaboration, it is still considered less reach than face to face communication (Ajjan et al., 2014).

iii) Intermediaries

The literature commonly suggests that, in the current shape of national and regional innovation systems, U-I communication is not intrinsic. The traditional research model enforces the need for a series of intermediary processes to generate innovation (Etzkowitz & Leydesdorff, 2000). The intermediaries, understood as linkage agents in any aspect of U-I communication in the scope of innovation, can cover a number of functions and be based on a number of models (Parker & Hine, 2014, Bayne et al., 2016).

The literature assigns to intermediaries different roles and relevance. While there is a number of possible models discussed in the literature (see Figure 2.3), they can be categorised as:

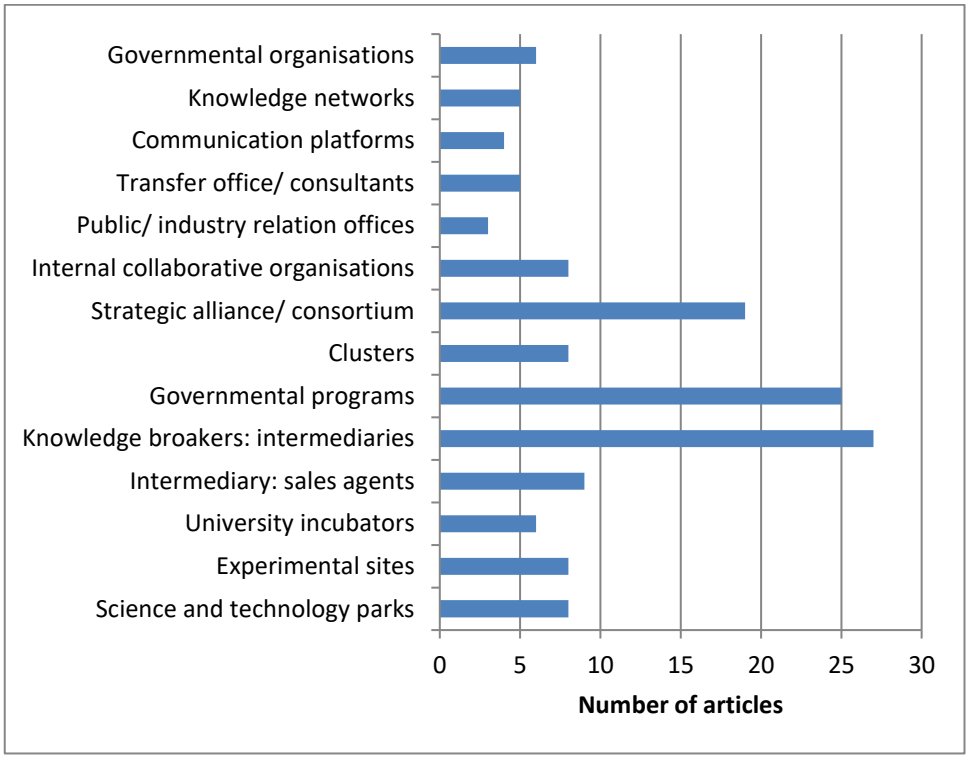
- 1st level communication platforms - unmediated model – based on personal mediation of internal agents or internal communication tools – (i.e. internal communication platforms, organisational leaders or project officers),

- 2nd level communication platforms – mediation based on internally established organisations (i.e. not-for-profit organisations, in-campus facilities, technology transfer offices),

- 3rd level communication platforms – mediation based on external organisations (i.e. governmental organisations, private brokers).

While specific models can differ depending on the nature of the organisational structure, as well as on specific needs of the region and stakeholders, the literature clearly assigns a number of intermediaries' brokering roles within U-I communication. The strongest rationale for embracing the role of intermediaries is their critical impact on overcoming well-established barriers to U-I communication (Parker & Hine, 2014). The cognitive distance and cultural and language barriers are pointed as the main challenges for intermediaries to overcome. Therefore, matching the supply and demand in-between the science and industry, bridging cultural and priority gaps and translate and repackage the information were pointed as the main intermediaries' functions (Parker & Hine, 2014; Sandberg et al., 2015, Bayne et al., 2016). Intermediaries' role in the communication establishment phase is broadly recognised (Welsh et al., 2008, Plewa et al., 2013b). But research suggests that the role of intermediaries can go far beyond that, as it may positively affect organisational learning and absorptive capacity (Parker & Hine, 2014).

Figure 2.3 Overview of intermediary organisations discussed in the body of literature in the scope of U-I communication for innovation



1st level intermediation model

While the opinions regarding which model should be applied are divided in the literature, some authors postulate the need for unmediated U-I communication (Bayne et al., 2016; Suomi et al. 2019). They emphasize the role of personal relationships, need for face-to-face contacts, a sense of common interests, insider knowledge and status (Porter, 1998; Lockett et

al., 2008; Welsh et al., 2008). Especially the establishment phase related with initial contacts, learning about partners, their goals and working styles put a lot of pressure on open and face-to-face communication based on informal and formal meetings (Plewa et al., 2013b). In that scope direct interactions communication tools are considered of crucial importance and dialogic model based on direct communication was suggested to be the optimal one (Lockett et al., 2008). However, due to existing barriers and current university and innovation systems models, expectations that all academics will be in close effective communication with industry seems unrealistic. Studies show that just a minority of academic inventors play breakages roles (Lissoni, 2010). Hence, at least a well-informed and networked individual is required to effectively mediate the contacts. The specific individual intermediary can have different expertise and positions within organisational structures. The literature recognises in that position organisational leaders, R&D and project managers or hybrid scientists. Some authors, especially in the context of emergent industries, accredit that role to students and employees with university degree (Yuthavong et al., 1993; Rad et al., 2015; Suomi et al., 2019). Independently from its type, to effectively mediate U-I communication in the scope of innovation, an individual has to:

- Have strong relational and social skills and understanding how to use them to bridge institutional gaps (Bjerregaard, 2010);

- Have a deep understanding of university culture, resources and capabilities, together with an understanding of the business environment and market needs that will allow to define matching opportunities and facilitate overcoming U-I communication barriers (Lockett et al., 2008);

- Have significant social capital and networks including internal and external stakeholders to obtain access to information and be able to promote U-I communication opportunities (Porter, 1998, Bjerregaard, 2010; Suomi et al. 2019);

- Combine strong communication and translational capabilities allowing effective understanding and communication of knowledge in the language of academia and business with technological competencies and relational capabilities (Sheen & MacBryde, 1995, Lissoni, 2010, Petroni et al., 2012, Sandberg et al., 2015, Bayne et al., 2016).

Open innovation changed the organisational reality for R&D units in both industry and university environments. It made R&D function not only scientific or technical, but the source of management, coordination and mobilization of resources (Yuthavong et al., 1993; Petroni et al., 2012). That brought a high demand for a T-man within the scope of innovation - a person integrating knowledge with management and relational capabilities (Sheen & MacBryde, 1995; Petroni et al., 2012).

A number of mechanisms is presented in the literature to obtain such a combination:

- Specific academic curricula allowing to acquire skills much beyond the technical competences, including relational and translational capabilities (Harris, 2009; Buser, 2013; Rad et al., 2015; Suomi et al., 2019);

- Double socialisation and mobility – shared educational background, work experience and training which facilitates communication, including initial contacts (Bjerregaard, 2010; Buser, 2013; Pablo-Hernando, 2015);

- Opportunities for building personal networks and social capital– such as meetings, conferences, study visits, collaborative projects or communities of practice (Plewa et al., 2013; Bayne et al., 2016);

- Technological integration model – which by providing equal initial training within R&D departments to all graduate employees independently from their desired position allows better communication and establishment of a common cultural core (Petroni et al., 2012);

- Community engagement – to contribute to the development of local communities and build personal ties with community members (Macleod et al., 1997; Hayden et al. 2018).

While the model can be facilitated, it is one of the models that can be grown organically by bringing into organisations or developing within people with the specific cross-referencing set of skills (t-man type of skills) and providing them with tools for formal and informal relationship building and improvement of internal organisational culture (Kim & Jang 2019).

While individuals can be an effective bridging mechanisms significant lost opportunity has been reported by studies related with a lack of clear information on research and competences possibly available at universities and a way to get in contact with a relevant contact person. Especially SMEs interested in establishing U-I communication found access to such information commonly highly obstructed. Positive practices in that area were not presented in depth in the body of literature, but it suggests application of such tools as:

- Industry oriented communication strategy (Ranga et al., 2008);

- Science knowledge bank (Venditti et al., 2013).

Increasing the visibility of university research within the industry will allow identifying synergies, opportunities and may encourage agents to engage in U-I relations. In that scope especially the role of public relation department with highly capable to communicate knowledge and research across organisational boarders professionals is pointed as a catalyst for increasing awareness of industrial sector regarding research potential and achievements

(Korzhenevskaya, 2014; Suomi et al., 2019). A required communication strategy should incorporate proper marketing, including industry oriented messaging. For a specific impact especially research and prototypes presentation were recognised as of high value. Assuming strong focus on the research/prototype functionality the presentation can result not only in raising interest in U-I further communication and gathering valuable external feedback to the current developments, but by focussing on specific problem/object can facilitate communication and relation building between university and industry agents (Sandberg et al., 2015). Communication strategies should ensure that the industry can access information regarding the pool of knowledge and research available in the specific institution and how they can contact an information-rich person regarding the specific research. This kind of data can be structured into science knowledge bank. In the tool the user not only is able to browse the research topics and identify personnel interested in the issue, but is able to conduct specific key words based search (Venditti et al., 2013). Alternatively, a higher level data base for research incorporating all university in the region was developed in Scotland (Papagiannidis et al., 2009). A comprehensive solution gathering the research base of Scottish universities allows access by the technology area to current research, allowing users to send direct inquiries regarding specific technology.

However, communication efforts should look also beyond marketing of research. Universities should develop strategies for building stronger stakeholders relationships. Especially lost opportunities in the area were related with not sustaining long term relationship with university alumni which could be considered natural links to industry if proper mechanism existed to retain significant links with alma mater past graduation (Suomi et al., 2019).

2nd level intermediation model

The literature commonly agrees regarding the crucial role of individuals in effective U-I communication in the scope of innovation. Some individuals prove to effectively use their relational skills and expertise to bridge institutional barriers to U-I communication. While, especially in less science intensive fields the possibility to use personal relationships mechanisms was shown as critical (Bjerregaard, 2010), the need for in-between agents to forge and develop connections is especially underlined in case of highly science intensive fields and multidisciplinary innovation where knowledge is commonly fragmented across different affiliation groups (Lissoni, 2010; Bjerregaard, 2010). To facilitate the U-I communication many organisations, especially universities try to establish specific objective-oriented organisations. Industrial/applied research institutes, in-campus incubators, technology transfer and university-industry-offices are commonly recognised internal structures with the mission to integrate science and business system and encourage U-I communication in the scope of innovation.

The need for formalised structures and comprehensive support system to complement the effect of personal relationships and social capital is underlined in the literature (Bayne et al., 2016). Due to currently limited amount of T-man like staff across organisations, internal intermediaries are the structures assigned to accumulate cross-organisational communication oriented capabilities, such as project management competences, interactional expertise, marketing or policy making for U-I relations (Petroni et al., 2012, Korzhenevskaya, 2014).

While a number of operational models for internal intermediaries exists – from the direct marketing of discoveries (Welsh et al., 2008) to equity based university business incubators (Grimaldi & Grandi, 2005), not much is known regarding their impact on U-I communication in the scope of innovation. However, some success factors can be drawn from the literature. In the case of Smart Structure Institute employment of director moving to university from industry is recognised as important for communication, translation of research and networking (Sheen & MacBryde, 1995). Three factors were recognised in the scope of technology transfer offices: 1/ establishing organisational policies shifting emphasis on applied research and enabling entrepreneurship among researchers (Welsh et al., 2008), 2/ ensuring engagement of researchers with high level of expertise and ensuring their industry experience through i.e. training or mentoring programs (Petroni et al., 2012), 3/ providing market based evaluation of research value (Cassanelli et al., 2017). Therefore, the literature suggests that technology transfer office should be the source of culture supporting U-I communication and especially the engine for shift towards entrepreneurial university and not only the specific organisational interface to establish U-I communication for innovation.

3rd level intermediation model

Some authors argue that the inclusion of external intermediary is essential to optimise the U-I communication (Parker & Hine, 2014). Authors argue that the general focus of universities on traditional research model demands involvement of external intermediaries and especially government to enable effective U-I communication (Etzkowitz & Leydesdorff, 2000, Ranga et al., 2008). They recognise the need for umbrella organisations that will take the breakage roles and support university and industry in overcoming the specified U-I communication barriers to enable collaborative innovation (Ranga et al., 2008; Pablo-Hernando, 2015). Superior character of external intermediaries was suggested based on their focus on accommodating needs of different agents rather than push for sale of R&D achievements (Chen et al., 2013).

While both private and public organisations were recognised as possible providers of effective solutions for U-I communication, the government role was emphasized as not only possible facilitator, infrastructure and communication mechanisms provider, but as possible engine of policy based shift of university research towards Mode 2 research (Welsh et al., 2008; Ranga et al., 2008; Rad et al., 2015). In the scope of its intermediary role, the government may

enable U-I communication for innovation by applying a number of tools with impact across different phases of U-I communication. The literature enlists three types of possible interventions:

1. Communication platforms – aiming at matching the supply and demand at the engagement stage;

2. Policies and projects – encouraging actors to engage in U-I communication and look to build U-I relationships;

3. Location based tools – science and technology parks, clusters, technopolis that aim at forging and strengthening regional links, including the U-I communication based on colocation.

Empirical studies show that government and public organisations such as development agencies, chamber of commerce etc. are often responsible for initiating U-I communication. They can contribute to U-I communication by aligning organisational objectives through policy instruments and programs and providing platforms for dialog in the form of round tables, workshops, working groups or information days bringing different organisations together. Consultations regarding U-I collaborative innovation and matching support are also possible services encountered in public organisations that can be a platform facilitating U-I communication (Ranga et al., 2008).

However, in addition to those commonly highly fragmented options, innovation oriented governments as China or Germany introduced specific intermediary platforms to support U-I communication. In Germany a number of platforms such as Bayern Innovativ aim is to connect business and research institutes and universities. The popularity of this mediated solutions is especially visible in the biomedical industry where a number of external platforms showcasing expertise and research as well as matching industry and university exists (Efferth, 2000). Recent developments allowed furthermore automatize the matching process by application of AI.

More traditional approach was a subject of a case study conducted in China. The governmental platform took a form of government managed technology transfer office (Chen et al., 2013). While the authors argue that the external platform is more efficient than a university one (which tends to focus directly on the sale of R&D achievements), no empirical prove was presented to support the claim.

To incentivise actors to engage in U-I communication governments possess a range of tools. Among those strongly mediating the engagement of both, industry and university partners, in networking and communication are publically funded projects (Bayne et al., 2016). Financial

incentives and social challenges underlined by the financial schemes can provide relevant incentives for universities and industries to look for establishing U-I relations as well as to overcome U-I communication barriers. By incorporating often conflicting objectives of organisations, publically funded projects were recognised as especially strong facilitation mechanism for U-I communication in sectors with huge requirements for capital investments (Runiewicz-Wardyn, 2014). However, some argue that innovation oriented collaborative research should be self-funded as targeted funding for collaborative research can be counterproductive leading to artificial research collaboration without realistic trajectory toward commercialisation (Suomi et al., 2019). That shows that effective application of policy related financial tools in the scope of U-I communication requires a better understanding of complexities regarding their application to generate positive sustainable effect for U-I innovation.

Another solution to encourage universities and industry to engage in communication aiming at solving specific issues within the industry are infrastructure based tools such as science and technology parks, research centers or technopolis. Basing on the assumption that proximity improves communication, helps to create personal relationships and facilitates flow of information, governments across the world are devoting significant investments into such infrastructures (Porter, 1998, Lockett et al., 2008). While traditionally the mission of such infrastructure was to bring university research and industrial technology together, more modern approach shows that in many cases to succeed in facilitating U-I communication in the scope of innovation infrastructure based intermediaries need to account for number of barriers within such organisations and specific requirements of U-I communication.

Colocation will improve communication only in the environment that will not support ‘us’ and ‘them’ attitude (Lockett et al., 2008). Some design solutions common in such facilities, as the location of research and industry in dedicated separate zones were suggested to offset the colocation potential benefits (Lockett et al., 2008). Further, collocation cannot bring expected benefits if barriers in the understanding of terms and assigning different meanings and/or characteristics to objects will not be effectively addressed (Teubner, 2007). Ignoring the issue can potentially lead to escalation of the language and cultural gap, despite the bounding character of the passion for specific subject (Neumann & Prusak, 2007). Therefore, in addition to traditionally defined intermediary roles a significant intermediary role has been in the last decade associated with the development of organisational mechanism for codification of internal knowledge and overcoming the cognitive and meaning barriers (Parker & Hine, 2014). Intermediary organisations can influence the ability of university and industry stakeholders to communicate by providing specific translations of meaning. However, as proximity is not uniquely tied to geographical factors, but includes cognitive, social and institutional proximity, support organisations should aim at building multidimensional

proximity and providing “temporary proximity” through workshops, events etc. to help accelerate flow of information and knowledge (Hassen, 2018).

While some authors assigned the intermediaries the role to translate and repackage the research, Parker & Hine (2014) postulate that the facilitating role of intermediaries in the translation of research should focus on enhancing directly the communication capacity of engaged organisations (Parker & Hine, 2014, Bayne et al., 2016). Based on Australia-based case study, they suggest that required mechanism for codification of internal knowledge can take the form of training and consulting allowing communicating based on visual codification of one’s knowledge. It may not only provide communication based on shared meanings and transfer of tacit into explicit knowledge to external stakeholders, but also may allow engagement of initially passive agents into problem solving oriented communication (Parker & Hine, 2014).

Furthermore, due to the often transitional character of staff engaged in innovation at the interface between university and industry, additional expectations for the modern external intermediary role are related to the support for creation of knowledge retention mechanisms protecting located organisations from loss of relevant knowledge with mobility of staff (Parker & Hine, 2014). The intermediaries attention to the issue is crucial also to encourage leaders to engage into supporting the U-I communication mobility of staff, between organisations, disciplines and projects. Moreover, development of specific management mechanisms for negotiating and juggling cultural differences and supporting informal relations and networking within the organisations are of the essence (Hong & Olander, 2010; Bjerregaard, 2010).

While the science and technology parks and other infrastructure based U-I communication tools are commonly associated with public organisations, some examples of private initiatives are studied in the literature. Frantz (1998) presents a success story of industry created university which not only allowed to design educational programs strictly adapted to the industry needs, but also by the constant flow of communication allows developing the company hosting the university into a provider of complete solutions rather than simple manufacturer (Frantz, 1998).

More commonly however private intermediary model takes the form of innovation consultants specialised in specific tasks and providing services on site. Alternatively, non-public intermediary can take the form of NGO. This form may directly involve the actors (from university and industry) which brings benefits of reducing bureaucracy required on site of universities to engage into U-I communication (Marques et al., 2006). That can not only contribute to decreasing U-I communication barriers, but also to increase flexibility and dynamic of university contribution to innovation. Independently from the specific form of the

intermediary, the literature clearly points on the intermediaries general role as a mechanism to overcome specific barriers to U-I communication.

Highly specific form of intermediary with high relevance in the scope of knowledge creation, which can take the form of both, private or public structure, is a network. Networks may vary not only in the specific of ownership, but also in the level of formalisation and the level of physical presence. Independently of the characteristics, networks are forums where different actors can meet, present their competences and challenges and look for synergies (Sandberg et al., 2015). The role of networks in facilitating U-I communication comes not only from connecting organisations and individuals with specific interests, but also from providing a common framework for communication, stimulating discussion, knowledge exchange and engagement (Bayne et al., 2016).

The focus of networks should be primarily placed on targeted on knowledge-sharing relationship and social capital building, rather than on pure transfer of information (Bayne et al., 2016). It requires balancing trust, stability and knowledge mobility (Sandberg et al., 2015). To provide real value to participants, network should provide a mixture of weak and strong ties. While strong ties based on trust especially facilitate the communication of complex and tacit knowledge by extensive communication and understanding between actors, the weak ties bring significant value into the network by allowing the exchange of knowledge that is out of reach within the participating organisation knowledge base (Sandberg et al., 2015; Martins, 2016).

High level of diversity within a network can be of key importance for innovation, but can obstruct U-I communication, by enhancing the need for translating and transforming the messages. Balancing the benefits and challenges of network diversification requires proper strategy, strong interactional expertise from the network moderator and commitment and patience from network participants (Sandberg et al., 2015). Network strategy requires the definition of rules and norms to enhance collective capacity and provide network stability by clearly defining network framework and proper communication channels allowing effective communication despite gaps in communication patterns, motives and understanding (Sandberg et al., 2015; Bayne et al., 2016). Network strategy should aim at generating systematic behaviour of organisations and individuals that will lead to communicating expertise and sharing resources among participants (Bayne et al., 2016).

While networks can rise organically from personal networks, to bring essential value for innovation, it requires structuration to focus the communication on accelerating knowledge (Bayne et al., 2016). To work effectively within U-I communication in the scope of innovation central hubs organisations within networks need to develop specific translation skills to enable an exchange of information with different members or the exchange will require intermediary translating agent at the bottlenecks of the network (Bayne et al., 2016).

To facilitate both the translation and engagement into U-I communication, next to informal communication mechanisms, networks commonly integrate formal mechanisms such as regular discussion meetings, workshops, seminars, study visits or research presentations and collaborative prototyping (Sandberg et al., 2015; Bayne et al., 2016). Commonly the network embedded workshops aim at improving understanding of specific problems and defining possible solutions to be developed. They allow to network with people with similar or complementary expertise and similar mindset and initiate communication potentially leading to synergistic collaboration in innovation (Sandberg et al., 2015; Bayne et al., 2016). While all the mechanisms were considered as significant for facilitating U-I communication, workshops were recognised as the mechanism providing the best conditions for enhancing U-I communication specifically aiming at innovation oriented knowledge dissemination. Those interactions often led to continuing communication via phone and email (Bayne et al., 2016). Further, the research and prototype presentations were important mechanisms to provide balanced transfer of information between agents, allowing to not only exhibit the current state of the development, but also obtain important feedback and inputs from other participants (Sandberg et al., 2015).

The role of intermediaries includes a broad range of activities and functions with the potential to bridge U-I communication barriers. However, the body of literature shows that in the majority of cases the provided services are specialised. That would suggest the need for engagement of number of intermediary agents to establish a comprehensive mechanism for U-I communication via intermediary organisations. While the intermediaries can become facilitating link, strong engagement of intermediary organisations will move U-I communication toward linear model of communication. Meanwhile, implementing dialogic communication model will require translations through direct involvement of internal experts at the interface between the university and industry.

2.5. Discussion of results - Tools to overcome barriers to U-I communication

While a range of barriers to U-I communication is a long existing problem, the literature review shows a limited attention of academics to the issue until recently (see figure 2.2). As the recent development of digital tools decreased the role of geographic proximity and facilitated long-distance multiagent communication, the issue can be no longer to a significant degree accredited to the lack of proximity or colocation. This development reviled more complex roots of the lack of effective U-I communication. Based on the increased attention of the literature to U-I communication barriers, the study was able to identify

possible responses and their requirements to overcome the existing obstacles. Summary of possible responses to typical barriers is presented in the Table 2.3.

Following the discussion summarised in Table 2.2, literature commonly points on four top barriers to U-I communication - the differences in 1/ culture, 2/ language and understanding, 3/ procedures and quality systems, and 4/ purpose.

Purpose differences & incentive system

Many authors postulate increasing engagement of universities in the third mission and the shift of modern universities toward entrepreneurial university concept. That itself would result in bringing the purpose of universities and industry closer together. In that scope, among others, in-campus infrastructure holding business and technical facilities together can support strong convergence of university and industry interests. Specifically, position of university as a business partner can improve U-I communication in the scope of innovation (Salem & Amjed, 2008). However, in reality many universities still struggle to accept, initiate or effectively implement the entrepreneurial orientation. Some authors suggest the crucial role of policy-makers in enforcing the transition and the role of the state in reinforcing U-I relationships and specific directions for innovation (Lee & Yoo, 2007; Ranga et al., 2008). The suggested measures include i/ a cut in public funds for university research and legislation stimulating U-I collaboration which was shown to successfully stimulate biotechnology innovation in USA ii/ job mobility systems, iii/ tying the university inventors income to commercialisation success and their involvement in science communication while decreasing the pressure for quantity rather than quality of international publications, iv/ funds for collaboration (Kaklauskas et al., 2018; Welsh et al., 2008; Suomi et al., 2019). However, the measures should be carefully designed to fit specific local context and be established in form of system constituting culture for innovation rather than provide set of loosely related policies (Kim & Jang, 2019).

The suggested in the literature measures strongly underline the need for the evolution of academic incentive systems. Those were commonly pointed as a barrier enlarging the U-I gap due to its current strongly publication-based focus discouraging and often penalising industry reaching researchers (Suomi et al., 2019). The negative impact of general incentive system can be moderated by organisational strategy and internal policies encouraging engagement in economic development, including incorporation of U-I communication into educational programs (Bacon et al., 1994; Macleod et al., 1997; Ranga et al., 2008). To reach the desired effect, it requires a strong engagement of leaders in ensuring clear communication of the strategy and internal policies to both, internal and external agents and creation of collaborative organizational culture (Bacon et al., 1994; Kim & Jang, 2019). As the commercial engagement of academics can raise some doubts regarding conflicts of interests, a strong transparency of the policies is required (D'Hooghe, 2017; Welsh et al., 2008).

Literature suggests that modern policies should not only stimulate the higher freedom of operations of academics and their engagement in market oriented studies, entrepreneurial activities and analysis of invention impact, but should not emphasise the pressure on gaining incomes from inventions ownership to maintain position as a reliable source of information for firms and public (Welsh et al., 2008). From the other side, introducing a space for engagement of practitioners into scientific publications, PhD supervision or education advisory boards through internal policies or incentives by industrial partners was suggested as an important step to support convergence in the university and industry objectives (Alshehri et al., 2016; Bjerregaard, 2010).

While there is still a significant gap in priorities between university and industry, recent literature presents a range of mechanisms that can be applied to enable effective U-I communication in the scope of innovation despite the distance (see table 2.5 in appendixes). Especially importance of individuals to overcome the barrier is strongly underlined in the literature (Butcher & Jeffrey, 2005). Face to face contacts, both official and unofficial, allow building trust and openness of partners to understand and account for different or even conflicting objectives. It allows looking for possible ways to work out an acceptable compromise in designing a common project or a procedure (Bjerregaard, 2010; Plewa et al., 2013a; Rad et al., 2015).

In practice, especially a role of individuals with double socialisation bringing both understanding of university and industry objectives is of the essence (Bjerregaard, 2010). Commonly coming from industry to university teachers and research managers or PhDs working in industry strongly support U-I communication (Alshehri et al., 2016; Bjerregaard, 2010; Rad et al., 2015). They facilitate understanding and aligning objectives between universities and industry. Further, the boundary workers with double occupation, combining at the same time their engagement at universities and open market, may contribute further to overcoming the priority gap. They not only understand the differences in objectives. They possess practical experience in juggling them on daily basis and properly prioritize them to reach a desired outcome. As such, they can strongly facilitate finding the common ground for U-I communication (Bjerregaard, 2010; Lander & Atkinson-Grosjean, 2011; Pablo-Hernando, 2015). To be effective in that mission they need to integrate scientific knowledge and familiarity with organizational contexts with the knowledge of communication and motivation techniques (Petroni et al., 2012).

U-I communication would be strongly facilitated if all university and industry workers possess double socialisation, and the key relational capabilities. As in reality it is relatively rare case, it increases the role of leaders - especially for shaping projects to adapt them to different organisational objectives and ensuring the adaptation of assigned team members to established compromise (Davis & Eisenhardt, 2011; Kaklauskas et al., 2018). Due to diversified organisational logics, expertise and expectations, the literature underlines the

critical need for the establishment of specific project objectives and communication plan whenever partners are shifting from establishment to engagement phase (Kaklauskas et al., 2018). Recent literature proposes that project objectives should not focus on aligning conflicting organisational objectives, but should rather look to work around them.

Cases of successful collaboration in medicine or pharmaceutical industry show that boundary objects help to translate and communicate between domains allowing different organisations to identify common end, and work towards it. Boundary object can be information or an artefact that different agents can interpret in a different way or apply it differently, but which allows them to interact around them. They need to reflect concerns of each of involved groups. It can take a form of statistical data, a common core learning path that will be than adjusted to the need of specific community of practice or a common problem important to different agents which aim to solve it (Alshehri et al., 2016; Sandberg et al., 2015). Alternatively, the literature postulates the use of scenarios that allows visualising, organising and communicating solutions in the context of the value they provide to users and focus on the user perspective rather than on the organisational one. It concentrates the development process, brainstorming and discussions on customer-value based solutions (Kim, 2011). Similarly, focusing on common values and specific common knowledge can be a valid strategy to overcome a purpose gap (Kodama, 2002; Neumann & Prusak, 2007).

In some cases, especially of strongly conflicting priorities, an engagement of an intermediary to mediate between partners can facilitate the negotiation process (Sandberg et al., 2015). However, some authors suggest that this approach does not promote mutual understanding and does not effectively solve the problem. Independently, whether the negotiations take direct or indirect form, a specific project plan with a clear description of objectives, timeline, responsibilities and communication plan should be established (Kaklauskas et al., 2018). While a vast body of knowledge regarding project management can be applied in that scope, the body of literature on U-I communication proposes a few specific for open innovation practices. The model of rotational leadership studied by Davis and Eisenhardt (2011) shows its high value for collaborative innovation. The ability to control decisions at various times safeguards participants the space for incorporating their specific objectives and enriching projects with different perspectives and capacities. The process of exploring different objectives along the innovation process not only supports overcoming priority gaps, but accelerates creation of novelty in the process (Davis & Eisenhardt, 2011). The model should incorporate feedback loops engaging both university and industry in each phase to maximise synergies and ensure the alignment of the project with its specific objective (Kaklauskas et al., 2018). The projects should be also structured into task dependent stages with a possibility to discontinue the collaboration after evaluation of each stage. It facilitates optimal use of resources (which can be especially crucial for engagement of SMEs), helps to create mechanism for broad communication and evaluation between the stages and

opportunity to revise objectives/responsibilities, if needed. Within the framework, contract should clearly define an authority structure that will ensure balance of power between university and industry to avoid intimidation that could lead to break of communication on any side. The contract should specify incentives and penalties schemes clearly (Kaklauskas et al., 2018).

Cultural gap

The purpose gap is emphasised by the difference in culture between university and industry. While in the scope of U-I communication it is an organisational culture that is the most commonly pointed barrier, its possible evolution from barrier to enabler is driven by individuals through both their conscious and unconscious decisions (Etzkowitz & Leydesdorff, 2000; Kim & Jang 2019). The institutional cultural gap leads to lack of understanding and trust between the world of academia and business. Individuals with their intrinsic cooperative culture, associative disposition, learning orientation and quest for consensus can enable effective U-I communication in the scope of innovation above the thick organisational boarders. It requires committed to U-I communication bridging individuals on both sides of the organisational interface (Chakrabarti & Santoro, 2004). Mutual socialisation, shared educational background or work experience facilitate the brokering across organisational cultures (Bjerregaard, 2010; Sandberg et al., 2015). That allows the individuals to use their social capital and relational capabilities to take a role of 'honesty broker' using their personal position in a network between university and industry to ensure mutual respect for the cultural differences (Bjerregaard, 2010).

Some authors argue that to bridge the organisational gap, due to very thick university sector boundaries, the mobility between sectors is required to aid the process (Fujigaki & Leydesdorff, 2000; Shinn, 2005). Extensive mobility between sectors can lead to a blending of organisational culture and logic and increase sensitivity to cultural differences within the U-I communication (Bjerregaard, 2010). Within the scope of innovation, management strategies designed to support mobility and negotiate and mediate the cultural differences should support the process (Bjerregaard, 2010; Suomi et al., 2019). Among others, literature proposes the technological integration model. The mechanism looks to create a greater feeling of group identity by sharing technological background. That can be obtained by providing equal introductory training to agents with different socialisations (Petroni et al., 2012). It was also suggested that researchers in general should have a part time industrial employment and industrial agents should look to develop academic thesis and teach at universities to encourage understanding of university culture and develop absorptive capacity (Suomi et al., 2019). Managerial mechanisms supporting overcoming cultural barriers should further include a process of organisational learning from previous alliance experience, and especially inclusion of lessons learned from failed communication to develop better

understanding of cultural issues and required for overcoming them adjustments (Bjerregaard, 2010; Martins, 2016).

Working in industry PhD holders, as well as teachers with industry experience may bridge the cultures due to their double socialisation (Martins, 2016; Pablo-Hernando, 2015). To contribute to overcoming the barrier individuals with double socialisation need to be able to understand and interpret the culture and dynamic of both communities (Pablo-Hernando, 2015). Moreover, industrial employment of researchers can stimulate cultural intersection of industry with university system. That can lead to introduction of elements of academic culture to industry - the scientification of industry (Bjerregaard, 2010; Pablo-Hernando, 2015). Till recently the literature was strongly focusing on measures for universities to improve their communication. Currently some authors suggested that industry should engage in the efforts to encourage universities to effectively communicate and collaborate with industry. Possible measures include co-publications, consultative committees supporting research and evaluating university curricula or employment of PhDs. Especially encouraging R&D staff and employed PhDs to engage in academic community and academic discussion contributed to improving U-I contacts, as the industry contribution into academic discussion makes the communication more symmetric (Bjerregaard, 2010; Cassanelli et al., 2017; Pablo-Hernando, 2015).

Moreover, the body of the literature proposes inclusion of industrial elements in student programs, from short term projects, through industrial placements and mentoring programs to industrial PhDs. Literature on the issue often suggests that such mechanism through co-supervision system and the mediating role of students can bring researchers and practitioners together (Buser, 2013; Pablo-Hernando, 2015; Rad et al., 2015). However, the thick organisational barriers and lack of trust between organisations show limited effectiveness of the mechanism if the engaged individuals do not possess collaborative and brokering orientation (Salimi, et al., 2016). Empirical studies show that without specific culture on individual or organisational level mentors on both sides can struggle with the cultural differences, especially their views being challenged or lack of control over the overall process (Buser, 2013). While CMC may in that scope mediate the process, by decreasing common biases and importance of sociability (Pendergast & Hayne, 1999; Rad et al., 2015; Santoro & Saparito, 2003), leaders should motivate individuals to work across cultural barriers by building culture based on collaborative spirit, spontaneous communication patterns and trust (Kim & Jang, 2019).

While a number of approaches to bridging the university and industry cultures in the scope of U-I communication exists, intensive U-I communication itself has a key impact on reducing both, cultural and language differences (Vick & Nagano, 2018).

Language and understanding gap

Language differences enhancing the cultural gap highly obstruct not only the U-I communication, but also multidisciplinary innovation. The increasing complexity and format of innovation require broad engagement of agents across organisations and disciplines which increases the role of overcoming the language and understanding gap for innovativeness (Petroni et al., 2012, Bayne et al., 2016). The literature broadly underlines the need to translate academic and industrial jargon and identifies a number of mechanisms to decrease the level of mutual redundancy and uncertainty within U-I communication (Leydesdorff & Ivanova, 2014; Suomi et al., 2019). The most traditional academic mechanism takes a form of practical recommendations focusing on implications from research results of relevance for stakeholders (Teubner, 2007). Their inclusion in academic literature has been pointed though as of low relevance for U-I communication as the attention of industry to academic literature was shown to be highly limited in the scope of innovation.

Some authors accredit the function of repackaging science to intermediary brokers (Bayne et al., 2016; Lockett et al., 2008; Sandberg et al., 2015). Their role in translating codified knowledge and inventions, especially in the scope of their marketing, is broadly recognised within the literature (Parker & Hine, 2014; Sandberg et al., 2015). The ability to manage the diversity under the umbrella of an intermediary and translate it into synergies is the intermediary main success factor (Sandberg et al., 2015). The knowledge broker can be an effective mechanism to translate codified knowledge and inventions in a linear model of innovation. It may be especially effective in the scope of marketing of inventions (Parker & Hine, 2014). However, its effectiveness in overcoming U-I barriers requires embeddedness in both, academic and business world (Lockett et al., 2008). Some authors suggest though that intermediaries mediation is not an efficient solution for continues U-I communication in the scope of innovation. It was proposed that it is rather academics that should uptake the role of entrepreneurial couches responsible for converging language of academia and business to ensure continues discussion regarding innovation (Korzhenevskaya, 2014; Lockett et al., 2008).

However, the body of literature shows that intermediaries may provide support infrastructures enabling the translation within a non-linear model of innovation, and especially support development of the organisational learning and absorptive capacity (Parker & Hine, 2014). Intermediaries can be a viable source for communication strategies and systems that will support overcoming the language and understanding gap through proper organisational mechanisms for codification of knowledge for U-I communication (Parker & Hine, 2014; Sandberg et al., 2015). Literature shows examples of specific training in translating abstract knowledge into visual representations or consulting for creation of proper communication channels for visual codification of problems and involvement of agents with passive attitude toward U-I communication (Parker & Hine, 2014). Support measures should

account for lack of academic education on how to translate knowledge to stakeholders language, but also improve understanding of what kind of forums/channels to use and when it is beneficial (Suomi et al., 2019). Among others, Park & Hine (2014) within their study that supported by intermediary communication platform in which stakeholders record and exchange information in a single format resulted in new opportunities for U-I communication and learning (Parker & Hine, 2014). Specific strategies can include industry oriented research presentations and presentation of working prototypes. Those allow focusing discussion on specific objects and better understand research capabilities and possible synergies. They may initiate feedback loops which may not only provide important for research improvement inputs or provide ideas for new research directions, but also lead to continues U-I communication regarding the issues or move forward toward institutionalised collaboration. The presentations can be supported by U-I industry workshops and study visits designed to improve understanding of problems and possible solutions (Sandberg et al., 2015).

Intermediary organisation role in overcoming the language and understanding barriers was shown to be complementary rather than primary. It is especially due to the need for engagement of top specialists in U-I communication to optimise outcomes of innovation (Plewa et al., 2013b; Sherwood & Covin, 2008). That requires ability to communicate in a more direct and continuous manner. It calls for strong individual competencies of academics on the U-I communication interface and positive attitude towards industry-oriented dissemination of both explicit and tacit knowledge. Such combination is however not common among PhD holders as a consequence of rare inclusion of soft skills training within PhD programs up till now (Pablo-Hernando, 2015; Vick & Nagano, 2018). In that scope boundary workers with double socialisation speaking both, the language of research and practice, were recognised as valuable assets (Lander & Atkinson-Grosjean, 2011). The value of such individuals was associated not only with their knowledge of the language on both frontiers, but also in their practical experience in communicating in both worlds. That allows them to anticipate the gaps in which the specific language differences can lead to problems in understanding and therefore to breaks in the communication. On the other side, boundary workers tend to have rather broad than deep expertise in the boundary areas. Therefore, their main value for innovation is related to their collaboration on both frontiers within their innovation network (Lander & Atkinson-Grosjean, 2011). They create the personal interface for U-I communication incorporating not only their language and cultural understanding, but also their integrative capacities based on expertise on the frontier. They commonly take central hub positions in the innovation networks and develop translator skills not only regarding the translation of meaning, but also the translation of knowledge needs of different agents within the network (Bayne et al., 2016). While not all movers between sectors will possess the capability to take central translating position in the process of meaning translation, industrial employment of researchers was shown to increase the technical capacity of firms to absorb scientific knowledge and allow embedding the company within

scientific community. That can be seen as a guarantee for mutual understanding and trust by academic partners (Bjerregaard, 2010; Pablo-Hernando, 2015). Continuous interaction with individuals with academic socialisation helps at the same time to gain better understanding of abstract theoretical knowledge, improve absorptive capacity and the attitude of industry towards academic knowledge

Communities of practice are an important mechanism for U-I communication in the scope of innovation which requires common basis of meanings and semantics hold by the members (Neumann & Prusak, 2007). Those can be provided by the double socialisation individuals translating at the network knots or by agreeing on general procedures of exchange through negotiation of meanings (Neumann & Prusak, 2007; Sandberg et al., 2015; Sherwood & Covin, 2008). Different communities may apply different tools to establish common vocabularies and ontologies. Terminology chapters or dictionaries providing shared representations, interpretations and systems of meanings are often used to allow the use of collective knowledge in the communities. The involved negotiation process should focus on establishing a meaning specific for the community and not be uniquely linked to the terminology (Fiehe et al., 2014; Neumann & Prusak, 2007). The process can be supported by focus on boundary objects, specific activities or values which are common and relevant for the group participants (Neumann & Prusak, 2007; Sandberg et al., 2015). Empirical research within the sectors where the U-I communication is effectively resulting in open innovation – such as medicine, biotechnology and pharmaceuticals, shows that the strongest factor enabling effective U-I communication is a common ownership of a problem. Convergence around a specific problem that acts as a boundary object allows translating the language to a common one and working towards a common goal without the need to develop a common group identity (Sandberg et al., 2015). Similarly, proposed in the literature methodology for service innovation shows a positive translating effect of focus of design team on potential scenarios in which a solution will provide specific value (Kim, 2011). Alternatively, establishing prototyping schedule and use presentation of prototypes as a boundary activity for translation can aid U-I communication (Bacon et al., 1994).

Modern technology aids the process by from one side providing means of shared imagination, broadly accessible visual aids and image technology for providing simple and straightforward visualisations, from the other causing changes in communication language – increasing its simplicity and universal character (Treadaway, 2004). The literature suggests also that technologies tend to establish specific logic and language which allow a transversal communication. The specific language of innovation spoken by all their users can become the translating mechanism bounding the users across organisational and disciplinary boundaries (Shinn, 2005). The technology becomes the mediator between different languages through the language of basic instruments common to all their users, such as measures or methodologies. That creates a communication platform and common language allowing

translation (Shinn, 2005). The broad use of ICT technology increases further the need for the establishment of common meanings, as semantics are especially important in the scope of commonly applied for the research and information gathering search tools (Neumann & Prusak, 2007).

The broad discussion regarding the need for overcoming the language and understanding gap between organisations to enable the U-I communication in the scope of innovation shows that the successful mechanisms focus on 1/ commonalities rather than differences or/and 2/ simplification of messaging.

Differences in procedures and quality standards

Interorganisational contacts, even in case of organisations with aligning objectives and culture, often do not translate into innovation due to a gap in specific processes for innovation (Davis & Eisenhardt, 2011). In case of U-I relations the highly bureaucratic academic procedures commonly obstruct U-I relations in the scope of innovation while the lack of industry required quality standards in many areas makes academic research unreliable in the scope of commercialising inventions (Bjerregaard, 2010; Lockett et al., 2008; Marques et al., 2006).

Government and organisations commonly establish the framework for research and innovation processes within the public sector and through specific infrastructure, policies and legal requirements impact the level of bureaucracy and quality standards (Alshehri et al., 2016; Rad et al., 2015). The literature shows that to enhance effective U-I communication in the scope of innovation there is a strong need for internal and external policies increasing flexibility of organisational and financial procedures in the scope of innovation, especially decreasing the bureaucracy and simplifying subsidy applications (Bayne et al., 2016; Ranga et al., 2008; Sandberg et al., 2015). In practice, the rules and standards governing universities do not commonly favour entrepreneurial exploitation of university research by not providing sufficient time for communication and knowledge transfer and especially prolonging time to market (Fiehe et al., 2014; Rad et al., 2015; Suomi et al. 2019). With the increase of public funding, universities face new layers of bureaucracy which lead to decrease of R&D performance (Kim & Jang, 2018). While a strong political will on governmental and university level is required to enable necessary changes, a few mechanisms that can moderate the barrier were pointed in the literature. Mechanisms for building trust and personal relations can facilitate the process by often allowing skipping the official procedures or getting a proper guidance of insiders regarding how to maximally shorten the process (Davis & Eisenhardt, 2011; Papagiannidis et al., 2009). That requires efforts of leaders to build a proper environment for relationship building with increased level of interactions and less formalised structures for U-I communication (Bayne et al., 2016; Macleod et al., 1997). Meetings, visits and especially extensive mobility can lead to encouraging comingling of

innovation procedures (Alshehri et al., 2016; Bjerregaard, 2010). Industrial relations committees aiming at exploring industry requirements through broad interactions, including study visits and involvement of industrial partners; and their further display to faculty members can encourage adoption of industry oriented procedures and policies (Alshehri et al., 2016). Especially introduction of industry quality standards, such as quality management system, into academic research was suggested as a main pillar to encourage U-I communication in the scope of innovation and to shorten the time to market (Fiehe et al., 2014; Fujigaki & Leydesdorff, 2000).

Different procedures can be also bridged by the presence of an intermediary. An external intermediary can provide intermediary processes needed to link the research with processes required for practical application (Etzkowitz & Leydesdorff, 2000). However, it can take also a form of institutionalisation of the interface between university and industry in a form of non-governmental organisation which will allow overcoming administrative and financial limitations encountered by universities (Marques et al., 2006). Those organisations can also promote necessary transformation by lobbying for specific policy changes or providing training and mentoring for organisations struggling to overcome the differences in procedures (Plewa et al., 2013b).

Other barriers

While a broad scope of barriers was identified in the study, their significant part is strongly related to one another, as in the case of the incentive systems gap direct relation with difference in organisational purpose. Table 2.3 summarises the application of identified tools in the context of specific barriers to U-I communication. The initiation of any U-I communication was reported as often difficult due to lack of clear access mechanisms on both sides of U-I communication. It was especially often reported within industry interested in exploring university research. From one side, the direct interaction communication tools and especially mechanisms encouraging building social capital of researchers and strong personal network can aid the process (Allen et al., 2016; Bayne et al., 2016; Pablo-Hernando, 2015). From the other side, a number of mechanisms for university to disseminate their research efforts and achievements among industrial partners exists. The interface for U-I communication commonly takes a form of communication platform, either institutionalised either virtual. Proposed solutions include specific governmental platforms. Via development agencies, chamber of commerce or targeted umbrella organisations government contributes specific resources to initiating U-I communication and provide matching between supply and demand. Similar mission is often taken upon by private or internal organisations positioning themselves as the interface for U-I communication within innovation system (Bayne et al., 2016; Efferth, 2000; Marques et al., 2006; Ranga et al., 2008). A number of initiatives suggests that, independently from the chosen channel, the crucial mean to overcome the

barrier is the direct and actualised public information regarding the research efforts, interests and capabilities, as well as the communication relevant internal contact person (Papagiannidis et al., 2009; Venditti et al., 2013). The platform can be integrated in a university website, take a form of university technology website or knowledge bank (Papagiannidis et al., 2009; Venditti et al., 2013). The organisational interface should allow the knowledge seeking organisation unobstructed access to information through multipoint real time contact to the most knowledgeable individuals (Sherwood & Covin, 2008). The specific communication mechanism should allow not only on-demand basis access, but should aim at information and ideas flow on continuous basis to lead to recognition of opportunities (Langford et al., 1997). That suggests a crucial need for formal and informal channel allowing human interaction. To promote the research and possibility to engage and benefit from the knowledge base, research and prototypes showcasing proved to be a valuable mechanisms (Sandberg et al., 2015). It can be supported by using public advertisement to establish contact with industry, if institutional gaps are not extensive (Bjerregaard, 2010). Further, together with broader recognition for the university third mission, the need for effective communication of research to the public by engagement in popular and digital media – i.e. media briefings, participation in TV science shows, blogs etc. (Haynes et al. 2018; Suomi et al., 2019).

To encourage the initiation of U-I contacts however, a number of barriers related to the reputation of university as knowledge provider needs to be overcome. Negative reputation of university is closely related with the traditional university focus, procedure gaps or different perception of time. That results in the perceived disconnection of science from the market and in low credibility of academics in the industry perception. While existing policy and culture are strong contributors to the gap that need to be approached on the system level, a number of practices bridging that gap have been identified in the literature. Human interface was once again suggested as one of the crucial bridging mechanisms. The importance of academic staff industrial experience and contacts were often underlined (Martins, 2016; Welsh et al., 2008). The technological integration model suggests that providing all academics without double socialisation training in industrial R&D centers could bridge that gap through shared technological knowledge (Petroni et al., 2012). To bring expected benefit, it should however take a form of middle-term assignments as empirical study shows that in average two to four weeks are required to understand the new industrial environment, with 25% requiring up to 4 months (Buser, 2013). Next to staff mobility, mutual reciprocal visits and different forms of students' engagement in the industry were suggested as methods to ensure continuous learning from industry and to bring confidence and trust between the two spheres (Alshehri et al., 2016; Hotaling et al., 2012; Kaklauskas et al., 2018). The openness to industry and U-I communication can be shown in a clear way via research presentations and demonstrations of working prototypes. To be of use in that scope, they strongly need to focus

on functionality of the research or the invention (Bacon et al., 1994; Sandberg et al., 2015; Vries et al., 2018).

Establishing a consultative committee where the industry will provide insights regarding quality of academic curriculum and work with academia to maximally adjust education to market requirements can be an important enabling mechanism for U-I communication. It can help not only to provide market oriented education, but also to show university willingness to evolve and adjust to optimally realise its educational mission (Alshehri et al., 2016; Harris, 2009). Postulated as crucial for the market evolution, integration of industry experience in higher education can vary from short term exposures – study visits, workshops, fairs to long term assignments – projects or industrial PhDs (Alshehri et al., 2016; Salimi et al., 2016). Quality of interactions at the U-I interface will in case of all the mechanisms strongly impact the reputation of academics and university sector within industry. The body of literature shows that to meet industry requirements and overcome the negative reputation, next to orientation toward market and high level expertise, collaborative orientation, relational and project management skills are required from the people engaging on U-I interface (Buser, 2013; Hotaling et al., 2012; Korzhenevskaya, 2014; Plewa et al., 2013b).

Engagement of such individuals in regular discussion, meetings, students co-supervision, seminars, workshops, collaborative industry-led research activities and other activities allowing U-I communication commonly allows to break the negative reputation of academia. Such individuals with an innovative mindset often initiate U-I knowledge dissemination that results in its structuration into U-I projects (Bayne et al., 2016). Building a portfolio of successful U-I R&D projects can strongly support breaking negative stereotypes of university within industry (Bayne et al., 2016; Kaklauskas et al., 2018). However, their applicability is of crucial importance (Vries et al., 2018). Proper project management procedures within university can be further enabling alignment between practical objectives and outcomes and ensuring proper time management (Kim, 2011; Vries, 2018). Use of scenarios from the external point of view can help establish optimal time frames for the project (Kim, 2011). Flexible and non-ambiguous communication mechanisms need to be created for the efficient management of cooperation activities (Kaklauskas et al., 2018). From the other side, collaboration methods based on simple, task-oriented stages that allow industrial partner terminate the project at the stage gate may encourage firms, especially SMEs to engage in U-I projects despite the negative reputation (Kaklauskas et al., 2018). The mechanisms allowing minimising invested resources in case of not meeting time requirements or established objectives minimise risks of industrial partner from one side and maximise the chance of academic partner to gain a chance to present their competences and capabilities in practice from the other. Community engagement can be another mean to improve reputation of academia (Macleod et al., 1997). Organisations can escalate the return on resources invested

in breaking negative reputation by communicating it to public via media exposure (Bayne et al., 2016; Korzhenevskaya, 2014).

U-I communication can be from the other side obstructed by the negative reputation of industry, the perceived knowledge gaps and related with collaboration with industry restrictions on publications. Especially SMEs struggle with the perception as not generating meaningful cutting edge research among academics (Lockett et al., 2008). While not much attention has been devoted to the industrial perspective, the existing body of literature suggests positive impact of employment of PhDs in industry on encouraging U-I communication. However, to stimulate university interest in engaging in U-I communication in the scope of innovation they need to possess social capital and be an active members of academic community with the facility of interacting in both worlds (Pablo-Hernando, 2015). Unfortunately, reputation of academic knowledge and lack of its understanding within society is a barrier to employment of PhDs in industry. Better strategies for science-to-public communication can be supported by organisations providing matching of PhD holders with companies (Suomi et al., 2019). While PhDs in the industry can facilitate U-I communication and aid overcoming the low knowledge focus reputation of firms, scientification of industry was suggested as a strong enabling mechanism to overcome the resistance of academics for collaboration, both related with reputation and restrictions on publications (Bjerregaard, 2010; Pablo-Hernando, 2015). The measures can be of especially high importance for SMEs that encounter stronger barriers to U-I communication due to university preference to engage with bigger, more recognised industrial partners (Lockett et al., 2008). It can also contribute to increased understanding of academic research value and absorptive capacity.

Some authors suggest that funded projects are the policy measures that bring the university and industry together in the scope of innovation (Runiewicz-Wardyn, 2014; Vick & Nagano, 2018). Research shows however that, just a minority of academic inventors engage in further research collaborations with former co-inventors not related with university. The probability that collaboration will be followed by another one is higher if industry counterpart has a high academic degree (Lissoni, 2010; Salimi et al., 2016). This suggests that engagement of PhDs in industry may have a significant impact on building long term U-I communication in the scope of innovation. In that context, inclusion of academic practices in industrial context can encourage move of PhDs to industry as well as can support increasing openness of academics to communicate with industry, by making the communication more symmetric (Pablo-Hernando, 2015). PhDs recruitment and inclusion of academic practices were shown to increase organisation reputation not only among academics, but also among other stakeholders (Pablo-Hernando, 2015).

Moreover, the engagement of PhD holders as an interface in U-I communication can mediate the authority barrier. It was shown that in U-I communication the academic experts were often more receptive if communicating with a PhD holder (Pablo-Hernando, 2015). Due to

possible authority conflict, the rules of communication and specific roles need to be clearly established and formalised within the communication context; in case of communication institutionalised under a project or umbrella organisation, within a management plan. Contract or a management plan should clearly define authority structure in a way that balances gaps in social power between organisations. It should ensure that none of the organisations feels intimidated or marginalised (Kaklauskas et al., 2018). Strong personal relationships were shown to often moderate the authority conflicts and increasing the openness of engaged parties for deeper understanding of the counterpart. But, in case of very thick organisational barriers, engagement of intermediaries may be required to structure communication in a proper way to avoid break of communication due to authority conflicts.

Intermediaries are often highly important for support to negotiations and establishments of contracts regarding not only the communication requirements, but especially regarding the intellectual property rights (IPR) and confidentiality issues (Parker & Hine, 2014). A proper contract safeguarding the rights of both sides and specifying the legal requirements in the area can decrease the risk for industrial partners. Engagement of intermediaries in the process, as well as involvement of individuals with double socialisation can help also to overcome unrealistic expectations of university regarding the values and reality of IPR.

Table 2.3 Application of identified tools in the context of specific barriers to U-I communication

Barriers	***Tools***
Cultural gap	Job mobility - double socialisation
	Demonstration of research or prototypes
	Knowledge brokers: intermediaries
	T-man and hybrid scientists
	Institutionalisation of alliance experience
	Industrial exposure within education programs
	Personal contacts
Language and understanding gap	Job mobility- double socialisation
	Boundary workers
	Boundary objects/problems
	T-man and hybrid scientists
	Internal communication skills
	Workshops and training
	Research and prototypes presentations
	Terminology chapters and visualisations
	Communities of practice
	Knowledge brokers – intermediaries
	Personal contacts
Purpose differences	Boundary objects/problems

Barriers	*Tools*
	Scenarios
	Scientification of industry
	T-man and hybrid scientists
	Job mobility – double socialisation
	Leaders and organisational culture
	Communication/project plans
	Contracts
	University incubators
	University investment in industry
	Intermediaries
Differences in procedures & quality standards	Institutionalisation of alliance experience
	Collaborative organisations
	Committees
	Leaders
	Job mobility – double socialisation
	Personal contacts
Incentives systems	Internal strategies and policies
	Leaders
	Industrial exposure within education programs
	Scientification of industry
	Personal contacts
Disconnection of science from market	Job mobility
	Site visits
	Research and prototypes presentations
	Consultative committees
	Knowledge networks
	Boundary individuals
	Transfer consultants
	Industrial exposure within education programs
Confidentiality issues	Boundary individuals
	Contracts
	Intermediaries
Different perception of time	Job mobility - double socialisation
	Project managers
	Scenarios
Access issues	University communication platforms
	Umbrella organisations
	Public/industry relations offices
	Transfer officer/consultant
	Knowledge networks
	Research and prototypes presentations
	Advertisements/ marketing
	Personal contacts

Barriers	*Tools*
Negative reputation of university	Personal contacts
	Job mobility – double socialisation
	Industrial exposure within education programs
	Research and prototypes presentations
	Stage-gate types of contracts
	Collaborative experience
	Consultative committees
	Project management procedures
	Community engagement
	Communication strategy
	Site visits
Negative reputation of industry	Collaborative experience
	Employment of PhDs
	Scientification of industry
Authority conflict	Intermediaries
	Contracts
	Management plans
	Employment of PhDs in industry

2.6. Conclusions and future directions

The current body of literature shows a strong recognition for the importance of U-I communication for innovation. It discusses the barriers, tools and factors of communication. The study based on systematic literature review identifies a broad range of communication tools and mechanisms for facilitation of U-I communication in the scope of innovation and discusses their applicability in the scope of specific UI communication barriers. However, it shows that the knowledge is strongly fragmented and that the current understanding of interactions between the tools within complex systems and their applicability in specific conditions is unsatisfactory for allowing well-informed strategic decisions.

The body of literature shows a strong need for improving U-I communication mechanisms and supporting them systems. Identified in the literature solutions and factors with potential for overcoming the existing barriers should be especially accounted for. Overcoming the barriers requires designing communication mechanisms that will allow open and professional U-I communication supporting collaborative culture and quest for consensus (Etzkowitz & Leydesdorff, 2000; Korzhenevskaya, 2014; Kim & Jang, 2019). Despite the fact that there is significant lack of understanding of efficiency of specific tools in the scope of U-I communication, the presented cases show that a number of complementary agents and solutions need to be incorporated to generate effective U-I communication. Those include specific governmental policies aiming at building collaborative environment within NIS and

RIS. The content analysis suggests that currently implemented policies commonly do not generate the desired impact. Sustainable engagement of universities and industry in mutual communication flows aiming at sparking and developing innovation is rare and strategies should be rethought to provide better framework. Organisational and governmental policies should aim at decreasing institutional U-I gaps and building environment encouraging developing formal and informal relationships, with a focus on development of social capital and networks. The main government related barrier was commonly associated with publication focused incentive system of universities and stronger recognition for engagement in third mission in that scope raise as a logical next step for fostering U-I communication for innovation. However, communication system should incorporate multiple complementary mechanisms with government playing just a supporting role focusing on encouraging proper culture (Peng et al., 2017). The main tools to overcome U-I communication barriers are associated with internal measures: organizational culture supporting cross-organisational communication and innovative activities aligned with collaborative leadership patterns, strong relational, translational and absorptive capacity, proper communication and marketing strategy and efficient communication channels and tools.

The literature clearly suggests the transversal and crucial role of direct interaction communication tools. Relation building oriented mechanisms were shown to have especially significant mediating impact in case of U-I communication barriers when individuals combining a high level of knowledge and expertise with interactional capabilities (Bayne et al., 2016) are engaged at the organisational interface. Due to the recent development of CMC, such interactions are no longer location dependant. The literature suggests that proper CMC tools may not only allow focussing on cognitive, social and institutional proximity rather than geographical one, but that they can contribute to overcoming U-I communication barriers through facilitating sense making, decreasing the role of sociability and bias and enabling group familiarity and personal relations across locations. However, how exactly specific systems could effectively provide improvements to U-I communication across the typical barriers is not discussed in the literature.

Due to lack of required systems, the strong impact of the identified barriers on U-I communication and common shortage of brokering individuals within organisations, an intervention of private or governmental intermediary can be beneficial to support creation of proper mechanism for U-I communication. The study identifies how to effectively use intermediary mechanisms to overcome barriers to U-I communication. It provides categorisation of intermediation models, requirements for their effective support of U-I open innovation and bridging UI communication gaps and rationale for application of specific models. The identified models strongly vary from static one-side communication tools, through technology mediated including recent inclusion of AI solutions to highly interactive human based mechanisms. Not surprisingly, they differ regarding their applicability in

different contexts, requirements and mechanisms for optimisation of potential positive impact. The study summarizing the current knowledge regarding those characteristics, together with the models' drawbacks show that lack of their understanding may lead to ineffective investments of resources into supporting U-I communication. Therefore, building strategy for supporting U-I communication should be based on in-depth analysis of the specific local/regional or national context and selection of mechanisms corresponding to the available resources and capabilities. Especially, the available pool and level of communicational skills and absorptive capacity, and their development potential, on both university and industry side should be well understood to define the tools and intermediation level that will generate optimal result, especially balancing benefits and drawbacks of each intermediation form. However, beforehand often omitted verification that a well-recognised access point for industry interested in open innovation with university is available should be the starting point.

The study shows, that in the long term, U-I communication should be unmediated. It requires in the first place our educational systems to provide managerial and relational skills to both, future academics and industrial agents. That would require making the development of relational and managerial skills as a transversal position in curriculum across fields and educational levels. That development could benefit from intermediaries support, which role should evolve from direct linking agents to agents supporting customized solutions focused on local needs of U-I communication and increasing the absorptive and relational capabilities on organisational level. It identifies requirement for evolution of intermediary roles to effectively support transition of U-I communication from linear to dialogic mode, by supporting design of proper capacity building mechanisms for effective knowledge transfer, but also strategies and systems for retention of the knowledge in organisations.

Despite a number of organisational gaps, positive examples of open innovation are especially visible in sectors such as biotechnology or ICT. Studied cases suggest that common ownership of a specific problem is the strongest mechanism bridging existing gaps and enabling effective U-I communication. Use of boundary objects or mechanisms which allow convergence around a specific problem, object or concept was shown to overcome differences in culture or purpose and allow translating the language to enable effective U-I communication in the scope of innovation. Those solutions can especially ease engaging in U-I communication across barriers up to the moment when efficient comprehensive communication systems and systemic change resulting in a drop of the barriers will take place.

Future lines of research

The conducted systematic literature review shows that despite the broad role of communication for U-I open innovation up till now the topic of U-I communication has been commonly studied as a factor of collaboration rather than as a specific enabling process.

While significant knowledge can be extracted from existing research, a range of gaps exists that may obstruct proper implementation of systems required for U-I communication for innovation. Within the gaps comprehensive analysis regarding applicability of specific tools in different contexts is lacking (Salem & Amjed, 2008). For that purpose broader understanding of effectiveness of the tools in specific conditions is required. The study contributes to filling the gap in the literature by systematising the described tools in the context of its application to overcome specific U-I communication barriers. It is expected to aid optimal implementation and adaptation of the tools to organisational and environmental specifics. Nevertheless, better understanding of the tools efficiency based on empirical research is required. The content analysis suggested that the tools application and effectiveness can vary depending on the type of knowledge, phase of U-I communication, regional development level or even industry (Plewa et al., 2013b; Runiewicz-Wardyn, 2014). Further research should account for the differences and explore their impact on the tools effectiveness. It especially should aim to provide knowledge on how to support UI communication depending on different socio-economic characteristics that could allow properly adjusting tools and support measures to real needs of regions and nations, rather than to transfer incompatible solutions from regions with different characteristics.

Fiehe et al. (2014) underline that, stakeholders adapted and optimized communication should be studied in details (Fiehe et al., 2014). The multitude of potential U-I communication mechanisms from direct through brokers to government-mediated, underlines the strong need to not only strategically adapt communication mechanisms to the need of target groups, but to clearly communicate access channels to stakeholders which otherwise can be discouraged to engage in U-I communication by possible lack of clarity and possibly misleading perceptions. While a few studies approached the topic of different platforms to communicate research to external agents, the knowledge in the area is not only strongly fragmented but superficial. In depth studies increasing understanding of requirements for effective communication of collaboration opportunities to industry could aid establishing U-I communication in the scope of innovation.

Our study, similarly to a knowledge transfer literature review by Vries et al. (2018), reviled also a strongly one sided focus of the literature on tools for university to improve its communication with industry. The analysed studies commonly discussed university-led mechanisms facilitating U-I communication or the role of external intermediaries. While being scarce, our study identified however studies approaching the possible improvements and adaptations on the industry side. However, as studies in that area are recent and scarce, impact of such approaches and potential developments in the area should be monitored and studied. Moreover, the research underlines that communication with university is especially challenging for SMEs. Specific research looking into approaching the SMEs specifics could bring additional value to the discussion (Ranga et al. 2008).

Among other shortcomings, while some authors underline the need for bi-directional U-I communication, the body of literature focuses rather on the linear model of communication with a knowledge transfer from university to industry. That suggests a significant need to provide better understanding of effective mechanism for bi-directional feedback-based communication and tools for its support. In that scope an enabling character of ICT-based solutions was recognised. The body of literature recognises the role of modern technology for enabling non-linear U-I communication for innovation on the global scale (Lan, 2004; Neumann & Prusak, 2007; Treadaway, 2004), its impact on reconfiguration of organisational environment (Fields, 2006) and the vast opportunity for innovation brought by ICT. However, despite increasing role of ICT in innovation environment and overcoming geographical barriers, studies of CMC in the scope of U-I communication are scarce, with especially limited studies within the last decade. The impact of ICT tools on the U-I communication in the scope of innovation beyond their enabling character was not studied with exception of two studies in the scope of biomedical and textile industry (Kodama, 2002; Treadaway, 2004). The strong focus of literature on location-based communication mechanisms may suggest currently limited engagement of academics in CMC in the scope of innovation and e-innovation. The limited interest also shows small attention to the potential of long distance U-I communication which has been enabled by ICT developments. Specific studies in those areas, especially looking to define is there a possible gap in communication tools used within university and industry, that can be an additional U-I communication specific barrier, could contribute to the discussion. Further, specific factors of CMC enabling effective U-I communication across boarders should be better understood to aid better capitalisation on funds invested in facilitating U-I cross-border collaboration in the scope of innovation.

Meanwhile, literature broadly discusses practices related with location based intermediaries, such as science and technology parks or clusters. While there is a broad research on the role of location-based intermediaries, they are commonly strongly embedded in a specific socio-economic context and a comparative studies on applicability of specific support mechanisms depending on local needs and requirements is missing. Understanding of such relations should be especially important in scope of peripheral regions which often struggle with difficulties to spark U-I communication for innovation, often despite significant investments in the area. From the other side together with shift of U-I communication from linear to dialogic mode of communication, more attention should be paid in studies of U-I intermediaries to changing challenges and new requirements for intermediaries.

Finally, the review of the literature shows that represented methodological approach strongly focuses on a case study methodology. Diversification of applied methodology is especially poor in case of European studies. Following Kim and Jang (2018), there is a need to reassess policies supporting cross-organisational interactions and quantitative studies should be conducted and then substantiate with qualitative studies to avoid misleading policies

decisions. Therefore, in the scope of our review it suggests a need for inclusion of quantitative studies to be further linked to specific in-depth qualitative studies.

2.7. Appendixes

Table 2.4 Base of the articles included into the content analysis

No.	Title	Authors	Main Focus in the relation to the specific study topic	Study of communication
1	Communication within a national R&D-system: A study of iron and steel in Sweden	(Höglund & Persson, 1987)	General study of U-I contacts	yes
2	Communication strategies in tissue culture an seed research in Thailand	(Yuthavong et al., 1993)	Knowledge transfer mechanisms between University and SMEs - focus on communication	yes
3	Dynamic knowledge nets in a changing building process	(Christiansson, 1993)	Communication - Dynamic Knowledge Networks	yes
4	Managing Product Definition in High-Technology Industries: A Pilot Study	(Bacon et al., 1994)	Collaboration on product definition - success factors	no
5	The importance of complementry assets in the development of smart technology	(SHEEN & MACBRYDE, 1995)	Collaboration - multidisciplinary	no
6	Changes in Information Technology, Changes in Work	(Graham, 1996)	New communication technology	yes
7	The 'well-stirred reactor': evolution of industry-government-university relations in Canada	(Langford et al., 1997)	Public role in facilitating collaboration	no
8	The knowledge economy and the social economy: university support for community enterprise development as a strategy for economic regeneration in distressed regions in Canada and Mexico	(Macleod et al., 1997)	University role in regional and community development - peripheral regions	no
9	Clusters and the new economics of competition	(Porter, 1998)	Clusters as facilitators of collaboration	no
10	From risky business to big business	(Frantz, 1998)	University programme established by a business	no
11	Triple Helix of innovation: introduction	(Leydesdorff & Etzkowitz, 1998)	The triple helix model	yes
12	Groupware and social networks: will life ever be the same again	(Pendergast & Hayne, 1999)	Groupware - support systems for collaborative work	yes
13	Quality control and validation boundaries in a triple helix of university-industry-government Mode 2 and the future of university research	(Fujigaki & Leydesdorff, 2000)	Differences in quality requirements in classic and multidisciplinary research	yes

14	Biomedical technology in Franconia	(Efferth, 2000)	Support system for Biomedical Industry - including communication platforms	no
15	The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university -industry-government relations	(Etzkowitz & Leydesdorff, 2000)	Collaboration in Triple Helix	yes
16	The promotion of strategic community management utilising video-based information networks	(Kodama, 2002)	Remote diagnosis in veterinary medicine based on video-nets	yes
17	Biotechnology clusters as regional, sectoral innovation systems,	(Cooke, 2002)	Studies of collaboration within the triple helix model	no
18	The mutual information of university-industry-government relations: An indicator of the Triple Helix dynamics.	(Leydesdorff, 2003)	Contains a complex methodology of a bibliographic analysis	yes
19	The Firm's Trust in Its University Partner as key mediator in Advancing Knowledge and New Technologies	(Santoro & Saparito, 2003)	Communication and trust in U-I relations	yes
20	Digital creativity: the impact of digital imaging technology on the creative practice of printed textile and surface pattern design	(Treadaway, 2004)	The impact of digital imaging technology on the creative practice	yes/partial
21	Building social capital and learning environment in university – industry relationships	(Chakrabarti & Santoro, 2004)	Focuses on social capital as a measure of university contribution in U-I relationships	no
22	Three new features of innovation brought about by information and communication technology	(Lan, 2004)	Focuses on ICT impact on enabling distant collaboration in innovation	yes
23	Business incubators and new venture creation: an assessment of incubating models	(Grimaldi & Grandi, 2005)	University Business Incubators	no
24	The use of biometric indicators to explore industry-academia collaboration trends over time in the field of membrane use for water treatment	(Butcher & Jeffrey, 2005),	Trends in U-I relations studies	no
25	New sources of radical innovation: research technologies, transversality and distributed learning in a post-industrial order	(Shinn, 2005)	Common language as a tool enabling innovation	yes

26	How can university- industry – government interactions change the innovation scenario in Portugal? – the case of university of Coimbra	(Marques et al., 2006)	The role of university in fostering regional innovation and entrepreneurship	no
27	Innovation Time and Teritory: Space and the Business Organisation of Dell Computer	(Fields, 2006)	Shows how communication technology reshaped strategic distribution of companies	yes
28	Strategic information systems planning: A case study from the financial service industry	(Teubner, 2007).	Study a gap between research and practice	yes
29	Government Policy and Trajectories of radical innovation in dirigiste states: a comparative analysis of national innovation systems in France and Korea.	(Lee & Yoo, 2007)	Studies the impact of NIS on triple helix collaboration	no
30	Knowledge networks in the age of the Semantic Web	(Neumann & Prusak, 2007)	The role of Web-based communities and tools development on knowledge and innovation development	yes
31	Knowledge Acquisition in University- Industry Alliance. An empirical Investigation from a learning theory perspective.	(Sherwood & Covin, 2008)	The impact of different interface factors on knowledge transfer	no
32	An innovative mode for university-industry partnership	(Salem & Amjed, 2008)	In Campus research facility as a model facilitating U-I collaboration	no
33	The strategic value of new university technology and its impact on exclusivity of licencing transactions: An empirical study	(van den Berghe & Guild, 2008)	Attractiveness of university technology for industry and agreements	no
34	Multiple perspectives on the challenges for knowledge transfer between higher education institutions and industry	(Lockett et al., 2008)	Identifies key practices impacting the U-I knowledge transfer	no
35	Close enough but not too far: assessing the effects of university-industry research relationships and the rise of academic capitalism.	(Welsh et al., 2008)	Conditions required for university shift toward industry	no
36	Enhancing the innovative capacity of small firms through triple helix interactions: challenges and opportunities	(Ranga et al., 2008)	Causes of poor knowledge transfer in Triple Helix Model	no
37	Entrepreneurial networks: A triple helix approach for brokering human and social capital	(Papagiannidis et al., 2009)	Skills brokage model as a model for UI collaboration	no

38	Help wanted: "T-Shaped" skills to meet 21st century needs	(Harris, 2009)	The need to incorporate multidisciplinary skills in learning - curriculum designed by industry	no
39	AAC technology transfer: An AAC-RERC report	(Higginbotham et al., 2009)	Barriers and strategies of technology transfer	no
40	Academic inventors as brokers	(Lissoni, 2010)	Academic inventors role in U-I knowledge transfer	no
41	University-industry knowledge interaction: Case studies from Finland and China	(Hong & Olander, 2010)	Formal governance and informal social networking as enabler for UI knowledge interaction	no
42	Industry and academia in convergence: Micro-institutional dimensions of R&D collaboration	(Bjerregaard, 2010)	The impact of different institutional logic between SMEs and universities and the impact on R&D collaboration	no
43	The effect of competitive and non-competitive R&D collaboration on firm innovation	(Huang & Yu, 2011)	Compares the impact of competitive and non-competitive collaboration	no
44	Rotating Leadership and Collaborative innovation: Recombination process in Symbiotic Relationships	(Davis & Eisenhardt, 2011)	Examines success factors of interorganisational collaboration	no
45	Evaluation of design for service innovation curriculum – validation framework and preliminary results	(Kim, 2011)	A scenario-based method to help design teams envisage user needs, organise information and communicate ideas to other stakeholders	yes (partial)
46	Translational science and the hidden research system in university and academic hospitals: a case study	(Lander & Atkinson-Grosjean, 2011)	Boundary spanning individuals and objects as a way to translate between academic and practitioners	yes
47	Patenting and licencing of university research: Promoting innovation or undermining academic values?	(Sterckx, 2011)	Discusses the patenting and licencing policies as a barrier for university mission to provide knowledge to society	no
48	Open innovation and new issues in R&D organization and personnel management	(Petroni et al., 2012)	Impact of open innovation on R&D structures and HR management	no
49	Mapping interactions within the evolving science of science and innovation policy community	(Zoss & Börner, 2012)	Mapping the collaboration networks under the SciSIP program	no
50	Bridging the gap in knowledge transfer between academia and practitioners	(Gera, 2012)	It aims to identify and understand the sources of barriers to academic knowledge creation and transfer	no
51	A quantitative analysis of the effects of a multidisciplinary engineering capstone design course	(Hotaling et al., 2012)	Examines the impact of cross sectorial curriculum on performance and employability of students	no

52	University-industry linkage evolution: an empirical investigation of relational success factors	(Plewa et al., 2013a)	It investigates the impact of relational success factors on U-I performance, taking into account different phases of collaboration process	no
53	The evolution of university-industry linkages - A framework	(Plewa et al., 2013b)	Analyses the success factors in specific phases of UI relationships	no
54	S&T Collaboration Platform for Higher Education Institutions and Industry: a Case Study of Wenzhou, China	(Chen et al., 2013)	Studies the public S&T communication platform as a channel enabling communication between SMEs and universities	no
55	Digital based media design: the innovative contribution of design graduates from vocational and higher education sectors	(Doloswala et al., 2013)	Analyses the capacities of VET and HEI graduates showing their shortcomings on communication/adaptation to industry skills	no
56	Disclosure of university research to third parties: A non-market perspective on an Italian university	(Venditti et al., 2013)	Describes piloting experiences in creating a 'science knowledge bank' for the communication to external partners	yes
57	Engineering students as innovation facilitators of enterprises	(Buser, 2013)	It presents an innovative curriculum combining traditional academic curriculum with problem oriented approaches	no
58	A routine for measuring synergy in university-industry-government relations: mutual information as a Triple-Helix and Quadruple-Helix indicator	(Leydesdorff, Park, & Lengyel, 2014)	Presents software for mapping knowledge in Triple Helix Model	no
59	Mutual redundancies in Interhuman Communication Systems: Steps Toward a Calculus of Processing Meaning	(Leydesdorff & Ivanova, 2014)	Discusses the issues of uncertainty and redundancy in communication	yes
60	The socio-economic role of entrepreneurial universities in development of innovation driven clusters: the Russian case	(Korzhenevskaya, 2014)	It analysis the role of entrepreneurial university in enabling innovative clusters	no
61	Geographic and technological patterns of knowledge spillovers as evidenced by technical universities in CEE countries	(Runiewicz-Wardyn, 2014)	Shows importance of different communication channels depending on specific industry	no
62	A simulation model of the Triple Helix of university-industry-government relations and the decomposition of the redundancy	(Ivanova & Leydesdorff, 2014)	Proposes how to model interaction in a triple helix using mathematical modelling	yes
63	Continuance use intention of enterprise instant messaging: A knowledge management perspective	(Ajjan et al., 2014)	Usage of instant messaging and its impact on knowledge creation, transfer and retention	yes

64	Food policy in cyberspace: A webometric analysis of national food clusters in South Korea	(Kim & Park, 2014)	Analyses communication patterns within online national food cluster	yes
65	The Role of Knowledge Intermediaries in Developing Firm Learning Capabilities	(Parker & Hine, 2014)	Shows a positive impact of intermediaries on learning and communication capacities	no
66	Implementation of quality management in early stages of research and development projects at a university	(Fiehe et al., 2014)	Analysis the impact of quality management on UI knowledge transfer	no
67	Balancing diversity in innovation networks. Trading zones in university-industry R&D collaboration	(Sandberg et al., 2015)	Studies strategies for balancing diversity in UI collaboration	no
68	An effective collaboration model between industry and university based on the theory of self organisation	(Rad et al., 2015)	Discusses a model of UI dynamic relations evolving in time based on systems thinking approach.	no
69	Modernization of curriculum in construction management based on EU funds	(Paslawski, Milwicz, & Nowotarski, 2015)	Discusses projects aiming at adaptation of curriculum to industry needs	no
70	Transferring knowledge: PhD holders employed in Spanish technology centers	(Pablo-Hernando, 2015)	Analysis the knowledge transfer process in technology centres through the employment of PhD holders	no
71	Structural and relational support for innovation – formal versus informal knowledge exchange mechanisms in forest-sector learning	(Bayne et al., 2016)	Focuses on mechanisms to effectively communicate knowledge between university and industry	yes
72	Understanding barriers to decision making in the UK energy-food-water nexus: The added value of interdisciplinary approaches	(Howarth & Monasterolo, 2016)	Analysis factors of communication and collaboration across disciplines	no
73	The power of reciprocal knowledge sharing relationship for startup success.	(Allen et al., 2016)	Analysis the impact of colocation and social capital on innovative capacity	no
74	Success factors in university-industry PhD projects	(Salimi et al., 2016)	The effects of project management, communication, and supervision characteristics on the success U-I PhD projects	no
75	Integration between industry and university: Case study	(Alshehri et al., 2016)	Studies measures for establishing UI collaboration	no
76	Relational capabilities to leverage new knowledge	(Martins, 2016)	Importance of relational capabilities for regional development	no
77	Knowledge transfer capacity of universities and knowledge transfer success: evidence from university - industry collaborations in China	(Ju et al., 2016)	Analysis the elements of knowledge transfer and its factors	no

78	Principal researcher and project manager: who should drive R&D projects?	(Cassanelli et al., 2017)	Analysing project management at universities	no
79	A university – industry cooperation model for small and medium enterprises	(Peng et al. 2017)	U-I cooperation model for SMEs	no
80	Transparent collaboration between industry and academia can serve unmet patient need and contribute to reproductive public health	(D'Hooghe, 2017)	Defines the need for transparency in U-I collaboration allowing avoiding conflicts of interests and bias accusations	no
81	An evolution System for University Industry Partnership Sustainability	(Kaklauskas et al., 2018)	System for evaluation of U-I collaboration sustainability	no
82	Preconditions for successful knowledge creation in the context of academic innovation projects	(Vick & Nagano, 2018)	Factors of knowledge creation	no
83	Direct associations of the terminology of knowledge transfer - differences between the social sciences and humanities and other disciplines	(Hayden et al., 2018)	Discusses understanding of knowledge-transfer and 3rd mission of universities across academics from different academic fields	no
84	Knowledge and innovation in the Lebanese software industry	(Hassen 2018)	Based on a study of Lebanese software industry discusses how different types of proximity can affect cross-organisational interactions	no
85	Revisiting "the shotgun wedding of industry and academia" - empirical evidence from Finland	(Suomi et al. 2019)	Discuss university dilemmas related with 3rd mission of universities and university marketing aiming at surrounding society	yes (partially)
86	Culturing Atmosphere for Spontaneous Innovation: Academic Action and Triple-Helix Dynamics in South Korea	(Kim and Jang, 2019)	Impact of leadership and communication on innovative atmosphere and its relation with governmental policies.	yes (partially)
87	The emergence of neuromarketing investigated though online public communications	(Levallois et al., 2019)	Discusses creation of new academic research field and industry as a result of exposing researchers to industrial innovation and flow of knowledge and information between university and industry	no
88	Knowledge transfer in university-industry research partnerships: a review	(Vries et al., 2019)	Reviews barriers and practicies supporting academic engagement	no

Table 2.5 Systematisation of communication channels discussed in the body of literature (a – communication channels; b – mechanisms)

	Communication channels																								
	Publishing and printed media				ICT mediated channels										Face to face personal interactions										
																		Feedback mechanisms							
																				exhibitions					
	Scientific literature and patents	Grey literature	Commercial and industry journals	Mailing	Media briefings	Video and imaging technology	Phone	Instant messaging	Online publications - blogs, web publications etc.	Collaborative integrated platforms	Online meetings	university or external communication platforms	chats and forums	resource allocation features - file sharing systems	conferences and seminars	consulting	meetings	Committees and advisory boards	Round tables	prototypes presentations	demonstration of research	demonstration of capabilities	community engagement	informal personal contacts and social networks
(Höglund & Persson, 1987)	x														x			x						
(Yuthavong et al., 1993)	x	x	x	x											x	x	x			x				x
(Christiansson, 1993)					x	x	x				x													
(Bacon et al., 1994)																	x							
(Graham, 1996)						x																		
(Macleod et al., 1997)																x							x	
(Porter, 1998)															x									
(Leydesdorff & Etzkowitz, 1998)																	x							
(Pendergast & Hayne, 1999)						x				x	x			x										
(Fujigaki & Leydesdorff, 2000)	x	x																						
(Efferth, 2000)												x												
(Kodama, 2002)						x																		x
(Santoro & Saparito, 2003)							x																	x
(Treadaway, 2004)						x																		

(Chakrabarti & Santoro, 2004)															x	x		x							x
(Lan, 2004)													x	x											
(Butcher & Jeffrey, 2005),	x																x								
(Shinn, 2005)	x	x	x													x									
(Marques et al., 2006)																									x
(Teubner, 2007).	x																								
(Neumann & Prusak, 2007)						x			x			x	x	x											
(Sherwood & Covin, 2008)							x				x						x	x							x
(Salem & Amjed, 2008)																									x
(Lockett et al., 2008)																									x
(Welsh et al., 2008)																x									
(Ranga et al., 2008)																		x	x						
(Papagiannidis et al., 2009)												x													
(Harris, 2009)														x											x
(Higginbotham et al., 2009)	X														x	x					x				
(Lissoni, 2010)																x									
(Hong & Olander, 2010)															x		x			x	x				x
(Bjerregaard, 2010)			x																						x
(Kim, 2011)																	x								
(Lander & Atkinson-Grosjean, 2011)	x																								
(Sterckx, 2011)	x														x										
(Gera, 2012)	x	x															x	x			x				x
(Carolin Plewa, Korff, Baaken, et al., 2013)																									x
(Carolin Plewa, Korff, Johnson, et al., 2013)							x					x			x		x								x
(Chen et al., 2013)												x													
(Doloswala et al.,												x													

2013)																								
(Venditti et al., 2013)	x																							
(Buser, 2013)																	x							
(Korzhenevskaya, 2014)					x										x	x	x		x	x				
(Runiewicz-Wardyn, 2014)	x																							x
(Ajjan et al., 2014)							x	X																
(J. H. Kim & Park, 2014)									x															
(Parker & Hine, 2014)												x												
(Fiehe et al., 2014)														x			x							x
(Sandberg et al., 2015)															x		x			x	x			
(Rad et al., 2015)																x								x
(Paslawski et al., 2015)						x					x													
(Pablo-Hernando, 2015)	x																							x
(Bayne et al., 2016)		x					x								x		x	x			x	x		x
(Howarth & Monasterolo, 2016)									x															
(Allen et al., 2016)																								x
(Salimi et al., 2016)	x														x	x	x							
(Alshehri et al., 2016)	x																	x						x
(Martins, 2016)																								x
(Ju et al., 2016)													x		x									x
(Cassanelli et al., 2017)	x																							
(D'Hooghe, 2017)	x														x	x	x	x						
(Kaklauskas et al., 2018)															x	x		x						
(Vick & Nagano, 2018)																								x
(Hayden et al., 2018)	x		x		x										x	x				x				
(Hassen 2018)															x		x			x				
(Suomi et al. 2019)	x		x		x				x						x			x		x		x		

(Kim and Jang, 2019)																x									x
(Levallois et al., 2019)	x	x	x		x				x									x		x					
(Vries et al., 2019)	x	x					x									x	x			x	x	x			x

	Mechanisms																								
			job mobility/ double socialisation														Language adaptation								
			industry to universities			universities to industry																			
Authors	communication strategy	Contracts and formal agreements	research managers	students mentoring	teachers from industry	graduates	students projects in industry	studentships	PhDs - scientists and entrepreneurs	Personnel exchange/ placement	Governance mechanisms	Scientification of industry/ publications	University investment in industry	Training/ workshops	Site visits/ information days	Market monitoring	scenarios	Terminology policies/directories	skills development - workshops training	Simple representations - image, graphics	practical recommendations	boundary individuals	boundary objects/procedures
(Höglund & Persson, 1987)			x																				
(Yuthavong et al., 1993)						x	x	x					x		x								
(Bacon et al., 1994)																							x
(SHEEN & MACBRYDE, 1995)			x																				
(Graham, 1996)																				x			
(Macleod et al., 1997)													x										
(Porter, 1998)															x								
(Frantz, 1998)					x																		
(Pendergast & Hayne, 1999)																							x
(Fujigaki & Leydesdorff, 2000)			x														x						
(Kodama, 2002)																				x			x
(Chakrabarti & Santoro, 2004)						x	x	x		x		x		x									
(Butcher & Jeffrey, 2005),		x						x		x													
(Shinn, 2005)										x				x						x			x
(Teubner, 2007).																					x		
(Neumann & Prusak, 2007)																		x					x
(Sherwood & Covin, 2008)		x													x								
(Salem & Amjed, 2008)		x						x															

(van den Berghe & Guild, 2008)		x																					
(Lockett et al., 2008)							x																
(Ranga et al., 2008)	x				x									x	x								
(Harris, 2009)				x																			
(Higginbotham et al., 2009)		x																					
(Lissoni, 2010)		x																					
(Bjerregaard, 2010)			x						x	x	x	x											x
(Davis & Eisenhardt, 2011)		x									x											x	
(Petroni et al., 2012)		x												x					x				
(Kim, 2011)																	x			x			
(Lander & Atkinson-Grosjean, 2011)																						x	x
(Sterckx, 2011)		x																					
(Gera, 2012)				x						x													
(Hotaling et al., 2012)							x																
(Plewa et al., 2013a)		x																					
(Plewa et al., 2013b)		x									x			x					x				
(Chen et al., 2013)	x								x		x												
(Doloswala et al., 2013)						x	x	x															
(Buser, 2013)				x				x						x	x								
(Runiewicz-Wardyn, 2014)														x									
(J. H. Kim & Park, 2014)	x																						
(Parker & Hine, 2014)		x				x			x	x									x				
(Fiehe et al., 2014)	x	x																x					
(Sandberg et al., 2015)	x													x	x							x	x
(Rad et al., 2015)		x																					
(Paslawski et al., 2015)							x	x							x								
(Pablo-Hernando, 2015)							x		x			x							x				
(Bayne et al., 2016)	x	x												x	x							x	
(Allen et al., 2016)									x														
(Salimi et al., 2016)		x					x																
(Alshehri et al., 2016)		x					x	x		x				x	x								x
(Martins, 2016)					x									x									
(Ju et al., 2016)				x						x													
(Cassanelli et al., 2017)									x			x											
(Peng et al., 2018)	x	x																					
(Kaklauskas et al., 2018)		x		x	x	x		x						x	x								

(Vick & Nagano, 2018)																						x		
(Hayden et al., 2018)						x								x	x		x							
(Hassen 2018)						x								x										
(Suomi et al. 2019)	x				x	x			x	x	x			x					x					
(Kim and Jang, 2019)		x									x													
(Levallois et al., 2019)																								
(Vries et al., 2019)						x					x			x								x	x	

Chapter 3

The bilateral relation between university – industry communication and government - does development level matter?

3.1. Introduction

While the level of innovation is a result of innovation generated within the academic and industrial sector, the strong dependence of both from the national and regional innovation systems is commonly recognised. Among others, the Triple Helix Model postulates the need for engagement of academic, industrial and governmental stakeholders for effective innovation (Etzkowitz & Leydesdorff, 2000). In that scope, literature recognises the possible impact of government on university-industry (U-I) communication. The postulated impact through assistance programs for industry oriented research, matching services or support infrastructures may significantly decrease U-I communication barriers, positively influence collaborative innovation and allow creation of integrated communities (Ranga et al., 2008; Chen et al., 2013; Runiewicz-Wardyn, 2014) .

The recognition for the role of government to create proper environment for innovation, including U-I open innovation is common. That encourages governments across the globe to invest significant resources in R&D projects, transfer funds, umbrella organisations or collaborative platforms (Cooke, 2002; Peng et al., 2017). Common governmental measures used to encourage U-I communication take form of science and technology parks and funds for collaborative R&D projects. Successful models are often transferred between regions. However, some authors argue that transfer of governmental measures from developed to developing countries is not the most effective solution (Lee & Yoo, 2007; Salem & Amjed, 2008). Ineffectiveness of such investments was associated in the literature with different needs of economic environment, culture, knowledge and lack of properly developed national innovation system (NIS) that could facilitate capitalisation on the invested resource (Macleod et al., 1997; Salem & Amjed, 2008; Sandberg et al., 2015; Kim & Jang, 2019). From the other side in less developed countries the role of participation of universities in the community

economic regeneration was postulated to be especially high (Macleod et al., 1997; Rad et al., 2015).

Despite the fact that literature in the scope of U-I communication postulates differences in effectiveness of specific governmental measures between regions with different development level and their possible impact on economic growth (Al-Agtash & Al-Fahoum, 2008; Rad et al., 2015; Kim & Jang, 2019), no empirical study was identified in the literature testing such a research hypothesis. To fill this gap in the literature our study tests whether the U-I communication effect on economic development differs depending on a country development level and whether enabling character of policies and mechanisms on U-I communication differs between countries at different development level. Our quantitative analysis suggests that up till now U-I communication is lacking critical mass to generate significant positive effect on economic development. Therefore, more effective and specifically adapted to economic conditions measures are needed to stimulate effective U-I communication for innovation. Our results show that while quality of research institutions and private R&D investments are relevant at all development levels and staff training is of relevance at lower development levels, significant differences exist not only in the influence of specific measures, but also in which measures are relevant for U-I communication depending on development level.

The introductory section is followed by Theoretical framework and Methodology sections. In section 4 we present the data analysis process and obtained results which are further discussed in section 5. The chapter is finalised with conclusions summarising key takeaways, study limitations and further research directions.

3.2. Theoretical framework

Together with increasing complexity of innovation and strong shift of global economy toward knowledge-based competition, the role of U-I communication increases not only for competitiveness of organisations. Its level and quality is commonly suggested to impact economic development of regions and nations, as well as to impact life quality of all by influencing the pool of available innovation and the quality of information and knowledge available (Howarth & Monasterolo, 2016). Governments across the globe, in recognition of the relevance of U-I communication for competitiveness of their economies, implement support for U-I communication in their strategies. Common government policies take forms of (Alshehri et al., 2016; Peng et al., 2017):

- Schemes and incentives to support to U-I communication;
- U-I relations enabling legal frameworks;

- Establishment of research centers or service providers for facilitation to U-I communication;

- Providing support for clusters, science and technology parks (STPs), innovation centers and business incubators infrastructures.

Furthermore, some countries made U-I communication a strategic priority, i.e. China which already in 1994 called all universities and research centres to prioritise services to industry, in 2005 made U-I cooperation a national strategy (Peng et al., 2017). Despite the common recognition to the U-I communication importance, the current body of literature suggests that the progress in the level and quality of U-I communication in the scope of innovation is limited and the progress is unsatisfactory on a global scale, including countries with a strong focus on the specific policies (Rad et al., 2015; Peng et al., 2017). That can raise some doubts related with the significance of governmental engagement, proper application of current measures, as well as suggests the need for better understanding of the existing models and their impact.

The role of government in U-I communication

Current body of literature postulates far reaching benefits of U-I communication for economies. Literature links U-I communication and knowledge transfer with national prosperity and intellectual capital (Salem & Amjed, 2008). It is suggested to positively impact economic growth through direct impact on its competitiveness, as well as in indirect way, by improving efficiency of resources exploitation and increasing innovativeness and capabilities of industry.

Due to a broad number of barriers, U-I communication is however commonly obstructed (Gera, 2012). While the need for triple helix collaboration is commonly recognised, authors differ in their recognition for the level of governmental impact on the U-I communication level and quality. Some authors accredit to government the mission of fostering and coordinating U-I relations (Lee and Yoo, 2007; Rad et al., 2015). Others postulate governments' supportive character related with its coordination of national innovation system and suggest that the U-I communication should be facilitated intrinsically due to, among others, little awareness of governmental agencies of the needs within business environment (Langford et al., 1997; Etzkowitz & Leydesdorff, 2000; Lee & Yoo, 2007; Suomi et al., 2019).

Unfortunately, despite common application of policy measures aiming at support of U-I communication across the globe, specific dynamics in the scope of Triple Helix Model are poorly theorized and clear guidance for decision-makers are lacking (Sandberg et al., 2015; Kim & Jang, 2019). The literature is however consistent that government may have enabling role for U-I communication. Authors especially point the political will to improve U-I

collaborative environment and intelligent strategies, frameworks and mechanisms as key success factors to enhance U-I communication in the scope of innovation (Al-Agtash & Al-Fahoum, 2008; Sandberg et al., 2015; Rad et al., 2015). The government effort in bridging U-I communication can significantly moderate U-I communication gap by, from one side, political encouragement for companies (Al-Agtash & Al-Fahoum, 2008) and, from the other, impacting university policies and providing external incentives for universities to engage in U-I communication in the scope of innovation (Welsch et al., 2008; Rad et al., 2015). Maximising public benefits from knowledge by enhancing U-I communication will require creation of strongly articulated and clearly defined policies protecting intellectual property and companies trade secrets from one side, and the autonomy and freedom of operation and communication of university scientists on the other (Welsch et al., 2008; Sandberg et al., 2015; Alshehri et al., 2016). Policies should cultivate a harmonious environment fostering communication and open innovation between various entities (Alshehri et al., 2016; Peng et al., 2017). In that scope, government should aim to bridge the organisational barriers and make U-I relationships a win-win situation.

While the government strong mandate to bridge U-I incentives discrepancies is commonly recognised, the efforts are challenged by the culture, goals and knowledge gaps (Sandberg et al., 2015; Kim & Jang, 2019). Furthermore, additional challenge of retaining the wealth from knowledge locally comes together with globalisation, when regions and nations need to create organisational framework that will allow agents to be both local and global players (Leydesdorff et al., 2014). A clear answer how to overcome the challenges does not rise from the existing body of literature. Empirical studies focused on policy analysis and case studies show that even in similar conditions policies may result in different outcomes. That can be dependant from, among others, market characteristics and differences in industrial context (Lee & Yoo, 2007; Al-Agtash & Al-Fahoum, 2008; Kim & Jang, 2019). One of the most successful cases of policy framework impact on U-I communication is the US biotechnology industry in which decline for public funding for university research together with U-I collaboration promoting legislation pushed universities to actively engage in market activities. That resulted in new techniques and products and increasing economic contribution of the biotechnology sector to US economy (Welsch et al., 2008). However, studies of less developed countries suggest that such measures will not provide similar result. Due to stronger barriers such as capital limitations of industry that do not possess resources to fund industry oriented R&D at universities or lack of sufficient knowledge and absorptive capacity, the expected impact of policy measures is expected to differ (Rad et al., 2015). Authors accredit the key role in stimulating U-I communication, and the industry development itself, to universities, pointing the need for increase of governmental incentives for universities to engage in that mission by rewarding universities for driving and contributing U-I communication and mediate the lack of trust on the side of companies (Yuthavong et al. 1993; MacLead, McFarlane & Davis, 1997; Rad et al., 2015). Among others, commonly highly

limited possibility to obtain financial benefits from U-I knowledge transfer in less developed countries will increase the role of governmental support for the third mission of universities (Rad et al., 2015). Following the argument we hypothesise that:

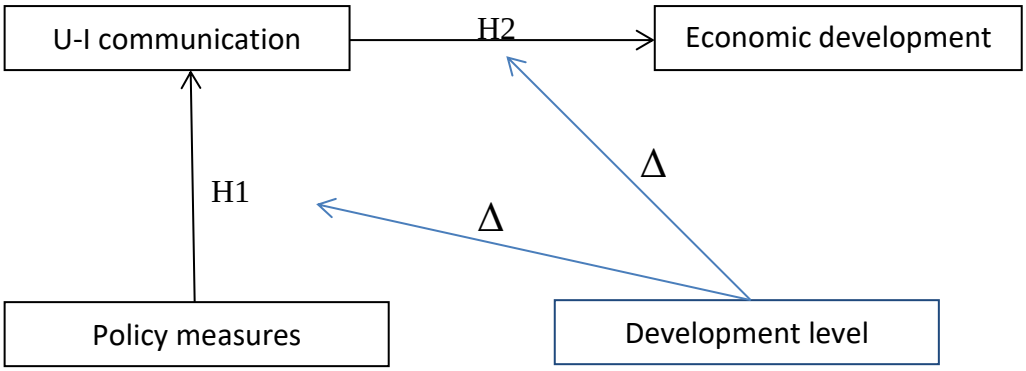
H1 – enabling character of policies and mechanisms on U-I communication differs between countries at different development level.

The existing literature suggests that the developed countries main policy concern related with U-I communication are associated with intellectual property rights, concerns related with researcher conflict of interest and pressure on scientific communication (Welsh et al., 2008; Suomi et al., 2019). Meanwhile, less developed countries in the first place need to overcome the extensive gap in culture and knowledge and the issues related with common concentration of knowledge pool within academia and their pressure on issues such as i.e. IPR are highly limited (MacLead et al., 1997; Rad et al., 2015; Cassanelli et al., 2017). That requires different focus and specific approaches. Among others, addressing lack of support mechanism within institutional environment and especially establishment of effective political and social systems which complexity would enable rather than obstruct interactions between different innovation actors are of the essence (Hassen, 2018; Kim & Jang, 2019). While, some issues such as macro-level pressure on publishing are a universal global problem, countries at different development levels differ in their ability and needs for mechanisms for U-I communication, but as well as in the potential for U-I communication to contribute to provide economic and social impact (MacLead et al., 1997; Kim & Jang, 2019). In a scope of low development level, related with low intensity of knowledge within industry, the egalitarian character of knowledge can result in highly limited size and competitiveness of industries, and therefore of the overall economy (Pablo-Hernando, 2015; Suomi et al., 2019). Especially with the increase in complexity of knowledge and increase of the role of knowledge for competitiveness, the importance of circulating academic knowledge in economic environment and ensure cross-organisational co-production of knowledge increases (Suomi et al., 2019). In such a global market, it suggests that effective engagement of universities with industry and making modern knowledge available and assimilated by industry may in that scope have stronger impact on stimulating development of companies and economy and that evolution of economic systems requires specific adjustments in governance (Petroni et al., 2011; Martins, 2016). Such postulated differences are strongly in line with well-established theory of stages of development, according to which economic competitiveness and economic growth is driven by different factors at different level of development (Rostow, 1962). The effect can be obtained by transfer of knowledge, encouraging entrepreneurship or providing university resources to industry. As hypothesis regarding such differences were not previously analysed in a comparative scope, our study aims at testing that proposition:

H2 – the U-I communication will stronger stimulate economic growth in less developed countries.

Therefore, our research model aims at verifying in the first place whether U-I communication can provide stronger stimuli to the economic growth in less developing countries and whether the potential of specific policy related factors and measures to stimulate U-I communication differs in countries at different stages of development (see Figure 3.1).

Figure 3.1. Research model



3.3. Methodology

To reach the research objectives, we aimed at verifying the postulated hypothesis based on multivariate regression models of 1/ economic growth (H2) and 2/ U-I communication at a macro level (H1). For the purpose of analysis of the postulated causal relation between U-I communication and economic growth, following the existing literature, the proposed model of economic growth proxied by growth of Gross Domestic Product per capita (Simionescu et al., 2017) was a function of bilateral U-I communication which was proxied by its structured form of U-I collaboration (Plewa et al., 2013a; Ambroziak et al., 2016; Simionescu et al., 2017); Financial variables including inflation proxied by Customer price index (CPI) (Fischer, 1993; Simionescu et al., 2017) trade balance and Inwards foreign direct investments (FDI) (Alfaro et al., 2004; Gonzalez-Pernia & Pena-Legazkue, 2015); Entrepreneurship variables – Relative Prevalence (Valliere and Peterson, 2009), Established Business Ownership Rate (EBO) (Gonzalez-Pernia & Pena-Legazkue, 2015), Nascent Entrepreneurship Rate (van Stel et al., 2005), New Business Ownership Rate (van Stel et al., 2005) and innovation variables represented by Patent numbers (Gonzalez-Pernia and Pena-Legazkue, 2015) and R&D expenditures as % of GDP (R&D) (Gonzalez-Pernia and Pena-Legazkue, 2015; Wong et al., 2005). The established data base was based on the World Bank and Global Innovation Index (GII) data sets.

In case of the U-I communication model the perceived U-I communication proxied by U-I collaboration was expected to be dependant from policies related with i/ the pool of knowledge, skills and absorptive capacity of stakeholders (Susana Pablo-Hernando, 2015;

Martins, 2016; Suomi et al., 2019) reflecting in Quality of the education system, Tertiary education enrolment rate and Extent of staff training; ii/ the standards and culture within business environment (Yuthavong et al., 1993; Levallois et al. 2019; Vries et al., 2019) proxied by Business sophistication; iii/ financial capacity of industry to contribute to academic R&D (D'Hooghe, 2017; Haynes et al., 2018) represented by Company spending on R&D, Ease of access to loans, Effect of taxation on incentives to invest, Availability of financial services; iv/ accessibility of quality research (D'Hooghe 2017; Kim & Jang, 2019) – Quality of scientific research institutions, Availability of scientists and engineers; v/ existence of innovation system support measures (van den Bergha & Guild, 2008; D'Hooghe, 2017; Hassen, 2018; Kim & Jang, 2019) – Quality of overall infrastructure; Intellectual property protection; Efficiency of legal framework in settling disputes; Efficiency of legal framework in challenging regulations; vi/ the orientation of government toward creating innovation-enabling culture (Kim & Jang, 2019; Suomi et al., 2019) – Transparency of government policymaking; Burden of government regulation. The potential indicators were defined by crossing the existing literature on the topic and the publically available data. Relevant secondary data were identified within Executive Opinion Survey conducted by World Bank for the needs of supporting policy makers, business executives and academics in monitor economic productivity and economies ability to achieve sustained levels of prosperity and growth (The Global Competitiveness Report 2017-2018, p. 333). For systematization of included into the model analysis measures together with their definitions consult Table 3.12 in Appendixes.

Obtained from the World Bank and GII total sample covered 151 countries. Existing data was grouped according to methodology of United Nations into three categories – developed economies, developing economies excluding Least Developed Countries (LDCs) and LDCs (for the sample summary see Table 3.1 in appendixes). Due to limited range of currently available data which did not cover in majority of periods sufficient number of countries, to optimise opportunity for providing valuable conclusions two periods of time following the World Bank data were analysed which provided data coverage at the minimum level of 90% of the total sample, 2014-2015 and 2017-2018.

The data were processed and estimated with use of SPSS 23 and Excel 2010 packages.

3.4. Results

To validate postulated causality between U-I communication and economic growth before regression analysis initial data analysis focused on validating basic relations.

In the first place a plot analysis of the relation between U-I collaboration data and Gross Domestic Product per capita has been conducted. Following the presented in the Figure 3.2 plots, no significant positive relation between the variables was suggested. To validate the

initial observation, correlation coefficients were calculated. Due to lack of observed linear relation, Spearman's correlation was applied. As presented in the Table 3.2, the correlation coefficients confirmed suggested within the plot analysis lack of significant positive correlation between the variables. However, as economic effects are commonly observed in time. To confirm the lack of postulated relation we conducted second analysis. As academic perspective for research period is currently short (2/3 years), we accounted for the possible lagged effect (Suomi et al., 2019). Therefore, second plot analysis was conducted to analyse the relation between U-I collaboration in 2014-2015 and 2016-2017 gross domestic product per capita growth. Presented in the Figure 3.3 and Table 3.2 results show, that there is also no positive correlation between these variables.

Figure 3.2. Relation between U-I collaboration and Gross Domestic Product per capita Growth

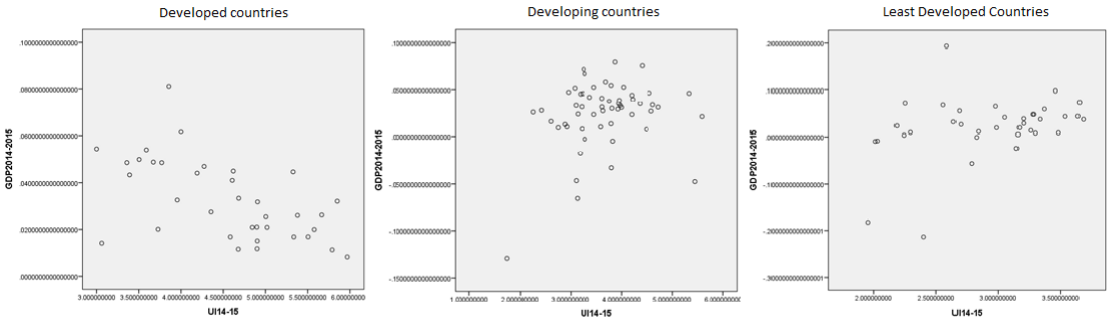


Figure 3.3. Relation between 2014 U-I collaboration and 2016 – 2017 Gross Domestic Product per capita Growth

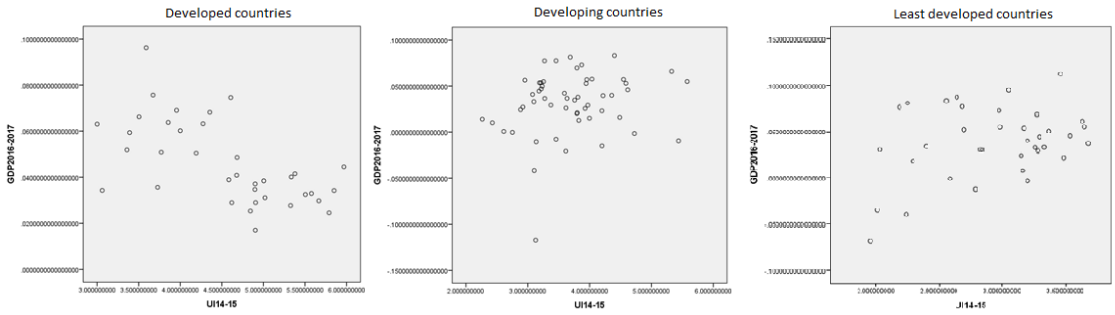


Table 3.2 Correlations between U-I collaboration data and gross domestic product per capita growth.

Correlation				
		Developed	Developing	LDCs
UI 14-15 to GDP 2014-2015	Spearman Correlation Coefficient	-0.588	0.17	0.383
	Sig. (2-tailed)	0.000	0.220	0.021
	N	36	54	36
UI 14-15 to GDP 2016-2017	Spearman Correlation Coefficient	-0.633	0.217	0.205
	Sig. (2-tailed)	0.000	0.116	0.231
	N	36	54	36

Note: significance was assessed at the .005 level

The initial results show that in none of the countries group the U-I communication proxied by the level of U-I collaboration did show significant positive impact on economic growth. The impact of U-I communication was insignificant already at the stage of correlation analysis proving further regressions counterproductive. Therefore, there is no evidence supporting our H2 hypothesis. Despite the postulated importance of U-I communication for economic development and innovativeness of countries the study does not show significant positive impact of U-I communication on economic growth. The effect can be however accredited to strongly limited effective U-I communication which across the globe did not reached the critical mass to obtain the postulated benefits from U-I communication.

From the other side, comparison of the list of top innovators with the list of countries with top U-I communication performance shows that the highest levels of U-I collaboration are not reached only by countries at the highest development levels and innovation leaders. While top innovators among the developed countries such as Switzerland (5.77), Japan (4.74) or USA (5.71) are among top achievers in that category, among others developing and least developed countries such as Kenia (4.3) and Guinea (5.03) (respectively) present higher level of U-I communication than many developed countries (see Figure 3.4).

Figure 3.4. University-industry collaboration in Research & Development, Index 2017 – 2018

Source: The World Bank – https://tcdata360.worldbank.org

Our results related with validation of H2 underline the need for improving the extent and/or quality of U-I communication to realistically generate the postulated in the literature positive impact of U-I communication on economic development. Therefore, following the study design, and the need for policy related research regarding encouraging inter-sphere collaboration (Kim & Jang, 2019), we follow with analyses of the relation between policy-related factors and U-I communication in countries on different development level. In the analysis we focused on the specific elements of innovation system resulting from public measures and overall R&D environment. As presented in the methodology section our analysis covers a broad numbers of variables as expected predictor variables:

E(UI_collaboration) = f(transparency of policymaking, Availability of scientists and engineers, Availability of financial services, Burden of government regulation, Business Sophistication, Company spending on Research & Development, Ease of access to loans, Effect of taxation on incentives to invest, Efficiency of legal framework in challenging regulations, Efficiency of legal framework in settling disputes, Extent of staff training, Intellectual property protection, Quality of overall infrastructure, Quality of scientific research institutions, Quality of the education system, Tertiary education enrolment)

While we were interested in identifying most relevant predictors of U-I communication for each of the countries groups, due to the big number of potential factors a stepwise procedure was used to obtain optimal match of the model with identification of critical success factors for U-I communication within the countries groups.

Resulting from the stepwise procedure multiple regression of the model within the group of developed countries (covering in the data set 37 countries (see Table 3.1 in Appendixes) identified three significant for the U-I collaboration factors: the quality of research institutions (2014-2015: Bi=.727; 2017-2018: Bi=.452), private R&D investments (2014-2015: Bi=.137; 2017-2018: Bi=.477) and bureaucratic burden (2014-2015: Bi=.259; 2017-2018: Bi=.205) as predictors of U-I communication (see Table 3.3, full output is attached in the Appendixes section).

Table 3.3. Models of U-I communication in developed countries

		Included variables			
Model1 2014-2015	Adj. R Square 0.942	Constant	**Quality of research institutions**	**Bureaucratic burden**	**Private R&D investments**
	Coefficients (B)	-0.513	0.727	0.259	0.137
	Significance [t(sig)]	-2.048 (.049)	9.969 (.000)	4.711 (.000)	2.220(.034)
Model2 2017-2018	Adj. R Square 0.948	Constant	**Private R&D investments**	**Quality of research institutions**	**Bureaucratic burden**
	Coefficients (B)	-0.787	0.477	0.452	0.205
	Significance [t(sig)]	-2.746 (.011)	4.932 (.000)	4.077 (.000)	2.668 (.013)

Note. Final models of U-I communication verified under the .05 confidence level condition

While the importance of the factors was confirmed in both analysed periods, the results from period 2014-2015 suggested stronger impact of research institutions quality over private R&D investments, while the 2017-2018 results show the primary role of the private R&D investments for U-I collaboration within the developed countries group.

For the group of the developing countries covering in the period 2014-2015 data for 55 countries (see table 3.1 in Appendixes), the stepwise procedure resulted in the complex model including eight independent variables as factors influencing U-I communication (see Table 3.4; for full output see Table 3.7 in Appendixes). The estimation results shown high significant and positive impact of Quality of research institutions (B1=.498), private R&D investments (B2=.486) and staff training (B3=.251) on U-I communication. Transparency of policy making (B4=.480) and ease of access to loans (B5=.140) also show positive and significant impact on improving U-I communication. Meanwhile, bureaucratic burden (B6=-.256) and education quality (B7=-.108) were associated with negative impact on U-I communication.

Table 3.4. Initial model of U-I communication in developing countries (without LDCs) 2014-2015

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
8	(Constant)	-.602	.225		-2.674	.011
	ResInstQ14-15	.498	.083	.520	5.986	.000
	PRVR&D14-15	.486	.102	.447	4.751	.000
	StafTR14-15	.251	.086	.186	2.906	.006
	EducQ14-15	-.108	.055	-.129	-1.957	.058
	LoanAc14-15	.140	.064	.155	2.199	.034
	SetDisp14-15	-.330	.073	-.378	-4.488	.000
	Tranp14-15	.480	.111	.464	4.334	.000
	BurecrBurd14-15	-.256	.105	-.242	-2.431	.020

While the negative impact of bureaucratic burden is generally supported by the literature on U-I communication barriers (Plewa et al., 2013b) and general understanding, the negative relation between the quality of education and U-I communication is not often recognised. Especially the opposite impact to Quality of research institution and education quality can raise doubts regarding the model. However, the negative relation, especially in the specific country group may suggest that with the increased quality of education the private sector have higher innovation capacity and the dependence from universities in providing innovation decreases.

To ensure that the study will generate a quality contribution we carefully re-examined the theory and procedures. The significance of each independent variable shown that the Quality of education does not meet the criterion of 0.05 confidence level (see Table 3.4). Taking into account the objective to identify the crucial success factors for U-I communication in the context of Triple Helix Model, as no strong theoretical reasons to keep the variable in the model was identified in the literature, a decision to exclude the variable from the list and conducting second regression with stepwise procedure on the limited variables list has been taken (Welfe, 2008). The adjusted procedure resulted in a model limited to 3 significant independent variables with the strongest impact on the U-I communication. The model 3 presented in the table 3.5 (for full output see Table 3.8 in Appendixes) shows strong positive impact of Quality of research institutions (B1=.451), private R&D investments (B2=.358) and staff training (B3=.293) on U-I communication in developing countries excluding the LDCs.

Table 3.5. Models of U-I communication in developing countries (with exclusion of LDCs)

		Included variables			
Model3 2014-2015	Adj. R Square 0.892	Constant	**Quality of research institutions**	**Private R&D investments**	**Staff Training**
	Coefficients (B)	-0.361	0.451	0.358	0.293
	Significance [t(sig)]	-1.317 (.195)	5.076 (.000)	3.233 (.002)	2.838 (.007)
Model4 2017-2018	Adj. R Square 0.916	Constant	**Private R&D investments**	**Quality of research institutions**	**Easiness of access to loans**
	Coefficients (B)	-0.323	0.631	0.254	0.184
	Significance [t(sig)]	-1.508 (.139)	8.408 (.000)	3.781 (.000)	3.635 (.001)

Note. Final models of U-I communication obtained under the .05 confidence level condition

Table 3.6. Models of U-I communication in LDCs

		Included variables			
Model5 2014-2015	Adj. R Square 0.795	Constant	**Quality of research institutions**		
	Coefficients (B)	0.565	0.811		
	Significance [t(sig)]	2.634 (.013)	11.173 (.000)		
Model6 2017-2018	Adj. R Square 0.835	Constant	**Private R&D investments**	**Staff training**	**Bureaucratic burden**
	Coefficients (B)	-0.864	0.938	0.583	-0.256
	Significance [t(sig)]	-2.093 (.048)	5.987 (.000)	4.117 (.000)	-2.268 (.033)

Note. Final models of U-I communication verified under the .05 confidence level condition

To reach final conclusions regarding the establish hypothesis, all 6 models verified under the under the condition of 0.05 confidence level has been a subject of comparative analysis. The comparison of results of conducted regressions (see Table 3.7) and their analyses show that the different development levels are not only related with different level of policy measures impact, but that different policies are of relevance for U-I communication in countries at different level of development, supporting the H1: enabling character of policies and mechanisms on U-I communication differs between countries at different development level.

Due to the lack of significant positive impact of U-I communication on economic growth in none of the defined groups of the countries there is no base for conclusive validation of H2: the U-I communication will stronger stimulate economic growth in less developed countries. Hence, there is no evidence that the U-I communication will have stronger impact on economic growth in less developed countries.

Table 3.7. Models of U-I communication – summary

Model	Period	Adj. R Square	Included variables			
1	2014-2015	Adj. R Square 0.942	Constant	Quality of research institutions	Bureaucratic burden	Private R&D investments
		Coefficients (B)	-0.513	0.727	0.259	0.137
		Significance [t(sig)]	-2.048 (.049)	9.969 (.000)	4.711 (.000)	2.220(.034)
2	2017-2018	Adj. R Square 0.948	Constant	Private R&D investments	Quality of research institutions	Bureaucratic burden
		Coefficients (B)	-0.787	0.477	0.452	0.205
		Significance [t(sig)]	-2.746 (.011)	4.932 (.000)	4.077 (.000)	2.668 (.013)
3	2014-2015	Adj. R Square 0.892	Constant	Quality of research institutions	Private R&D investments	Staff Training
		Coefficients (B)	-0.361	0.451	0.358	0.293
		Significance [t(sig)]	-1.317 (.195)	5.076 (.000)	3.233 (.002)	2.838 (.007)
4	2017-2018	Adj. R Square 0.916	Constant	Private R&D investments	Quality of research institutions	Easiness of access to loans
		Coefficients (B)	-0.323	0.631	0.254	0.184
		Significance [t(sig)]	-1.508 (.139)	8.408 (.000)	3.781 (.000)	3.635 (.001)
5	2014-2015	Adj. R Square 0.795	Constant	Quality of research institutions		
		Coefficients (B)	0.565	0.811		
		Significance [t(sig)]	2.634 (.013)	11.173 (.000)		
6	2017-2018	Adj. R Square 0.835	Constant	Private R&D investments	Staff training	Bureaucratic burden
		Coefficients (B)	-0.864	0.938	0.583	-0.256
		Significance [t(sig)]	-2.093 (.048)	5.987 (.000)	4.117 (.000)	-2.268 (.033)

Note. Final models of U-I communication obtained under the .05 confidence level condition

3.5. Discussion of results

Following theoretical framework and established objectives our research model postulated that there are significant differences in the positive influence of U-I communication on economic growth in countries at different development level (H2), and that enabling character of policy measures in countries at different development level differs (H1).

Against expectations, our data analysis suggests however that there is no significant positive impact of U-I communication on economic development on macro level at any of the development levels. Therefore, there is no evidence that H2 – the U-I communication will stronger stimulate economic growth in less developed countries. While literature broadly suggests relevant impact of U-I communication on economic growth (MacLead et al., 1997; Al-Agtash & Al-Fahoum, 2008; van den Bergha & Guild, 2008; Sandberg et al., 2015), the effect was not confirmed. That implies that countries at all levels of development struggle with reaching significant level and quality of U-I communication that would effectively translate into economic development. Our results suggest that at the moment the level of U-I communication is not significant enough to have a global impact on economic development, neither in developed nor developing or least developed countries. The results empirically confirm that the common in academic literature assumption that progress in the level and quality of U-I communication in the scope of innovation is, up till now, insignificant and that the U-I communication progress is unsatisfactory on a global scale - including countries with a strong focus on specific U-I communication related policies (Rad et al., 2015; Peng et al. 2017; Suomi et al. 2019). That underlines the global scope of the issue of encouraging objective oriented U-I communication in the area of innovation. It reflects the postulated need for better methodology for encouraging and supporting U-I communication that would lead to more optimal capitalisation on knowledge resources within NIS (Hassen, 2018; Kim & Jang, 2019).

Further data analysis allowed however to positively validate H1 postulating that enabling character of policies and mechanisms on U-I communication differs between countries at different development level. Our analysis of policy related indicators impact on U-I collaboration empirically shows different impact of policy related factors on U-I communication in countries at different development level (see Table 3.7). Our results suggest critical role of quality of research institutions and private R&D investment in developed countries. Therefore, in developed countries, to obtain significant for economic growth and innovativeness level of U-I communication in the scope of innovation universities need to generate high quality research as well as ensure its positive perception by external agents. From the other side the private industry needs to provide financial compensation for universities for devoting their attention to research commercialisation. The results goes however against the postulated by Vries et al. (2019) thesis that for establishment of U-I

knowledge transfer applicability rather than quality is of the essence. However, there are in line with the literature suggesting that as biotechnology and ICT are the fields with possible access to unlimited private R&D funds, those fields present the best performance in the scope of U-I communication for innovation. But those are also the fields that academic engagement is considered of the highest market value (D'Hooghe 2017; Hayden et al. 2018). That suggests that in developed countries with high level of private R&D investments such measures as cut in public financing for academic research can be a stimuli for academic engagement in U-I communication and increased focus on quality research standards. D'Hooghe (2017) shows based on the example of reproductive medicine that success of U-I collaborative research in 'non-headline' research areas which are lacking access to public finance is leading to effective U-I communication for innovation. However, to obtain positive results innovation system should embrace collaborative culture, including academic standards recognising value of such engagement for academic career advancement and decreasing pressure on publications in academic journals (Kim & Jang, 2019; Suomi et al., 2019). Further a better and more transparent to the public system for evaluation of quality of research institutions could contribute to increase interest of industrial partners in academic research. From the other side policies favouring financial engagement of private R&D fund into academic research could further encourage industrial engagement. The results show a positive impact of bureaucratic burden in developed countries. While bureaucratic burden is not commonly associated with positive impact, the study suggests that a well-designed administrative mechanisms with strong portfolio of effective innovation policies within NIS may have enabling character for U-I communication in innovation area (Gann et al., 1998; Freitas & Tunzelman 2008; Coccia, 2009). Increase in support measures, including financial support is commonly related with increase of bureaucratic burden. Studies show that bureaucratization related with administrative burden need to be kept at the level necessary for the governance of structures, whereas negative effects are obtained when administrative bureaucratization is generated by increase of administrative staff in comparison with research and operational staff (Coccia, 2009). It shows that it is in a governance role to ensure optimal level of bureaucratization that will support rather than jeopardize the U-I communication. But it also clearly supports the potential for enabling character of policy-measures on U-I communication.

In case of developing countries, similarly to the developed ones, our results show the importance of quality of research institutions and private R&D investments across both analysed periods. Furthermore, the regressions show significance of staff training (2014-2015) and easiness of access to loans (2017-2018). Once again in the second period the role of private R&D investments increased strongly its impact on U-I communication. Together with primary role of private investments in R&D in that specific period rather than quality of research organisations it may suggests that in this case the role of crucial for initiation sphere moved between those two periods from the university to business sphere. That may result

from increasing awareness of private sector of benefits from U-I communication in the scope of innovation and their increasing capacity to benefit from it (Vanhaverbeke, 2017), but it may also be related with specifies of economic cycle, where the lack of financing possibilities in 2014 needed to be more compensated by internal capacities within human resources. That rationale can be suggested by the positive impact of staff training in 2014-2015 which is related to the postulated in the literature absorptive capacity (Martins, 2016; Hassen, 2018), but which in 2017-2018 was replaced in the model by easiness of access to loans which may support the private R&D investments and willingness to take risks.

Also U-I collaboration level within LDCs was in the first period predicted by the quality of research institutions. In fact, in the first period, it was a unique predictor of U-I communication in LDCs. The strong positive impact can suggest the postulated in literature crucial role of research institutions as the engine for U-I communication and engine of knowledge transfer to private sector in LDCs (Macleod et al., 1997) due to lack of proper innovation system in place. In the second analysed period, the U-I communication in LDCs was positively related with private R&D investments and staff training and negative impact of bureaucratic burden. That shows that also in LDCs stimulating private sector oriented policies for increasing private funding for research and innovation and developing absorptive capacity is of the essence. However, public measures need to be well-designed not to create unnecessary bureaucratic barriers commonly discouraging engagement with public sector research institutions (Kim & Jang, 2019).

Our results suggest that at the moment the level of U-I communication is not significant enough to have a global impact on economic development. That empirically shows that there is strong demand for better understanding of tools and strategies to encourage and facilitate U-I communication for innovation to be able to obtain its postulated benefits for economy and society. Our study shows different impact of policy related factors on U-I communication in countries at different development level. That confirms postulated by some authors need for strategies adapted to needs of different regions, rather than transfer of best practices from most developed countries (Salem and Amjed, 2008). However, a number of policy measures was suggested to be of transversal importance.

U-I communication was especially positively influenced by the quality of research institutions and private R&D investments. It underlines the need for creating efficient strategies to increase the research institutions quality and incentives for private R&D investments to reach a level of U-I communication that could significantly impact the innovativeness and economic development at macro level. Interestingly, in all of the country groups, private R&D investments had major impact on U-I communication in 2017-2018, while its significance was lower or none in the period of 2014-2015. In the initial study period, the quality of research institutions was the major (or in case of LDCs the only) significant factor influencing the U-I communication level. That can from one side suggests that in initial stage it is the quality of

research institution that will be the key factor determining whether the U-I communication in the scope of innovation will take place. It can either be an effect of recognised by industry university competencies and reputation (as the results from the developed and developing countries (with exclusion of LDCs) could suggest). However, it can also be a result of a key role of university as an engine to establish U-I communication. That may be especially suggested by lack of significance of private sector factors in the LDCs in the initial period.

The increased role of industry factor in the second period may suggest that with time it is industry that is more engaged in fostering U-I communication in the scope of innovation. That could possibly result from better understanding of industry benefits from knowledge transfer or dropping barriers to U-I communication as it matures on a national scale. From the other side, the result can also be related with an impact of economic cycle and changing restrictions on access to financing. As the postulated reasons are not clear, the cause of this shift should be further examined.

From the other side, if the shift is related with the economic cycle, the results could suggest the substitutive character of the quality of research institutions and private R&D investments. Therefore, that could imply that not only in less developed countries the role of research institutions for driving U-I communication is higher and can drive economic regeneration (Macleod et al., 1997; Rad et al., 2015). But also that when the access to financing for private sector is more difficult, encouraging research institutions to more proactively engage in innovation oriented communication with industry can be a relevant policy to decrease negative impact of economic recession on the national economy.

Furthermore, the opposite impact of bureaucratic burden in the developed and least developed countries shows that it is not only the type of measures that is implemented, but also the governance that will decide on their impact on U-I communication level. Based on the results, that should also take into account specific of the economy. Our results support empirically the need for strategies adapted to needs of different regions rather than transfer of best practices from most developed countries, but it also suggests that support measures should consider the current state of the economic cycle.

3.6. Conclusions

Nowadays, economies across the globe look to embrace innovation as a way to economic development, competitiveness and improving citizens' life quality. In this scope, both industry and academia are crucial knowledge partners for governments to generate innovation. To maximise benefits from national resources, taking advantage of synergies between those agents is of high relevance. However, while successful measures of governmental support for U-I communication may encourage transfer and implementation of those practices in different economies, there is scarce evidence related with effectiveness of

those methods in different economic conditions. To contribute to the discussion, the study analysis the relation between U-I communication and economic development and how specific governmental measures may impact U-I communication in countries at different development levels.

Our analysis suggest that at the moment, in economies at any of the development groups, there is no sufficient level and/or quality of U-I communication in the scope of innovation to provide significant positive contribution to economic growth at macro level. Therefore, despite postulated in the literature positive impact of U-I communication for innovation we did not observed such a result. That shows that despite governmental efforts to stimulate U-I communication for innovation the objective has not been reached and more effective strategies are needed. Following, previous literature (Al-Agtash & Al-Fahoum, 2008; Rad et al., 2014) our data analysis confirms the need for solutions customised to different economic characteristics of the regions. Moreover, the results suggest that U-I communication for innovation can be of high importance in the times of economic downturn and may potentially be used for supporting business when access to external financing is more obstructed. Therefore, supporting U-I communication will require intelligent policy making. For that reason better understanding of relation between specific measures and particular characteristics of the economy is required. Our results show that strongly knowledge based approach to policies related with U-I communication and proper governance is needed as their design can result in both, positive and negative impact on U-I communication. While the factors impact differs between groups and periods, quality of research institution and private R&D investments raise as the critical and transversal factors of U-I communication. Therefore, those should be strongly encouraged and promoted. Further, in less developed countries groups, staff training shows relevant role, which suggests the need for public support for adult and vocational education in peripheral and emerging regions to enable U-I communication for innovation.

The study aiming at filling the gap in quantitative research of U-I communication faced a number of limitations. First of all, the topic of U-I communication is commonly limited to studies related to U-I collaboration and knowledge transfer. Therefore, no data exists to our knowledge reflecting unstructured into collaboration U-I communication, therefore our analysis have been limited to U-I collaboration data. Further, the data set we identified does not provide at the moment sufficient coverage of observations in time to make more comparative analysis that could allow comparing whether the shift in U-I communication factors across the time periods is cyclical. Comparative studies in the future including further points in time could contribute to better understanding of the analysed relations. Furthermore, our study is limited to quantitative study of the problem and is just a first step to provide relevant pointers on how to improve policies for support of U-I communication depending on specific socio-economic context. The findings should be further developed and

substantiate by mixed approach or qualitative research aiming at comparative analysis of impact of specific macro-level measures in relation of specific characteristics of economies. Further studies should look to clearly understand how specific structures of NIS, differences in culture, knowledge and resources will specifically impact the effectiveness of particular policy measures in countries at different levels of development and how policy makers in specific situation should structure their measures for fostering U-I communication to optimise benefits from the undertaken investments. Furthermore, our study is limited to the national economy level. As the role of regional context for innovation and policy-making is increasing some effects can be influenced by the high level aggregation. Therefore, studies based on regional level analysis and comparison of results could strongly contribute to better understanding of the analysed policy influence on U-I communication.

3.7. Appendixes

Table 3.1. Sample summary

2014 - 2015		
Developed	Developing without LDC	LDC
Australia	United Arab Emirates	Angola
Austria	Argentina	Armenia
Belgium	Bahrain	Azerbaijan
Bulgaria	Brazil	Burundi
Canada	Barbados	Burkina Faso
Switzerland	Chile	Bangladesh
Cyprus	China	Bolivia
Czech Republic	Cameroon	Bhutan
Germany	Colombia	Botswana
Denmark	Cabo Verde	Ethiopia
Spain	Costa Rica	Guinea
Estonia	Dominican Republic	Gambia, The
Finland	Algeria	Haiti
France	Egypt, Arab Rep.	Kazakhstan
United Kingdom	Gabon	Cambodia
Greece	Ghana	Lesotho
Croatia	Guatemala	Madagascar
Hungary	Guyana	Mali
Ireland	Hong Kong SAR, China	Myanmar
Iceland	Honduras	Mongolia
Israel	Indonesia	Mozambique
Italy	India	Mauritania
Japan	Iran, Islamic Rep.	Malawi
Lithuania	Jamaica	Nepal
Luxembourg	Jordan	Paraguay
Latvia	Kenya	Rwanda

Malta	Korea, Rep.	Senegal
Netherlands	Kuwait	Sierra Leone
Norway	Lebanon	Chad
New Zealand	Libya	Tajikistan
Poland	Sri Lanka	Timor-Leste
Portugal	Morocco	Tanzania
Romania	Mexico	Uganda
Slovak Republic	Mauritius	Yemen, Rep.
Slovenia	Malaysia	Zambia
Sweden	Namibia	Zimbabwe
United States	Nigeria	
	Nicaragua	
	Oman	
	Pakistan	
	Panama	
	Peru	
	Philippines	
	Qatar	
	Saudi Arabia	
	Singapore	
	El Salvador	
	Thailand	
	Trinidad and Tobago	
	Tunisia	
	Turkey	
	Uruguay	
	Venezuela, RB	
	Vietnam	
	South Africa	

2017-2018		
Developed	Developing without LDC	LDC
Australia	United Arab Emirates	Armenia
Austria	Argentina	Azerbaijan
Belgium	Bahrain	Burundi
Bulgaria	Brazil	Benin
Canada	Brunei Darussalam	Bangladesh
Switzerland	Chile	Bhutan
Cyprus	China	Botswana
Czech Republic	Cameroon	Congo, Dem. Rep.
Germany	Colombia	Ethiopia
Denmark	Cabo Verde	Guinea
Spain	Costa Rica	Gambia, The
Estonia	Dominican Republic	Haiti

Finland	Algeria	Kazakhstan
France	Ecuador	Cambodia
United Kingdom	Egypt, Arab Rep.	Liberia
Greece	Ghana	Lesotho
Croatia	Guatemala	Madagascar
Hungary	Hong Kong SAR, China	Mali
Ireland	Honduras	Mongolia
Iceland	Indonesia	Mozambique
Israel	India	Mauritania
Italy	Iran, Islamic Rep.	Malawi
Japan	Jamaica	Nepal
Lithuania	Jordan	Paraguay
Luxembourg	Kenya	Rwanda
Latvia	Korea, Rep.	Senegal
Malta	Kuwait	Sierra Leone
Netherlands	Lebanon	Chad
Norway	Sri Lanka	Tajikistan
New Zealand	Morocco	Tanzania
Poland	Mexico	Uganda
Portugal	Mauritius	Yemen, Rep.
Romania	Malaysia	Zambia
Slovak Republic	Namibia	Zimbabwe
Slovenia	Nigeria	
Sweden	Nicaragua	
United States	Oman	
	Pakistan	
	Panama	
	Peru	
	Philippines	
	Qatar	
	Saudi Arabia	
	Singapore	
	El Salvador	
	Thailand	
	Trinidad and Tobago	
	Tunisia	
	Turkey	
	Uruguay	
	Venezuela, RB	
	Vietnam	
	South Africa	

Table 3.5. Results of stepwise regression of U-I communication for developed countries 2014-2015

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.939[a]	.881	.878	.278174784743	.881	252.635	1	34	.000	
2	.969[b]	.939	.935	.202691554223	.057	31.039	1	33	.000	
3	.973[c]	.947	.942	.191605536017	.008	4.929	1	32	.034	2.477

a. Predictors: (Constant), ResInstQ14-15

b. Predictors: (Constant), ResInstQ14-15, BurecrBurd14-15

c. Predictors: (Constant), ResInstQ14-15, BurecrBurd14-15, PRVR&D14-15

d. Dependent Variable: UI14-15

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-.273	.311		-.878	.386	-.904	.359
	ResInstQ14-15	.959	.060	.939	15.895	.000	.837	1.082
2	(Constant)	-.741	.241		-3.067	.004	-1.232	-.249
	ResInstQ14-15	.854	.048	.835	17.817	.000	.756	.951
	BurecrBurd14-15	.303	.054	.261	5.571	.000	.192	.414
3	(Constant)	-.513	.250		-2.048	.049	-1.023	-.003
	ResInstQ14-15	.727	.073	.711	9.969	.000	.578	.875
	BurecrBurd14-15	.259	.055	.224	4.711	.000	.147	.372
	PRVR&D14-15	.137	.062	.169	2.220	.034	.011	.263

a. Dependent Variable: UI14-15

Table 3.6. Results of stepwise regression of U-I communication for developed countries 2017-2018

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.951[a]	.904	.901	.302157760394
2	.970[b]	.941	.937	.240815031099
3	.976[c]	.953	.948	.218161286887

a. Predictors: (Constant), PRVR&D17-18

b. Predictors: (Constant), PRVR&D17-18, ResInstQ17-18

c. Predictors: (Constant), PRVR&D17-18, ResInstQ17-18, BurBurd17-18

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.196	.263		.745	.462
	PRVR&D17-18	.944	.057	.951	16.533	.000
2	(Constant)	-.799	.316		-2.528	.017
	PRVR&D17-18	.579	.098	.583	5.896	.000
	ResInstQ17-18	.505	.120	.415	4.202	.000
3	(Constant)	-.787	.286		-2.746	.011
	PRVR&D17-18	.477	.097	.481	4.932	.000
	ResInstQ17-18	.452	.111	.371	4.077	.000
	BurBurd17-18	.205	.077	.181	2.668	.013

a. Dependent Variable: UI17-18

Table 3.7 Initial results of stepwise regression of U-I communication model (with a default SPSS confidence level).

Model Summary[i]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.907[a]	.823	.819	.318866501220	.823	214.175	1	46	.000	
2	.938[b]	.881	.875	.264930290400	.057	21.637	1	45	.000	
3	.948[c]	.899	.892	.246319301755	.018	8.057	1	44	.007	
4	.954[d]	.911	.902	.234564740301	.011	5.520	1	43	.023	
5	.959[e]	.920	.910	.225084134315	.009	4.699	1	42	.036	
6	.966[f]	.933	.923	.208187123474	.013	8.094	1	41	.007	
7	.974[g]	.948	.939	.185349440454	.015	11.726	1	40	.001	
8	.977[h]	.955	.946	.174921937593	.007	5.911	1	39	.020	1.983

a. Predictors: (Constant), ResInstQ14-15

b. Predictors: (Constant), ResInstQ14-15, PRVR&D14-15

c. Predictors: (Constant), ResInstQ14-15, PRVR&D14-15, StafTR14-15

d. Predictors: (Constant), ResInstQ14-15, PRVR&D14-15, StafTR14-15, EducQ14-15

e. Predictors: (Constant), ResInstQ14-15, PRVR∓D14-15, StafTR14-15, EducQ14-15, LoanAc14-15

f. Predictors: (Constant), ResInstQ14-15, PRVR&D14-15, StafTR14-15, EducQ14-15, LoanAc14-15, SetDisp14-15

g. Predictors: (Constant), ResInstQ14-15, PRVR&D14-15, StafTR14-15, EducQ14-15, LoanAc14-15, SetDisp14-15, Tranp14-15

h. Predictors: (Constant), ResInstQ14-15, PRVR&D14-15, StafTR14-15, EducQ14-15, LoanAc14-15, SetDisp14-15, Tranp14-15, BurecrBurd14-15

i. Dependent Variable: UI14-15

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.453	.226		2.003	.051
	ResInstQ14-15	.868	.059	.907	14.635	.000
2	(Constant)	.224	.194		1.151	.256
	ResInstQ14-15	.495	.094	.518	5.266	.000
	PRVR&D14-15	.496	.107	.457	4.652	.000
3	(Constant)	-.361	.274		-1.317	.195
	ResInstQ14-15	.451	.089	.471	5.076	.000
	PRVR&D14-15	.358	.111	.329	3.233	.002
	StafTR14-15	.293	.103	.217	2.838	.007

4	(Constant)	-.441	.263		-1.677	.101
	ResInstQ14-15	.475	.085	.496	5.573	.000
	PRVR&D14-15	.456	.113	.420	4.022	.000
	StafTR14-15	.347	.101	.257	3.438	.001
	EducQ14-15	-.152	.065	-.181	-2.350	.023
5	(Constant)	-.309	.260		-1.190	.241
	ResInstQ14-15	.517	.084	.541	6.152	.000
	PRVR&D14-15	.406	.111	.374	3.654	.001
	StafTR14-15	.247	.107	.183	2.296	.027
	EducQ14-15	-.190	.065	-.226	-2.939	.005
	LoanAc14-15	.136	.063	.151	2.168	.036
6	(Constant)	-.294	.240		-1.222	.229
	ResInstQ14-15	.618	.085	.646	7.232	.000
	PRVR&D14-15	.328	.106	.303	3.087	.004
	StafTR14-15	.295	.101	.219	2.932	.005
	EducQ14-15	-.169	.060	-.201	-2.808	.008
	LoanAc14-15	.242	.069	.268	3.507	.001
	SetDisp14-15	-.191	.067	-.219	-2.845	.007
7	(Constant)	-.648	.238		-2.728	.009
	ResInstQ14-15	.599	.076	.626	7.846	.000
	PRVR&D14-15	.368	.095	.339	3.857	.000
	StafTR14-15	.291	.090	.215	3.239	.002
	EducQ14-15	-.163	.054	-.193	-3.034	.004
	LoanAc14-15	.146	.068	.162	2.163	.037
	SetDisp14-15	-.357	.077	-.409	-4.638	.000
	Tranp14-15	.304	.089	.293	3.424	.001
8	(Constant)	-.602	.225		-2.674	.011
	ResInstQ14-15	.498	.083	.520	5.986	.000
	PRVR&D14-15	.486	.102	.447	4.751	.000
	StafTR14-15	.251	.086	.186	2.906	.006
	EducQ14-15	-.108	.055	-.129	-1.957	.058
	LoanAc14-15	.140	.064	.155	2.199	.034
	SetDisp14-15	-.330	.073	-.378	-4.488	.000
	Tranp14-15	.480	.111	.464	4.334	.000
	BurecrBurd14-15	-.256	.105	-.242	-2.431	.020

a. Dependent Variable: UI14-15

Table 3.8 Results of stepwise regression of U-I communication for developing countries without LDCs 2014-2015.

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.907[a]	.823	.819	.318866501220	.823	214.175	1	46	.000	
2	.938[b]	.881	.875	.264930290400	.057	21.637	1	45	.000	
3	.948[c]	.899	.892	.246319301755	.018	8.057	1	44	.007	2.028

a. Predictors: (Constant), ResInstQ14-15

b. Predictors: (Constant), ResInstQ14-15, PRVR&D14-15

c. Predictors: (Constant), ResInstQ14-15, PRVR&D14-15, StafTR14-15

d. Dependent Variable: UI14-15

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.453	.226		2.003	.051
	ResInstQ14-15	.868	.059	.907	14.635	.000
2	(Constant)	.224	.194		1.151	.256
	ResInstQ14-15	.495	.094	.518	5.266	.000
	PRVR&D14-15	.496	.107	.457	4.652	.000
3	(Constant)	-.361	.274		-1.317	.195
	ResInstQ14-15	.451	.089	.471	5.076	.000
	PRVR&D14-15	.358	.111	.329	3.233	.002
	StafTR14-15	.293	.103	.217	2.838	.007

a. Dependent Variable: UI14-15

Table3.9 Results of stepwise regression of U-I communication for developing countries without LDCs 2017-2018.

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.933[a]	.871	.868	.230027078577	.871	290.344	1	43	.000	
2	.947[b]	.897	.892	.208297512772	.026	10.439	1	42	.002	
3	.960[c]	.922	.916	.183336008092	.025	13.215	1	41	.001	2.123

a. Predictors: (Constant), PRVR&D17-18

b. Predictors: (Constant), PRVR&D17-18, ResInstQ17-18

c. Predictors: (Constant), PRVR&D17-18, ResInstQ17-18, LoanAc17-18

d. Dependent Variable: UI17-18

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.409	.184		2.223	.032	.038	.780
	PRVR&D17-18	.914	.054	.933	17.039	.000	.806	1.022
2	(Constant)	.209	.178		1.177	.246	-.149	.568
	PRVR&D17-18	.699	.083	.713	8.465	.000	.532	.865
	ResInstQ17-18	.247	.076	.272	3.231	.002	.093	.401
3	(Constant)	-.323	.214		-1.508	.139	-.756	.109
	PRVR&D17-18	.631	.075	.644	8.408	.000	.479	.782
	ResInstQ17-18	.254	.067	.281	3.781	.000	.118	.390
	LoanAc17-18	.184	.051	.171	3.635	.001	.082	.286

a. Dependent Variable: UI17-18

Table 3.10 Results of stepwise regression of U-I communication for LDCs 2014-2015

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.895[a]	.801	.795	.233795525043	.801	124.845	1	31	.000	2.290

a. Predictors: (Constant), ResInstQ14-15

b. Dependent Variable: UI14-15

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.565	.214		2.634	.013	.127	1.002
	ResInstQ14-15	.811	.073	.895	11.173	.000	.663	.959

a. Dependent Variable: UI14-15

Table 3.11 Results of stepwise regression of U-I communication for LDCs 2017-2018

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.859[a]	.737	.727	.335677926849	.737	67.424	1	24	.000	
2	.906[b]	.821	.806	.282986652749	.084	10.770	1	23	.003	
3	.925[c]	.855	.835	.260490209582	.034	5.144	1	22	.033	1.823

a. Predictors: (Constant), PRVR&D17-18

b. Predictors: (Constant), PRVR&D17-18, StafTR17-18

c. Predictors: (Constant), PRVR&D17-18, StafTR17-18, BurBurd17-18

d. Dependent Variable: UI17-18

Table 3.11 Results of stepwise regression of U-I communication for LDCs 2017-2018 - continuation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-.538	.452		-1.191	.245	-1.471	.394
	PRVR&D17-18	1.221	.149	.859	8.211	.000	.914	1.528
2	(Constant)	-1.160	.425		-2.727	.012	-2.040	-.280
	PRVR&D17-18	.862	.166	.607	5.185	.000	.518	1.207
	StafTR17-18	.476	.145	.384	3.282	.003	.176	.776
3	(Constant)	-.864	.413		-2.093	.048	-1.720	-.008
	PRVR&D17-18	.938	.157	.660	5.987	.000	.613	1.263
	StafTR17-18	.583	.142	.470	4.117	.000	.289	.876
	BurBurd17-18	-.256	.113	-.224	-2.268	.033	-.490	-.022

a. Dependent Variable: UI17-18

Table 3.12. List of variables used in the U-I communication models

The used variables resulted from Executive Opinion Survey conducted by World Bank. The process involved for the 2017/2018 data 14 375 respondents, with total of 12 775 responses included in the study and 14000 in 2014/2015. In the survey respondents evaluate specific aspects of their environment on a 7 point scale (1 - the worst possible situation; 7 - the best possible situation)

Area	Support	Variables	Description
U-I communication		University-industry collaboration in R&D	Survey Item: In your country, to what extent do business and universities collaborate on research and development (R&D)? [1 = do not collaborate at all; 7 = collaborate extensively] | 2016–17 weighted average.
knowledge, skills and absorptive capacity of stakeholders	Susana Pablo-Hernando, 2015; Martins, 2016; Suomi et al., 2019	Quality of the education system	Survey Item: In your country, how well does the education system meet the needs of a competitive economy? [1 = not well at all; 7 = extremely well] | weighted average
		Tertiary education enrolment rate	Gross tertiary education enrollment rate
		Extent of staff training	Survey Item: In your country, to what extent do companies invest in training and employee development? [1 = not at all; 7 = to a great extent] |weighted average
standards and culture within business environment	Yuthavong et al., 1993; Levallois et al. 2019; Vries et al. 2019	Business sophistication	aggregated survey based variable including: Local supplier quantity, Local supplier quality, State of cluster development, Nature of competitive advantage, Value chain breadth, Control of international distribution, Production process sophistication, Extent of marketing, Willingness to delegate authority, Reliance on professional management
financial capacity of industry to contribute to academic R&D	D'Hooghe 2017; Haynes et al. 2018	Company spending on R&D	Survey Item - In your country, to what extent do companies invest in research and development (R&D)? [1 = do not invest at all in R&D; 7 = invest heavily in R&D] weighted average
		Ease of access to loans	Survey Item: In your country, how easy is it for businesses to obtain a bank loan? [1 = extremely difficult; 7 = extremely easy] | weighted average
		Effect of taxation on incentives to invest	Survey Item: In your country, to what extent do taxes reduce the incentive to invest? [1 = to a great extent; 7 = not at all] | weighted average
		Availability of financial services	Survey Item: In your country, to what extent does the financial sector provide the products and services that meet the needs of businesses? [1 = not at all; 7 = to a great extent]

accessibility of quality research	D'Hooghe 2017; Kim & Jang, 2019	Quality of scientific research institutions	Survey Item: In your country, how do you assess the quality of scientific research institutions? [1 = extremely poor—among the worst in the world; 7 = extremely good—among the best in the world] |weighted average
		Availability of scientists and engineers	Survey Item: In your country, to what extent are scientists and engineers available? [1 = not available at all; 7 = widely available] | weighted average
existence of innovation system support measures	van den Bergha & Guild 2008; D'Hooghe 2017; Hassen 2018; Kim & Jang, 2019	Quality of overall infrastructure	Survey Item: How do you assess the general state of infrastructure (e.g., transport, communications, and energy) in your country? [1 = extremely underdeveloped—among the worst in the world; 7 = extensive and efficient—among the best in the world] |
		Intellectual property protection	Survey Item: In your country, to what extent is intellectual property protected? [1 = not at all; 7 = to a great extent] | weighted average
		Efficiency of legal framework in settling disputes	Survey Item: In your country, how efficient are the legal and judicial systems for companies in settling disputes? [1 = extremely inefficient; 7 = extremely efficient] | weighted average
		Efficiency of legal framework in challenging regulations	Survey Item: In your country, how easy is it for private businesses to challenge government actions and/or regulations through the legal system? [1 = extremely difficult; 7 = extremely easy] | weighted average
orientation of government toward creating innovation-enabling culture	Kim & Jang, 2019; Suomi et al., 2019	Transparency of government policymaking	Survey Item: In your country, how easy is it for companies to obtain information about changes in government policies and regulations affecting their activities? [1 = extremely difficult; 7 = extremely easy] | weighted average
		Burden of government regulation	Survey Item: In your country, how burdensome is it for companies to comply with public administration's requirements (e.g., permits, regulations, reporting)? [1 = extremely burdensome; 7 = not burdensome at all]

Chapter 4

Social usefulness of groupware platforms as tools to overcome barriers to cross-organisational communication - case of AdminProject environment

4.1. Introduction

While a number of authors underlines the role of proximity for collaboration (Cooke, 2002; Hassen 2018), the fast development of communication technology in the last three decades provided means to collaborate not only on a local scale, but across regions, countries or continents (Graham, 1996; Ajjan et al., 2014). Private sector broadly capitalises on those benefits of technological development and globalisation and proves that long distance open innovation can be an effective and beneficial process (Fields, 2006). Meanwhile, universities and industry struggle to embrace advantages of such a mutual communication on a broad scale. That leads to lost opportunities for universities, companies, as well as whole economies (Bayne et al., 2016).

Literature clearly shows that university-industry (U-I) collaboration needs to overcome not only regional or national boarders and common barriers across industries, but also specific U-I cross-organisational barriers related with differences of culture, language, procedures or understanding gap (Vick & Nagano, 2018; Vries et al., 2019). The literature consistently underlines the primary role of effective communication as a transversal mean to overcome the barriers, develop successful collaboration for innovation and ensure knowledge transfer (Bayne et al., 2016; Howarth & Monasterolo, 2016).

Currently majority of U-I communication is a reaction to public schemes, which allow organisations to decrease incentives gap (Bayne et al., 2016; Peng et al., 2017). However, the efforts do not show commonly a sustainable effect in a form of establishment of long term dialog and collaboration in the scope of innovation between U-I agents (Lissoni, 2010). Recent

literature suggests that the purpose differences, the cultural gap, differences in procedures and quality standards together with language and understanding gap are the barriers responsible for the diminishing effects of public investments in U-I communication and decreasing their potential benefits for innovation (Vries et al., 2019; Suomi et al., 2019). While the literature points out a crucial role of proper communication for building effective U-I linkages (Suomi et al., 2019; Kim & Jang, 2019), the issue of long distance U-I communication has been given little attention. Moreover, studies analysing specific ICT tools that could facilitate the U-I communication are scarce. Especially, no solution designed specifically for the needs of cross-organisational communication has been identified in the scope of a literature review on U-I communication in the scope of innovation.

Meanwhile, as the current body of literature argues, clear structures enabling vivid communication are, next to communication plan, a base for smooth cooperation within projects scope (Fiehe et al., 2014; Bayne et al., 2016). However, these pose different challenges and require specific strategies for interdisciplinary partnerships facing specific organisational barriers (Sandberg et al., 2015; Howarth & Monasterolo, 2016). For that reason, stakeholders-adapted and optimized communication based on throughout examination and implementation of identified success factors is of high importance (Plewa et al., 2013a; Fiehe et al., 2014; Vick & Nagano, 2018). To contribute to that area not currently approached by U-I communication literature, the chapter aims to analyse a groupware platform specifically designed for the needs of Erasmus+ collaborative projects aiming at cooperation for innovation and exchange of good practices between different organisations across European Union and beyond. In that context, we aim to study whether the groupware support for computer mediated communication (CMC) through a targeted communication mechanism can decrease barriers to cross-organisational communication and foster U-I communication. Specifically, we analyse highly dispersed international partnerships which are highly dependent from long distance communication to analyse the groupware social usefulness related with trust building (Bacon et al., 1994; Ju et al., 2016), relation enhancement (Suomi et al., 2019) and mutual understanding (D'Hooghe, 2017; Martins, 2016) and their impact on cross-organisational communication and its continuance.

Based on structural equation modelling our study implies that groupware solutions can improve attitude toward cross-organisational communication in the scope of innovation by improving communication across organisational and geographical boarders and contributing to social proximity related within our results with its ability to contribute ideas to collective achievements and building familiarity.

Following the introduction the section 2 presents the theoretical framework which results in the research model. In section 3 we focus on the applied methodology to advance with data analysis and results in section 4. Proceeding section 5 provides discussion of results. The study is finalised with conclusions in section 6.

4.2. Theoretical framework

Computer mediated communication and collaborative environment

Changes in technology led to increase in communication possibilities which reduced the role of location for establishing communication in the scope of innovation (Christiansson, 1993). Solutions allowing computer mediated communication (CMC) brought about the possibility to link agents across locations, cultures and organisations decreasing the importance of centralised research and development (R&D) critical mass for innovative activities (Graham, 1996; Hassen, 2018). That resulted in social changes, reconstruction of collaborative environments, increasing role of network connections and the need for adaptations to new challenges (Leydesdorff & Etzkowitz, 1998; Pendergast & Hayne, 1999; Neumann & Prusak, 2007). Internet connection and technological progress enable distant agents to engage in the scope of innovation not only within the linear communication model, but provide solutions for non-linear interactivity across organisations, disciplines, boarders and projects (Lan, 2004; Butcher & Jeffrey, 2005).

Engagement of multiple agents in communication provides an opportunity for rich and potentially unexpected interactions which can lead to improved innovativeness, but also increases uncertainty within collaborative environment (Pendergast & Hayne, 1999; Gera, 2012). Common challenges for cross-organisational communication result from common barriers to cross-organisational communication, such as differences in culture (Bjerregaard, 2010), language and perception (Gera 2012; Howarth & Monasterolo, 2016), differences in management practices (Davis & Eisenhardt, 2011; Fiehe et al., 2014) or skills and expertise (Bayne et al., 2016). Those barriers resulting in different codes of reference can generate mutual redundancies within the system, increase uncertainty within the communication and discourage agents to engage in cross-organisational communication (Leydesdorff & Ivanova, 2014; Vries et al., 2019).

Mechanisms allowing access and exchange of information reduces that uncertainty (Plewa et al., 2013a, Leydesdorff & Ivanova, 2014) and it is suggested that a proper interface can help to overcome different frames of reference (Sherwood & Covin, 2008). Therefore, a comprehensive communication strategy including a communication platform with capability to minimise the effects and/or bridge organisational gaps are important for effective cross-organisational communication (Fiehe et al., 2014). Improving communication channels to establish a strong organisational interface may provide means for not only effectively interacting despite differences and potential disagreements, but allows identifying recurring problems and pooling knowledge to define optimal strategies for the problems resolution (Parker & Hine, 2014; Sandberg et al., 2015). Bayne et al. (2016) suggest that this kind of infrastructure can encourage agents to communicate, interact and build linkages (Bayne et al., 2016). This implies that specific objective oriented system positioned at the interface

between organisations can facilitate and encourage communication across organisational boarders as long as it helps to bridge the gaps between organisations. While CMC is perceived as less rich than face to face interaction (Ajjan et al., 2014; Ou & Davison, 2011), groupware enables the existence of virtual teams and can provide means for creating partners awareness and familiarity traditionally associated with a close physical proximity (Sheen & MacBryde, 1995; Pendergast & Hayne, 1999). By providing interactive space for interactions, CMC, such as groupware solutions, may create a sense of identity or relational trust, enable dialogic communication despite organisational or geographical distance (Santoro & Saparito, 2003; Bayne et al., 2016). Its ability to provide institutionalised 'consensus space' with atmosphere conductive to spontaneous communication can provide social proximity influencing how agents network, collaborate and innovate (Hassen, 2018; Kim & Jang, 2019). Hence, we expect that:

H1 – Groupware usefulness for cross organisational communication is positively related with its social usefulness.

ICT tools in the scope of U-I communication for innovation

In the scope of long distant communication in the context of open innovation, ICT tools may support the process by: i/ providing system for exchange of information across distant locations; ii/ supporting decision making; iii/ storing information and knowledge (Kodama, 2002). The existing communication tools applied in the scope of cross-organisational communication differ in the level of complexity, the range of provided functionality and interactivity. The body of literature commonly recognises importance of e-mails, resource allocation systems and organisational communication platforms (such as organisational or external webpages or search engines) (Pendergast & Hayne, 1999; Neumann & Prusak, 2007), as well as, recently more often recognised by researchers and users in the context of professional applications, instant messaging and social media (Ou & Davison, 2011; Ajjan et al., 2014). However, due to highly individual character of traditional ICT communication means, literature suggests that, in the specific scope of the cross organisational communication, richer communication media need to be employed at the organisational interface (Santoro & Saparito, 2003).

Groupware is a group of more complex and comprehensive virtual communication solutions – the support systems for computer mediated collaboration and group-decision making (Pendergast & Hayne, 1999; Harsleb et al., 2002). The basic groupware infrastructure covers : i/ pushing and pulling information, ii/ exchanging information to reach understanding, iii/ task delegation, iv/ conflict management, v/ collaborative work management (Pendergast & Hayne, 1999; Haruna & Mohammed, 2015). It is a specific software category designed to make a communication and coordination of cross-organisational and multi-agent collaboration easier independently from their geographical location (Haruna & Mohammed, 2015).

While no specific empirical study was identified in the scope of groupware application in the scope of U-I communication, the research on computer mediated communication (CMC) performance stresses its impact on communication and work performance (Ou & Davison, 2011). Virtual teams understood as a group of individuals working across space, time and boundaries to reach common result (Lipnack & Stamps, 2000; Fuller et al., 2007) are the typical groupware target users. While the geographic dispersion is common in virtual teams, it is not a prerequisite and in practice virtual teams commonly include a mixture of virtual and collocated members (Griffith et al., 2003; Johnson et al., 2000; Fuller et al., 2007). The fragmented existing literature regarding the requirements for communication tools to effectively stimulate cross-organisational dialog allows to identify a number of mechanisms and factors with the potential to moderate U-I organisational differences and provide facilitation for U-I communication using CMC. In case of remote communication, the interaction is still largely based on transmission between individuals (Yuthavong et al., 1993). As a result, its effectiveness is highly dependent from behavioural factors (Sheen & MacBryde, 1995; Bayne et al., 2016). In accordance with behavioural theories, including the Theory of Planned Behaviour and Decomposed Theory of Planned Behaviour, it is dependant from personal attitudes towards specific behaviours, social norms of behaviour and perceived behavioural controls. Those result from personal believes and perception (Ajjan et al., 2014). Those individual behaviours are pointed as effective transversal mechanism to overcome cross organisational barriers suggesting importance of personal factors and character of communication within the groupware. Individuals' attitude impacts negotiations across purpose and lexical differences, drives cultural adaptations and can support external partners in overcoming bureaucratic barriers (Papagiannidis, Li & Etzkowitz, 2009; Bjerregaard, 2010; Sandberg et al., 2015). Bayne et al. (2016) suggest that the quality and supply of information is in fact of lower importance for effectiveness of innovation networks than behaviours between individuals. A proper environment will influence individual attitude and motivation to cooperate and provide room for more experimental activities (Kim & Jang, 2019). Enabling organisation of such interactions can stimulate interest in collective achievements and innovative attempts based on bilateral communication and socialisation mechanisms supporting building familiarity and relationships between agents, trust and mutual understanding (Graham, 1996; Plewa et al., 2013a; Plewa et al. 2013b; D'Hooghe 2017; Kim & Jang, 2019). Following the literature based argument it is expected therefore that:

H2. Perceived social usefulness of groupware is related with the system ability to a/ enable mutual understanding (H2a) b/ enable relationship enhancement (H2b), c/ enable trust building (H2c).

The ICT impact on strategic renovation of organisational behaviours in the first place depends on innovation of individuals value system, the knowledge and core competences accumulated by them and attitudes towards behaviours and adjustments (Leydesdorff & Etzkowitz, 1998;

Etzkowitz & Leydesdorff, 2000; Kodama, 2002). The effectiveness of CMC is dependent on cross-organisational communication success factors such as leadership, shared space (technological space), trust, transactive memory, as well as users psychological attitude toward it and their intrinsic motivations (Mannix et al., 2002; Treadaway, 2004). The attitude impacts the behavioural intentions which in scope of ICT results in specific (positive or negative) feelings toward performing a behaviour (Ajjan et al., 2014). As international level cross organisational collaborations are highly dependent on CMC, the ability of specific solution to influence those attitudes and motivations will impact the attitude toward collaboration and the behavioural intention to continue engagement. Perceived usefulness of the system for improving cross-organisational communication is the main precondition of the continuance intention (Boe et al., 2015). As the tested within the study tool is specifically designed for the needs of cross-organisational collaboration, the continuance intention of use commonly associated with the long-term acceptance has been used as the proxy for the user interest to continue its engagement in U-I communication. Therefore, it is expected that:

H3. Perceived usefulness of groupware in the scope of cross-organizational communication has a positive impact on the user intention for continuous engagement in cross-organisational collaboration.

From the one hand, the current body of literature postulates the need for improving communication channels for cross-organisational communication across helixes boarders to increase innovativeness and economic performance (Butcher & Jeffrey, 2005; Plewa et al., 2013a; Sandberg et al., 2015) and recognises the role of supportive infrastructure, including CMC, for encouraging innovation actors to interact (Kim & Park, 2014; Bayne et al., 2016). From the other hand, it recognises the significant impact of cross-organisational barriers and the importance of personal attitude towards specific behaviours within organisations for the communication occurrence and longevity (Ajjan et al., 2014; Kim & Jang, 2019). However, despite the groupware application in the scope of U-I, as well as reaching more broadly communication for innovation, to our knowledge the issue of groupware adoption in the scope of U-I communication nor 4-helix communication was not previously empirically studied. More specifically, no study of behavioural factors and their possible impact on long distance communication across organisations have been identified.

To fill the gap, this paper studies a specific groupware solution –Admin Project which provides a communication and collaboration platform for multi-organisational projects, with a specific focus on European projects funded under the Erasmus+ scheme. Based on the existing experience of 258 repetitive users of the system (more than one project conducted within the environment), we integrate behavioural theories with the body of knowledge on U-I communication and technology assessment methodologies to verify whether a targeted communication mechanism can be useful to improve cross-organisational communication in the scope of innovation by enhancing bridging attitudes and beliefs of individuals – trust,

relationships and understanding resulting in its social usefulness. Si meliora dies, ut vina, poemata reddit, scire velim, chartis pretium otus arroget.

4.3. Research model

To reach the study objectives we propose an integrated theoretical model based on integration of Information Theory, Behavioural Theories and U-I communication studies.

Continuance intention and usefulness

Based on continuance theory used to explain user long-term acceptance, we examine how groupware technology can stimulate the users behavioural intention to continue the computer mediated U-I communication. Following the information theory, this behavioural intention will be in the first place dependant on perceived usefulness, while ease of use is expected to be of lower importance (Davis 1989; Chang & Wang, 2008). The perceived usefulness is the user's believe to what degree the tool will allow reaching specific objectives with effectiveness, efficiency and satisfaction (Chang and Wang, 2008). Hence, in the scope of our research, the perceived usefulness was defined as the belief that the groupware can positively impact the communication between agents across organisations. That usefulness can be an effect of not only system characteristics, but also of the system impact on social aspects of communication (Berne et al., 2015).

Factors of perceived usefulness

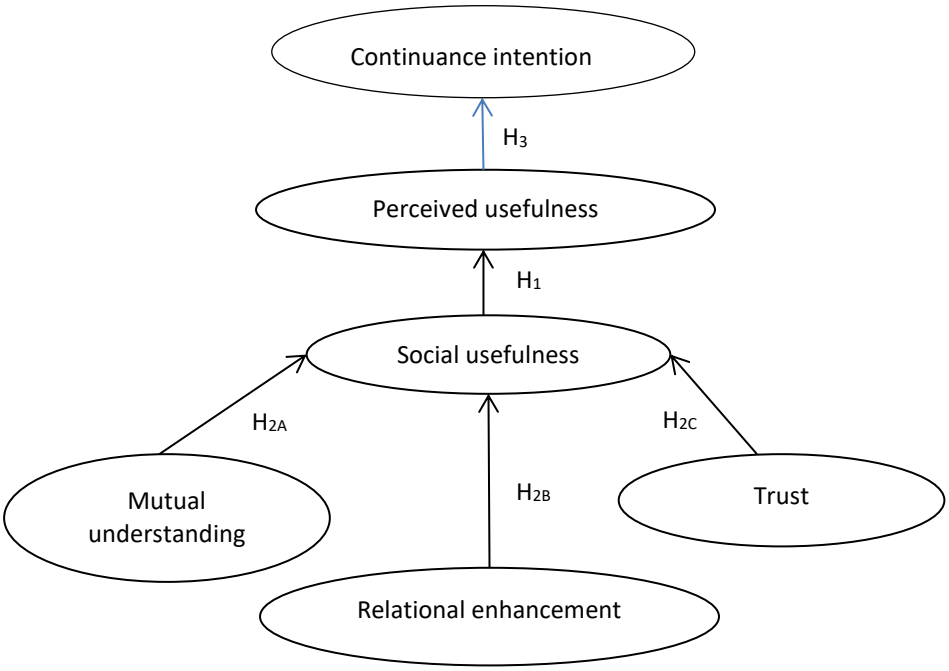
Based on the specific system objective definition, perceived usefulness and their factors will differ. Therefore, in the scope of communication facing specific barriers, the usefulness of the tool for supporting cross-organisational communication is expected to result not directly from the direct system characteristics, but more specifically from the system capacity to mediate barriers across organisations. Based on Lin (2008) we integrate social factors related to individual's acceptance of group culture and interpersonal liaison with others. As a result, we use in the context of the study the social usefulness as a proxy for decreasing organisational barriers. In the context of CMC the social usefulness refers to *perceived support (respect, recognition, approval etc.*) from other users (Lin 2008).

The social usefulness is expected to be a significant factor positively impacting the groupware perceived usefulness in the scope of cross-organisational communication. Following the literature specific system characteristics will be related with the perceived usefulness (Chang and Wang 2008) and in this specific scope with social usefulness.

Mutual understanding, trust building and relation enhancement were shown across literature to be the transversal facilitating mechanisms for bridging organisational gaps (Graham, 1996;

Plewa et al., 2013a; Plewa et al., 2013b; D'Hooghe, 2017; Kim & Jang, 2019). As a result, our initial model integrates Information Systems Continuance Theory with core concepts related with encouraging cross-organisational communication (see Figure 4.1).

Figure 4.1. Research model



By proposing the direct effect of system characteristics on the mutual understanding, trust and relation building the model is empirically testing the proposition of positive effect of groupware on social dimension of CMC, rather than its importance being limited to direct impact of the system characteristics on perceived usefulness (Lin, 2008; Ou & Davion 2011).

4.4. Methodology

The Case: Erasmus+ and Admin project

Within the European Union (EU) a number of schemes aims to encourage cross-organisational cooperation across disciplines and boarders to increase EU innovativeness. Among others, Erasmus+ is a highly inclusive financial scheme looking to bring different stakeholders together to support innovation, cooperation and reform, with a special focus on cooperation for innovation and exchange of good practices (http://ec.europa.eu/programmes/erasmus-plus/about_en). Within that objective, during the five years of the program existence (2014-2019) it has linked about 128,500 organisations including higher and adult Education institutions, youth organisations, enterprises, schools and vocational Education and Training providers and others in a collaborative work on innovation in the fields of education, training and youth bringing the market and educational perspectives together. The highly inclusive

collaboration for innovation is covered by Erasmus+ KA2 covering strategic partnerships, knowledge alliances and sector skills alliances (http://ec.europa.eu/programmes/erasmus-plus/about/key-figures_en).

While establishment of cross-organisational communication is in this case incentivised by the financial support, the project specifics requiring interdisciplinary competencies across organisations and boarders pose challenges brought up not only by the uncertainty of innovation projects, but by additional barriers to cross-organisational and cross-border communication, such as cultural, language or procedures differences (Fiehe et al., 2014; Howarth & Monasterolo, 2016). Additional interactional challenges may occur within international dimension when communication is more likely to encounter significant explicit cultural issues on both organisational and national level (Hong & Olander, 2010).

AdminProject is a web-based groupware solution which from its initiation aims at supporting diversified organisations in their project administration needs. While the initial product incorporated communication functions to enable direct contacts between engaged at the project interface individuals, the product was designed as a comprehensive project management tool which incorporated diversified project management methodologies. It included tools for management of working packages, files sharing, scheduling, contacts, as well as budgeting, critical path and resource and risk management tools. The system was created within a framework of Innovative Economy European Fund in 2011 and across the years went through a significant number of upgrades responding to reported customer feedback and needs analysis based on data gathered within the software support system. Independently from the changes in provided modules and constant product evolution, the main assumption of the program architecture is constantly the simplicity of the interface and facility of use. As the marketing strategy is mainly focused on the word-of-mouth, the developers approach strongly emphasize the optimization of user experience, minimization of customer friction and providing highly user friendly solution responding to the challenges met by organisations in the scope of projects.

One of the crucial shifts in the project development was narrowing the focus to EU funded projects and further to the needs of Erasmus+ KA2 scheme. The new direction allowed Danmar Computers, the SME responsible for AdminProject development, to incorporate their technical expertise with a vast experience in the scope of EU Projects and position the product in the niche market. While a range of complex groupware solutions exists, the major software developers do not provide specific for EU Projects management features. Conducted in the scope of the study market research allowed identifying a few EU projects dedicated solutions. However, AdminProject was identified as a unique Erasmus+ dedicated groupware solution. Those factors resulted in a highly Erasmus+ KA2 customised and user oriented solution. Based on the opinion of Danmar representative, the product competitive advantage lies in its customisation to the specific needs of Erasmus+ cross-organisational projects, web-

based character and integration of all resources and communication within a single on-demand platform – *...as long as partners follow the rules…it allows to keep everything in one place – messages, tasks, files. Otherwise it's very difficult to keep proper communication…I remember projects that were conducted via e-mail. It was a challenge to find the final file version in a specific language version. It wasn't clear who had the required file. Sure, you could use i.e. Dropbox for files, Trello for tasks, but Admin Project has one key advantage – everything is in one place and everything is created for the needs of European Projects*. This specific architecture alignes with the study condition for stakeholders need oriented solution. Specific functions that were pointed as distinctive and specifically facilitating collaboration within the environment include i/ additional system of email notifications which can be also used to respond directly via email to the communications taking place within the platform, ii/ specific design of task management function allowing to define the tasks within Intellectual Outputs as required by project application and iii/ specific functions for automation of reporting according to Erasmus+ specific requirements. While AdminProject covers a number of predefined modules, i.e. Discussion, Meeting Planners, Tasks, Intellectual Outputs or Dissemination, corresponding to management needs of Erasmus projects, thanks to the modular character, the workplace can be strongly customised to incorporate the functions you need at the time. The most commonly used functionalities are the discussion and file storing modules, followed by the task delegation function. It suggests the broad application of Admin Project as a tool for communication within the Erasmus+ KA2 environment.

Sample and data

Data were collected from the AdminProject users via online questionnaire (See Annex 1). The population consists of individuals engaged in cross-organisational collaboration for innovation in the scope of Erasmus+ funding scheme. Due to the The General Data Protection Regulation (GDRP) legal limitations within the EU area (requiring special permission for surveys distribution), the survey has been distributed to 187 users, which could be reached within legal boundaries for the purpose of a study. After three sets of reminders, we obtained 102 responses. Data screening did not revile missing data in the scope of latent variables or their indicators. To ensure that respondents had sufficient knowledge regarding use of AdminProject for cross-organisational collaboration, a minimum of six months of experience or engagement in min two projects managed via AdminProject were considered as the inclusion criterion. As a result, four observations were excluded from the study, limiting the analysed sample to 98 valid observations (reaching 38% of maximal available sample/population). Those were in the first place screened for unengaged responses, which were not identified in the sample, nor were outlier based anomalies.

Method

Following the established study objectives and the defined lack of quantitative study in the scope of U-I communication, our study applied in the scope of communication studies structural equation modelling (Holbert, 2002). To inform the model construction in addition to literature review an introductory phase aiming at in-depth understanding of the specific groupware under study – the AdminProject, covered a desk study, discussion panel with the product owners and a semi-structured interview with the developer pointed within the discussion panel as the most-informed person within the product owning organisation. Based on the procedure hypotheses were constructed, followed by the model construction.

Measures

Within the established research model (see Figure 4.1), the scale items were adapted from previously developed studies, with slight adaptation to the specific case of AdminProject (Lin, 2008). The initial measurement model included six latent variables. Each variable was represented by a set of literature based indicators. To be able to ensure optimal model fit, following previous research models (Chang & Wang 2008; Cho, Cheng & Lai, 2009), indicators related with Ease of Use were additionally collected for comparative model analysis purposes (Hair et al., 2010). All items have been pre-tested and after improving their clarity and pertinence, the constructs were measured defined in the literature Likert scales presented in the table 4.1.

To reach the study objectives the hypothesized model was tested using SEM methodology. SPSS 23, Amos 21 and Excel 2010 were used for the purpose of data analysis. The initial structural model contained six latent variables: (a) continuance intention (Continuance); (b) perceived usefulness (PercUseful); (c) social usefulness (SocUseful); (d) mutual understanding (Understanding); (e) relationship enhancement (Relationship); (f) trust (Trust), specified as per Table 4.1.

Table 4.1. Construct specification and item mean and standard deviations

Items	Source
Continuance intention (1=disagree strongly, 7=agree strongly)	
IU1: I intend to give priority to using Admin Project for communication within collaborative projects.	Chen and Tsai 2017
IU2: I think using Admin Project for communication within the collaborative projects is the right choice.	Chang and Wang 2008
IU3: I intend to increase the usage of Admin Project for communication within collaborative projects.	
IU4: I will strongly recommend others to use Admin Project for communication within collaborative projects.	
IU5: It is worth to use Admin Project for communication within collaborative projects.	
Perceived usefulness (1=strongly disagree, 7= strongly agree)	

PerU1 – Use of Admin project improves the quality of communication with other organisations	Chen & Tsai (2017);
PerU2 – Use of Admin project helps me exchange information within collaborative projects	Boe, Guldbrandsen, & Sorebo (2015)
PerU3 – Use of Admin project enhances effectiveness of communication with other organisations	
PerU4 – Overall, use of Admin project is useful for communication within collaborative projects	
Social usefulness (1 = strongly disagree to 5 = strongly agree)	
SU1: Using Admin project helps me to obtain respect from other virtual team members.	Lin (2008)
SU2: Using admin project improves how I am perceived by the other virtual team members.	
SU3: Using admin project gives me the opportunity to recommend ideas to other virtual team members.	
SU4: Using admin project helps me to form warm relationships with other virtual team members.	
Trust (1 = strongly disagree to 5 = strongly agree)	
TR1: I feel very confident about the value that the other Admin project users provide	Lin (2008);
TR2: The other Admin Project users have specialized capabilities that can add to the conversation	Riding et al. (2002ª)
TR3: Admin project users are concerned about what is important to others.	
TR4: Admin project users will do everything within their capacity to help others.	
TR5: Admin project users try hard to be fair in dealing with each other.	
TR6: The Admin Project users are concerned with what is important to others	
Relationship enhancement (1=totally disagree, 11=totally agree)	
RE1: The use of Admin project has intensified my relation with partners in projects	Berne et al. (2015)
RE2: The use of Admin project improved relationships among partners	
Mutual understanding (1 = strongly disagree, 6 = strongly agree)	
MU1: Within Admin project based communication I was able to understand the point of view of the others	Cornelius (2003)
MU2: Within Admin project based communication I could make myself heard	
MU3: Within Admin project based communication the others showed interest in my opinions	
MU4: Within Admin project based communication I could follow the flow of conversation	
MU5: Within Admin project based communication the others referred to me	
Ease of Use (1 = strongly disagree, 7 = strongly agree)	
peou1. Learning to operate Admin Project is easy for me	Chang & Wang (2008);
peou2. It is easy to get Admin Project to do what I want to do	Cho, Cheng, & Lai (2009)
peou3. I have no trouble communicating in Admin Project	
peou4 Overall, it will be easy to use Admin Project	

4.5. Data analysis and results

Users of AdminProject cover a broad range of institutions engaged in Erasmus+ collaborative projects (see Table 4.2). Those, next to universities and industry, include governmental and non-governmental organisations. In average participants were involved in 3.5 projects with

application of AdminProject (Mean = 3.559). The participants were in majority highly educated (86% of the sample).

Table 4.2. Sample analysis

Profile of 121espondentes (N=98)			
Measure	Item	Frequency	%
Type of organisation	Private company	43	44%
	Higher education or academic organisation	18	18%
	NGO	29	30%
	Governmental organisation	7	7%
	Others	1	1%
Size of organisation (employees number)	<10	28	29%
	10-100	31	32%
	101-500	20	20%
	>500	19	19%
Experience with AdminProject (in years)	<1	17	17%
	1 to 2	33	34%
	2 to 5	36	37%
	>5	12	12%
Number of projects	<5	78	80%
	5-10	17	17%
	11-20	2	2%
	>20	1	1%
Academic qualifications	Secondary education or below	14	14%
	Higher education – Bachelor, Engineer or Master Degree	53	54%
	Higher education – PhD Degree	31	32%
Age	<30	15	15%
	30-40	32	33%
	41-50	37	38%
	>50	14	14%
Gender	Male	67	68%
	Female	31	32%

Measurement model

The initial measurement model was estimated using CFA to test validity of the measurement model. The overall fit of measurement model was assessed using four measures – CMIN/DF (x2/d.f.), CFI, PCLOSE and RMSEA (see Table 4.3). The evaluation of model based on initial conceptualiation implied that improvements were necessary. Within the model evaluation procedures, based on initially obtained loadings, standardized covariance residuals matrix and modification indexes, the initial measurement model has been adjusted, resulting in additional covariance relations between residuals, as well as removing 2 items from the measurement model – social usefulness 1 and trust 6 (Anderson & Gerbing 1998, p. 417; Hermida, 2015) (for full list of removed across the SEM procedures items see Table 4.8 in appendixes).

As shown in the table 4.3, as a result, a good model fit (CMIN/DF (x2/d.f.)= 1.336, CFI=0.930, PCLOSE=0.199 and RMSEA=0.059) with all estimates regression weights being significant and all loadings exceeding .5) has been obtained (see Figure 4.2 and Table 4.4).

Table 4.3. Fit indexes for the measurement model

Index	Measurement model	Recommended value	Source
CMIN/DF	1.336	<2	Fornell (1983)
CFI	0.930	>0.9	Bagozzi and Yi (1988)
PCLOSE	0.199	>0.05	
RMSEA	0.059	<0.08	MacCallum et al. (1996)

Figure 4.2. The measurement model

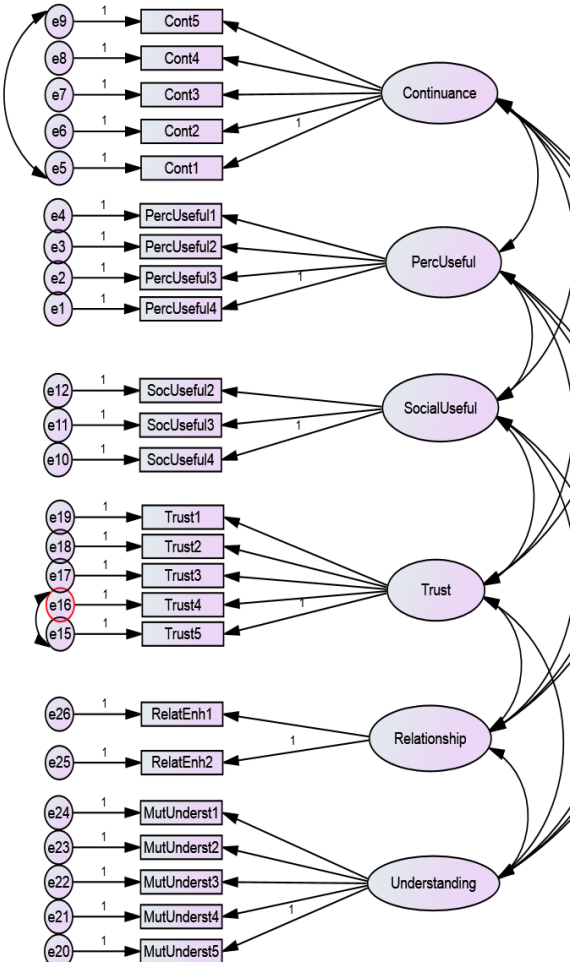


Table 4.4.
Standardized regression weights obtained

			Estimate
PercUseful4	←-	PercUseful	.573
PercUseful3	←-	PercUseful	.695
PercUseful2	←-	PercUseful	.593
PercUseful1	←-	PercUseful	.696
Cont1	←-	Continuance	.700
Cont2	←-	Continuance	.748
Cont3	←-	Continuance	.738
Cont4	←-	Continuance	.796
Cont5	←-	Continuance	.791
SocUseful4	←-	SocialUseful	.762
SocUseful3	←-	SocialUseful	.697
SocUseful2	←-	SocialUseful	.521
Trust5	←-	Trust	.654
Trust4	←-	Trust	.603
Trust3	←-	Trust	.654
Trust2	←-	Trust	.707
Trust1	←-	Trust	.742
MutUnderst5	←-	Understanding	.803
MutUnderst4	←-	Understanding	.669
MutUnderst3	←-	Understanding	.774
MutUnderst2	←-	Understanding	.636
MutUnderst1	←-	Understanding	.671
RelatEnh2	←-	Relationship	.934
RelatEnh1	←-	Relationship	.824

The model has been further compared with the extended model adding ease of use as a potential exogenous latent variable. However, the model fit has decreased (CMIN/DF = 1.374, CFI = .911, PCLOSE = 0.087, RMSEA = 0.062), resulting in acceptance of the presented in the Figure 2 model for further analysis.

As literature suggests that double socialisation can have highly positive impact on cross-organisational communication (Pablo-Hernando, 2015; Suomi et al., 2019), in the scope of our structural model, we have tested for its possible moderating character (Brown, 2015). The invariance test based on double socialisation showed that, for all of the constructs, majority of indicators is not significantly different for the group of users with the double and without the double socialisation. In fact, significant differences were only calculated in case of continuance intention for Item 3 and 5, showing that the double socialisation does not significantly impact the perception of usefulness of groupware for cross-organisational communication. The measurement model was then assessed for validity. Presented in the Table 4.5 initial values of AVE suggested the need for adjustments in 3 constructs – Perceived Usefulness (AVE=0.412), Social Usefulness (AVE=0.446) and Trust (AVE=0.454). Starting from items with the lowest factor loadings, 2 items have been removed from the trust construct (Trust4(λ=0.61) and Trust3(λ=0.66)) and 1 from social usefulness (SocUseful2(λ=0.52)) to resolve corresponding issues. Furthermore, an attempt to improve the validity of perceived usefulness has been made. However, none of the possible adjustments in the construct resulted in the AVE improvement. As the corrective measures led to decreasing validity and CR alone can be used to conclude that the convergent validity of the construct is adequate (Malhotra & Dash, 2011, p.702), a new model with AVE (PercUseful)<0.5 has been established as the valid measurement model (see Figure 4.3 and Table 4.6).

Table 4.5. Validity test values

	Initial model (figure 4.2)		**Adjusted model (figure 4.3)**	
	CR	**AVE**	**CR**	**AVE**
Understanding	0.837	0.509	0.838	0.510
PercUseful	0.735	0.412	0.736	0.413
Continuance	0.869	0.571	0.869	0.571
SocUseful	0.702	0.446	0.710	0.551
Trust	0.805	0.454	0.755	0.508
Relationship	0.873	0.776	0.871	0.771

Figure 4.3. Final Measurement model

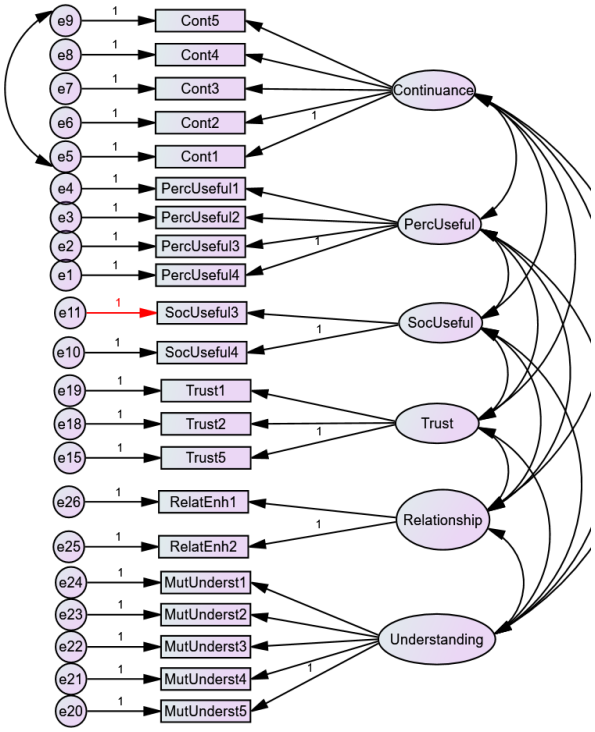


Table 4.6. Standardized Regression Weights:

			Estimate
PercUseful4	←-	PercUseful	.574
PercUseful3	←-	PercUseful	.700
PercUseful2	←-	PercUseful	.596
PercUseful1	←-	PercUseful	.690
Cont1	←-	Continuance	.698
Cont2	←-	Continuance	.748
Cont3	←-	Continuance	.735
Cont4	←-	Continuance	.798
Cont5	←-	Continuance	.793
SocUseful4	←-	SocUseful	.754
SocUseful3	←-	SocUseful	.730
Trust5	←-	Trust	.649
Trust2	←-	Trust	.715
Trust1	←-	Trust	.769
MutUnderst5	←-	Understanding	.795
MutUnderst4	←-	Understanding	.682
MutUnderst3	←-	Understanding	.768
MutUnderst2	←-	Understanding	.640
MutUnderst1	←-	Understanding	.674
RelatEnh2	←-	Relationship	.890
RelatEnh1	←-	Relationship	.866

The structural equation model

After establishing final measurement model, structural model has been established and analysed using AMOS 21 and Excel 2010. The structural model fit was validated using the same measurements applied in case of measurement model. The obtained fit indices, CMIN/DF=1.402, CFI=0.927, PCLOSE=0.110 and RMSEA=0.064, provided evidence of a good fit. Therefore, path analysis was conducted to verify the established hypotheses. The estimated path coefficients reviled significant relations between endogenous latent variables within the structural model. However, no significant impact of exogenous variables on social usefulness has been observed (See table 4.7).

Table 4.7. Standardized Regression Weights and significance

			Estimate	Sig.
SocUseful	←-	Understanding	-.296	Ns.
SocUseful	←-	Relationship	-.038	Ns.
SocUseful	←-	Trust	1.280	Ns.
PercUseful	←-	SocUseful	.772	***
Continiuance	←-	PercUseful	.921	***
PercUseful4	←-	PercUseful	.557	1
PercUseful3	←-	PercUseful	.681	***
PercUseful2	←-	PercUseful	.576	***
PercUseful1	←-	PercUseful	.701	***
Cont1	←-	Continiuance	.692	1
Cont2	←-	Continiuance	.745	***
Cont3	←-	Continiuance	.744	***

Cont4	←-	Continiuance	.795	***
Cont5	←-	Continiuance	.793	***
SocUseful4	←-	SocUseful	.732	[1]
SocUseful3	←-	SocUseful	.671	***
Trust5	←-	Trust	.655	[1]
Trust1	←-	Trust	.771	***
Trust2	←-	Trust	.709	***
MutUnderst5	←-	Understanding	.793	[1]
MutUnderst4	←-	Understanding	.674	***
MutUnderst3	←-	Understanding	.774	***
MutUnderst2	←-	Understanding	.637	***
MutUnderst1	←-	Understanding	.682	***
RelatEnh2	←-	Relationship	.848	[1]
RelatEnh1	←-	Relationship	.909	***

[1] marker variable/reference item for measurement
*** confidence level 0.005

The estimated model confirmed that in the context of cross-organisational collaboration the groupware solutions can positively impact the perceived communication by providing social usefulness (ß=0.77). The perceived social usefulness is a result of the opportunity to recommend ideas to other virtual team members (0.67), as well as form relationships with other virtual team members (0.73). However, the hypotheses (H2a, H2b, H2c) were not confirmed based on the lack of significance. Therefore, there is no evidence that the social usefulness, results from postulated ability of the system to enhance mutual understanding, trust, nor enhance the relationships with others.

However, social usefulness significantly relates with perceived usefulness (ß=0.77) and explains 60% of its variance (R2=0.6). That allows us to positively validate the H1. Further, the perceived usefulness has significant strong impact on the continuance intention (ß=0.92) and explains 92% of its variance (R2=0.92) which provide us support to positively validate H3.

4.6. Discussion of results

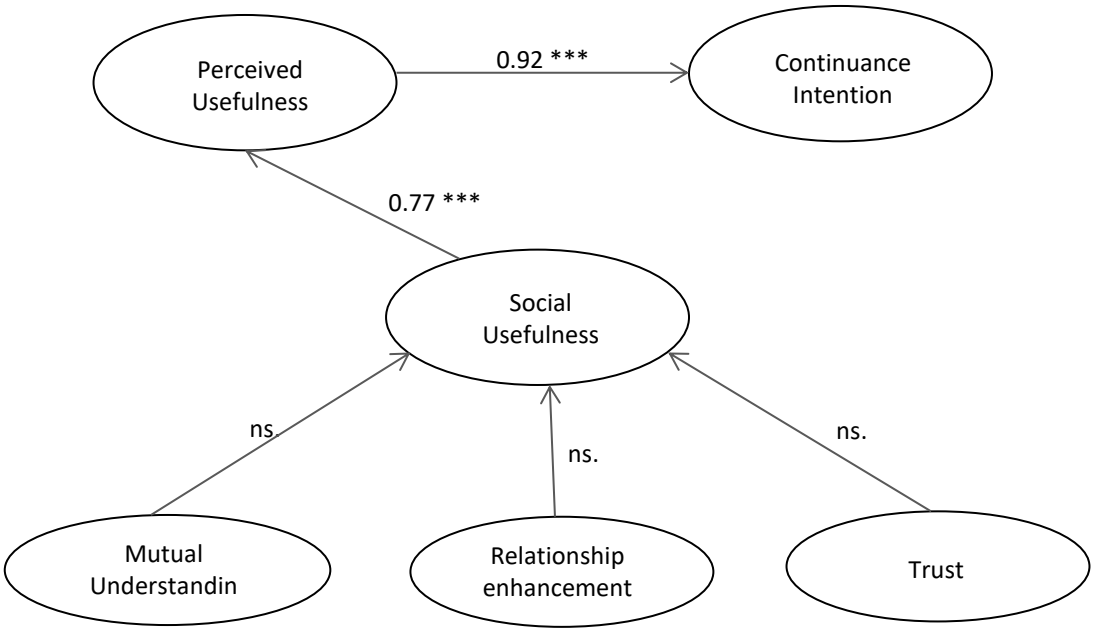
In accordance with information theory, our study shows that in the scope of cross-organisational collaboration the users' positive attitude towards further engagement in cross-organisational collaboration via AdminProject is related with its enabling character in the scope of cross-organisational communication (Perceived Usefulness). The results confirm therefore that, in the scope of cross-organisational communication for innovation, adjusted to the needs of stakeholders solution may positively influence attitude towards cross-organisational collaboration. In our model the outcome however did not result directly from the system factors, but was caused by social factors related specifically with its ability to build familiarity (su4) and ability to be heard and included (su3). Our results, based on the specific case of specialised groupware solution for cross-organisational collaboration for innovation, show that social usefulness is relevant for usefulness of groupware in the scope of

cross-organisational communication. But, more importantly, it empirically shows that such groupware can generate relevant social impact.

The social usefulness was indicated by the system ability to form relationships, confirming its ability to build awareness and familiarity between partners (Graham, 1996, Plewa et al., 2013a, Plewa et al., 2013b). By providing interactive space for interactions, computer mediated communication (CMC), such as AdminProject, may provide institutionalised 'consensus space' with atmosphere encouraging spontaneous communication. That will foster positive attitudes toward engagement and collective achievements (Hassen, 2018). Together with the support for establishing relations, it can contribute to social proximity influencing how agents network, collaborate and innovate (Kim & Jang, 2019). However, there is no evidence that the social usefulness is related with the system ability to encourage trust, mutual understanding or enhancing relationships. Those behavioural factors are in this case not the specific drivers of social usefulness that proved to indirectly affect the intention to continue engagement in cross-organizational communication.

From one side, the insignificant causal relations between the groupware ability to contribute to social usefulness by means of mutual understanding, relationship enhancement and trust may suggests that face-to-face relations are required for their development and should necessarily complement CMC solutions (Vick & Nagano, 2018; Salimi et al., 2016). From the other side, the analysed groupware is a tool supporting implementation of EU projects and is not purely focused on communication solutions. Hence, does not incorporate a broad range of CMC solutions. The results can be therefore related with its specific architecture. As literature on CMC suggests that not included in the scope of AdminProject communication solutions, such as i.e. video chats (Graham 1996; Kodama 2002) or instant messaging (Ajjan et al., 2014) can be of the essence for providing efficient means for enhancing mutual understanding, relationships and trust within CMC. While those relations were not confirmed the model shows that the system provides social mechanisms that are relevant for fostering and encouraging behavioural intentions toward cross-organisational communication (see Figure 4.4).

Figure 4.4 Hypothesis testing results: structural equation model (***p<0.001)



4.6. Conclusions

Both, existing literature and practice show that computer mediated communication (CMC) tools provided increased possibilities for knowledge reconfiguration for innovation. That includes the possibility to innovate and exchange knowledge not only across organisational, but also national borders. The new opportunities bring also new challenges related not only with cross organisational barriers to communication, but also with a geographic barriers making such communication highly CMC dependant. Literature suggests that to reduce barriers and uncertainty of such a communication, a proper interface providing mechanisms not only for communication, but also for socialisation has to be established (Sherwood & Covin, 2008; Plewa et al., 2013b; Ju et al., 2016). In the resulting from this study model, the social usefulness was postulated as an important factor of perceived usefulness which in turn influences the behavioural intention to continue the CMC based cross-organisational communication. Based on the specific case of specialised groupware solution for cross-organisational collaboration for innovation – AdminProject, our results show that social usefulness is relevant for usefulness of groupware in the scope of cross-organisational communication. However, there is no evidence that the social usefulness is related with the system ability to encourage trust, mutual understanding and enhancing relationships. Those behavioural factors did not significantly contributed to social usefulness of AdminProject that proved to indirectly affect the intention to continue engagement in cross-organiational communication.

However, while there is no evidence that the specific system enhances relationships, the social usefulness was indicated by the system ability to form relationships, confirming its

ability to build awareness and familiarity between partners (Graham, 1996, Plewa et al., 2013a, Plewa et al., 2013b). While the lack of the system ability to develop trust, mutual understanding and enhance relationship can be case specific and specific design could potentially provide those postulated benefits from groupware based communication (Santoro & Saparito, 2003; Bayne et al., 2016), the model shows that the system provides social mechanisms that are relevant for fostering and encouraging behavioural intentions toward cross-organisational communication.

Those empirical findings not only underline the need to account for social usefulness in analysis of groupware as a specific CMC, but show that to optimise the effectiveness of groupware solutions in the scope of collaborative innovation, developers need to design systems not only facilitating the communication and management, but also providing socialisation mechanisms that will facilitate communication across organisational boarders. Our study clearly underlines that despite limited attention of academic literature in the scope of cross-organisational communication for innovation to CMC, current ICT development provides significant potential to aid such interactions and can contribute to decreasing barriers between organisations. Therefore, further studies should be conducted to understand how to effectively use ICT technology to capitalise on dispersed across organisations knowledge sources. In that scope our study shows that not only system characteristics, but their interrelation with behavioural factors should be taken into account. From the other side as the reasons for the lack of expected impact of the system on enhancing mutual understanding, trust and relationships are unclear, alternative system with different types of solutions for cross organisational communication should be studied to obtain clarification in the matter. As the postulated mechanisms were not shown to be significant, further studies should look to answer what system characteristics and/or mechanisms would be relevant for enhancing system usefulness, with the special focus on social usefulness. Nevertheless, the obtained model suggests that specifically designed systems for cross-organisational collaboration have potential to positively contribute to the extent of cross-organisational communication for innovation, including the U-I communication. The study implies that decision makers should pay stronger attention to CMC solutions within strategies for cross organisational communication and should look not only look at ICT technology as on a tool for pure transfer of information, but as a potential tool to establish social proximity that can influence positive attitude toward cross-organisational communication and involvement in open innovation. Therefore, further studies should look to better understand the CMC potential to optimise potential benefits of long distance communication for innovation across organisations and national borders. As our study, due to the limited sample, did not allow for analysis of complex model integrating comprehensive set of groupware characteristics and behavioural factors, further studies should look to improve the model and test models better reflecting the complexities of groupware solutions and their potential to overcome organisational barriers.

4.7. Appendixes

Table 4.8. List of removed items

Items
Social usefulness (1 = strongly disagree to 5 = strongly agree)
SU1: Using Admin project helps me to obtain respect from other virtual team members.
SU2: Using admin project improves how I am perceived by the other virtual team members.
Trust (1 = strongly disagree to 5 = strongly agree)
TR3: Admin project users are concerned about what is important to others.
TR4: Admin project users will do everything within their capacity to help others.
TR6: The Admin Project users are concerned with what is important to others

Chapter 5

Understanding potential of groupware solutions for enhancing cross-organisational communication for innovation – bridging character of system functionalities

5.1. Introduction

Recent fast development of modern technologies led to new opportunities and challenges. From one side it generates opportunities and facilitates long distant communication providing opportunities to access information and knowledge globally. From the other side it intensified global competition demanding from organisations new strategies to remain relevant in the highly competitive environment (Korzhenevskaya, 2014). The global changes require moving toward knowledge and innovation based strategies for organisation at micro-, meso and macro level to remain competitive. However, the broad access to modern technology and intensification of competition made the knowledge highly dispersed and modern technologies and processes highly complex. As a result of increased body of knowledge, increasing importance of multidisciplinary approaches for modern innovation and shortening of knowledge lifecycle, modern economies require cross-organisational communication for innovation and development to remain competitive (Vanhaverbeke, 2017).

In that scope the capability to communicate and collaborate across organisational and geographical boarders to access, generate and apply the knowledge becomes a crucial factor of competitiveness (Martins, 2016). The capability allows not only to increase the knowledge available within the organisation, region or even a country, but provides a unique opportunity to compensate for lack of internal knowledge and resources (Vanhaverbeke, 2017). In that way the collaborative approach to innovation provides new development and growth opportunities to organisations and economies that were previously lagging due to i.e. small scale. The existing body of literature shows that taking full advantage of opportunities for the broad scope open innovation will require: 1/ proper innovation system (Hassen, 2018); 2/

organisational capacities (Martins, 2016); and 3/ specific tools and mechanism supporting long distance communication and knowledge exchange (Neumann & Prusak, 2007).

Currently literature on cross-organisational communication discusses the barriers and tools to support cross-organisational communication (Vries et al., 2019). However, it does not provide much attention to specific tools for long distance communication. Even though those tools are a requirement to make such a communication and knowledge exchange possible, there is not much known up to that point about the effectiveness of such tools in providing bridges between different types of organisations and locations. Literature on computer mediated communication (CMC) suggests that a proper communication platform may not only facilitate the communication, but also influence the behavioural aspects of communication (Graham, 1996; Kim & Lee, 2012). Therefore, providing long-distance communication tools that would foster and optimise cross-organisational communication for innovation may increase effectiveness and productivity of innovation on micro and macro level. But, it also may impact the attitude of participants toward such a communication as a way to overcome the typical barriers to cross-organisational communication i.e. differences in culture, purpose, processes or understanding gap. Furthermore, literature points on the specific need for studies regarding stakeholders adapted and optimised communication (Fiehe et al., 2014). Our study specifically aim to look into those gaps in the literature and analyse a specific groupware solution for cross-organisational communication to verify whether specific system characteristics providing participatory character of communication (Kim & Jang, 2019), transparency (Kim & Lee, 2012) and interactivity (Chang & Wang, 2008) can positively impact the usefulness of such ICT solution for cross-organisational communication for innovation and satisfaction of users from such a communication. As such we aim to underline the aspects of ICT infrastructure which should be implemented into solutions for cross-organisational communication that will help building proper attitude toward cross-organisational communication and building long term communication across organisations.

Our results imply that within groupware solutions proper mechanisms supporting transparency and inclusive character of communication, as well as system interactivity are solutions contributing to usefulness of such a solution in the scope of cross-organisational communication. Those may support building innovation culture on the cross-organisational interface and indirectly impact emotions related with such a communication. From the other side our survey results suggest that gaps in priorities, incentives, cultures or language can be still considered relevant by agents already involved in cross-organisational communication beyond its informal and formalisation stage. Analysed in the scope of the model system characteristics can support overcoming such barriers and contribute to engagement in cross-organisational communication for innovation. Therefore our study contributes to scarce literature on CMC application in the scope of inter-sphere communication by analysing enabling system mechanisms of a groupware solution. From the other side it contributes to

minimal empirical studies on how transparent communication affects attitudinal and behavioural outcomes.

5.2. Theoretical framework

Currently innovation is a common headline strategy for organisations, as well as whole economies. As it strongly benefits from broad inclusion of different visions, knowledge and ideas, the complexity of cross-organisational communication for innovation is commonly involved with specific requirements and challenges. While cross-organisational collaboration for innovation has been broadly recognised as a valid strategy for effective capitalisation on resources within economic systems (Sandberg et al., 2014), the communication processes required need to overcome a number of organisational barriers. Communication systems for cross-organisational communication need not only ensure effective and clear communication to ensure negotiations and mediations (Fields, 2006), but whenever a variety of different organisations is included, the communication process will encounter a number of barriers, such as gaps in cultures, language, understanding or organisational orientation and perception (Pablo-Hernando, 2015; Gera, 2012, Vick & Nagano, 2018). Especially communication with organisations applying egalitarian approach to communication limiting understanding and dissemination of produced knowledge to external stakeholders can be highly challenging (Lissoni, 2010).

Those gaps can from one side prevent the cross-organiational communication, but also can significantly decrease satisfaction from cross-organisational communication in a long term by decreasing mutual understanding, limiting trust and effectiveness of such communication. They can slow down growth of organisations, as well as can contribute to decreased benefits of macro-level efforts to bring different organisations together for exchange of knowledge in innovation (Suomi et al., 2019).

Communication is a consistent predictor of collaboration success by itself as it associates with trust, understanding, commitment and quality of decision making (Alsehru et al., 2016; Salimi et al., 2016). The literature shows that proper communication capacities can be a source of competitive advantage (Martins, 2016). As follows, a proper communication platform for cross-organisational communication that would effectively support communication across organisational boarders can lead to serious competitive advantage (Chen et al., 2013). While literature on cross-organisational communication suggests increasing role of computer mediated communication (CMC) in the scope of communication for innovation and it suggests CMC possible positive role for overcoming organisational barriers beyond the geographical distance (Treadaway, 2004; Santoro & Saparito, 2003), it does not provide information how to create a dedicated system that would enhance satisfaction from cross-organisational communication.

Study presented in the previous chapter shows that social usefulness is relevant in the scope of perceived usefulness of groupware for cross-organisational communication and continuance intention. However, the social usefulness was not shown to result from the system internal ability to encourage trust, mutual understanding or enhance relationships. Nevertheless, as previous communication studies shown that social and behavioural factors are the main tools to overcome organisational barriers (Santoro & Saparito, 2003; Papagiannidis et al., 2009; Bjerregaard, 2010; Allen et al., 2016) this study looks into specific characteristics of the system that through their mediating character could positively respond to the needs for strongly stakeholder oriented communication system for fostering cross-organisational communication for innovation (Fiehe et al., 2014).

Within the existing studies of computer systems, Kim and Lee (2012), based on a study of government e-participation system, show that specific technological functions within applications can support shared understanding, trust and motivation to participate. Specifically, providing transparency within the communication and information flow can stimulate direct involvement, trust and quality of communication, by i.e. providing new spaces for information and deliberation (Trechsel et al., 2003; Kim & Lee, 2012). Further, Men (2014) argues that day-to-day transparent communication practices largely contribute to positive perception of organisation by internal agents. This perception helps to engage them in dialogue and cooperation, keep them involved, generate greater productivity, improve relationships and collaborative behaviours (Fombrun & van Riel, 2004; Rawlins, 2008; Men, 2014). Transparent communication creates perception of organisations as genuine and credible, which can contribute to overcoming cross-organisational barriers (Rawlins, 2008; Stacks et al., 2013). It can especially positively impact overcoming the cross-organisational barriers as transparency indirectly facilitates individuals' engagement in common goals by their identification with those goals (Vogelgesang & Lester, 2009; Vogelgesang et al., 2013). However, transparency does not aim strictly to increase information flow, but to improve understanding. While limited empirical studies exist testing how mechanisms of transparent communication affect attitudinal and behavioural factors, Men (2014) shows that open and transparent communication encourages engagement in communication, help develop trust and relationships over time. Existing technology may provide tools for transparency (Rawlins, 2008). From that we hypothesise that:

H1 – Mechanisms providing transparency of communication positively influence the perceived usefulness of groupware systems for cross-organisational communication.

Transparency is not only related with providing information. To be transparent information should be kept on the level of substantial completeness (Klaidman & Beauchamp, 1987) when your specific audience is satisfied that they obtained as much information as is essential for them. However, availability of active participation mechanism that allows users acquiring distributing and creating information and knowledge needed for making accurate knowledge

is an important mechanism allowing real transparency, rather than mare disclosure of information (Cotterrell, 2000; Rawlins, 2008). It suggests that:

H2a – Mechanisms for participatory communication positively influence transparency of communication within groupware systems for cross-organisational communication.

Participatory mechanism of communication needs to provide the opportunity to evaluate and provide feedback in a way that motivates improvements and reinforces specific behaviours. Following the ladder of participation by Arnstein (1969), mechanisms for participation should allow interaction and influence by in-depth participation including information, communication, consultation, deliberation and decision making (Arnstein, 1969; Kim & Lee 2012). Participatory mechanisms, next to increased possibility for transparency may provide opportunities for obtaining support of other users and building shared understanding if those include function making it easy to share with others which in turn motivates others to participate frequently (Moon & Sproull, 2008; Kim & Lee, 2012). Therefore:

H2b – Mechanisms for participatory communication indirectly influence the perceived usefulness of the system for cross-organisational communication.

Specific system characteristics have the ability to directly impact the perceived usefulness of the system by the users even if it does not directly provide information. Iteractivity helps users to find, identify and make use of relevant information by providing information access on demand in organised way (Chang & Wang, 2008). As system interactivity is associated with increased attention, involvement and perceived ease of use, we hypothesise that:

H3 – System interactivity will positively influence the perceived usefulness of the system for cross-organisational communication.

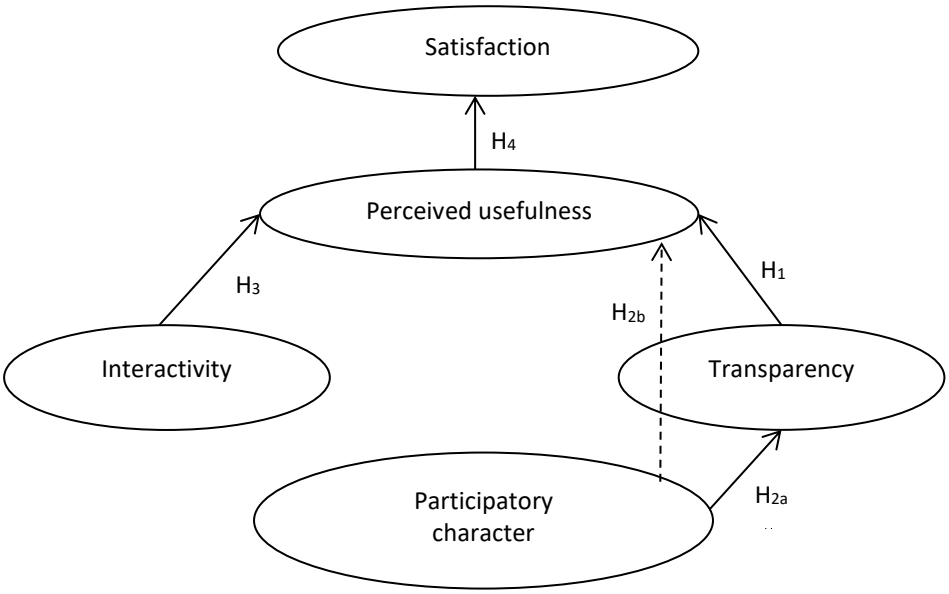
The perceived usefulness relates directly to the extent to which the groupware system is useful to achieve effective cross-organisational communication within the groupware, meaning that it provides improved quality, effectiveness and/or efficacy in the specific context of such a communication. However, satisfaction is more emotional response related with user opinion based on previous use of digital tools (Lin, 2008; Boe et al., 2015). Therefore we hypothesise that:

H4 – The perceived usefulness of system for cross-organisational communication will be positively associated with user satisfaction.

Following the established hypotheses, resulting research model presented in the Figure 5.1, assumes that perceived usefulness of the groupware system for cross organisational communication is positively influenced by providing mechanisms for transparency and participatory character of the communication and the system interactivity. The perceived

usefulness results in user satisfaction and positive emotional reaction related to the process (Lin, 2008; Boe et al., 2015).

Figure 5.1. Research model



5.3. Methodology

The study analyses postulated relations taking as a study subject system AdminProject (for more information see https://www.adminproject.eu/) established for supporting cross-organisational communication in the scope of Erasmus+ Program for cooperation for innovation and exchange of good practices (https://eacea.ec.europa.eu/erasmus-plus/actions/key-action-2-cooperation-for-innovation-and-exchange-good-practices_en). Data were collected from the AdminProject users via online questionnaire (See Annex 1). The population consists of individuals engaged in cross-organisational collaboration for innovation in the scope of Erasmus+ funding scheme. Due to the The General Data Protection Regulation (GDRP) legal limitations within the EU area (requiring special permission for surveys distribution), the survey has been distributed to 187 users, which could be reached within legal boundaries for purpose of a study. After three sets of reminders, we obtained 102 responses. Data screening did not revile missing data in the scope of latent variables or their indicators. To ensure that respondents had sufficient knowledge regarding use of AdminProject for cross-organisational collaboration, a minimum of six months of experience or engagement in min two projects managed via AdminProject were considered as the inclusion criterion. As a result, four observations were excluded from the study, limiting the analysed sample to 98 valid observations (reaching 38% of maximal available sample/population). Those were in the first place screened for unengaged responses, which were not identified in the sample, nor were outlier based anomalies.

To reach the established study objectives the model was estimated using Structural Equation Modelling Approach (Holbert, 2002). For that purpose the survey included the predefined 5 latent variables. The scale items were adapted from previously developed studies, with adaptation to the specific case of Admin project (Lin, 2008). Each of the variables was represented by a set of literature based indicators. All items were pretested and after improving their clarity and pertinence the construct were measured according to the defined in the literature Likert scales presented in the table 5.1.

Table 5.1. Constructs specification

Items	Source
Satisfaction (1=disagree strongly, 5=agree strongly)	
US1: I am satisfied with my communication via Admin Project	Lin (2008)
US2: The functions within Admin project meet my needs for communication within collaborative projects	
US3: Overall, I am satisfied with Admin project	
Perceived usefulness (1=strongly disagree, 7= strongly agree)	
PerU1 – Use of Admin project improves the quality of communication with other organisations	Chen & Tsai (2017);
PerU2 – Use of Admin project helps me exchange information within collaborative projects	Boe, Guldbrandsen, & Sorebo (2015)
PerU3 – Use of Admin project enhances effectiveness of communication with other organisations	
PerU4 – Overall, use of Admin project is useful for communication within collaborative projects	
Transparency (1 = strongly disagree to 7 = strongly agree)	
TRN1: Using Admin project communication between collaborating organisations has been more transparent.	Kim (2012)
TRN2: Using Admin project decreased the amount of information provided exclusively to some engaged partners.	
TRN3: Admin project promotes two-way communication between partners.	
TRN4: Admin project has provided greater opportunities to participate in decision making process.	
TRN5: Admin project has provided with an equal opportunity to participate in decision making process.	
Interactivity (1 = strongly disagree to 7 = strongly agree)	
i5. The Admin project enables obtaining responses fast	Chang & Wang (2008)
i6. The Admin project enables providing responses fast	
i7. The Admin project enables fast feedback	
i8. The Admin project provides forum for variety of content	
i9. The Admin project helps me keep engaged in discussions	
i10. The Admin project makes it easy to find what I want	
Participatory character (1 = strongly disagree, 7 = strongly agree)	
PC1: Using Admin project encourages asking for feedback from people like me about the quality of information/work/outputs.	Men (2014)
PC2: Using Admin project encourages involving others to help identify the information I need.	Rawlins (2008)
PC3: Using Admin project encourages sharing detailed information with all partners.	

PC4: Admin Project makes it easy to find the information people like me need.
PC5: Using Admin project encourages to ask opinions of others before making decisions.
(p) AdminProject helps us to understand who are our partners and what are their needs.

5.4. Data analysis and results

To verify the assumed hypotheses and proposed model, SEM methodology was used. The analysis was conducted using SPSS 23, Amos 21 and Excel 2010. Following the proposed model initial structural model contained five latent variables: (a) satisfaction (Satisfaction); (b) perceived usefulness (Usefulness); (c) interactivity (Interactivity); (d) transparency (Transparency); and (e) particiapatory character (ParticipatoryCh).

The obtained sample covered 98 AdminProject users representing diversified range of organisations across four helixes – industry, academia, governmental and social sector (see Table 5.2).

Table 5.2. Study sample

Profile of respondents (N=98)			
Measure	Item	Frequency	%
Type of organisation	Private company	43	44%
	Higher education or academic organisation	18	18%
	NGO	29	30%
	Governmental organisation	7	7%
	Others	1	1%
Size of organisation (employees number)	<10	28	29%
	10-100	31	32%
	101-500	20	20%
	>500	19	19%

Taking into account a broad scope of engaged organisations, to verify interest of specific organisation types in engagement with different helixes, respondents were asked to what extent the respondent believes it is important to his/her organisation to increase collaboration with organisations from each of helixes (see the full survey form in Attachment). Following the results presented in Table 5.3, participants considered increasing engagement with all types of organisations into cross-organisation collaboration for innovation important. While the interest in increased collaboration with industry was shown to be slightly higher than in other categories and with governmental organisations the lowest, all types of organisations recognised the need for increasing cross-organisational collaboration across all spheres. However, with exception of governmental organisations, the organisations from the same helix were recognised as the most important partners.

Table 5.3. The perceived importance of increasing collaboration across specific organisational spheres

N=98	I believe it is important to organisations like mine to increase collaboration with: (1 = strongly disagree; 5 = strongly agree)			
Respondents organisation:	Higher education or academic organisation	Private company	NGO	Governmental organisations
NGO	4.36	4.39	4.41	4.21
Higher education or academic organisation	4.50	4.33	4.39	4.11
Private company	4.27	4.34	4.25	4.24
Governmental organisations	4.00	4.43	4.14	4.14
Grand Total	4.32	4.36	4.32	4.20

Measurement model

To validate the established hypothesis the initial measurement model (see Figure 5.2) was estimated using CFA to test its validity. It overall fit was assessed using four measures – CMIN/DF (x2/d.f.), CFI, PCLOSE and RMSEA (see Table 5.4). The evaluation of the model based on initial conceptualization implied the need for further model adjustments.

Within the model evaluation procedures, based on initially obtained loadings, standardized covariance residuals matrix and modification indexes the initial measurement model has been adjusted, resulting in additional covariance relations between residuals, as well as removing specific items from the measurement model: transparency 1, transparency 2, perceived usefulness 2 and interactivity 6 (Anderson & Gerbing, 1998, p. 417; Hermida, 2015) (for full list of removed across the SEM procedures items see Table 5.8 in appendixes). That resulted in the adjusted measurement model presented in Figure 5.2 and Table 5.5.

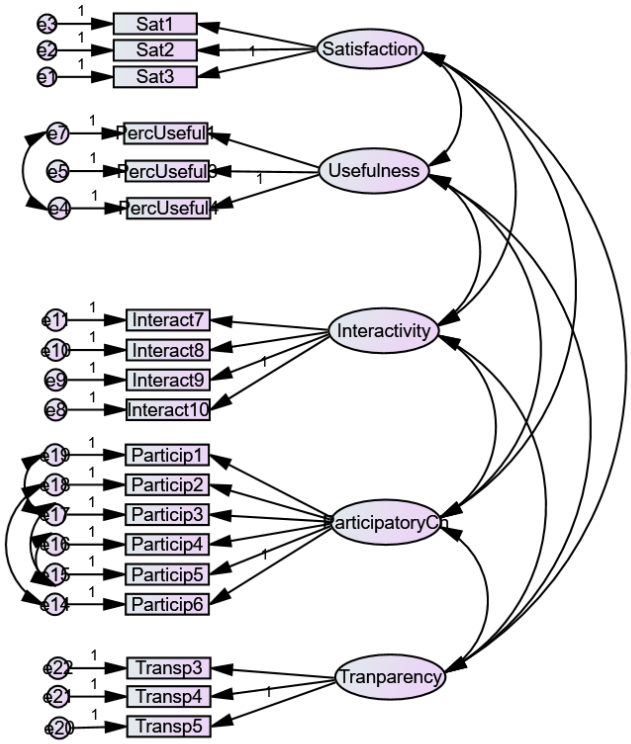
Table 5.4. Fit indexes for the measurement model

Index	Measurement model	Recommended value	Source
CMIN/DF	1.350	<2	Fornell (1983)
CFI	0.937	>0.9	Bagozzi & Yi (1988)
PCLOSE	0.227	>0.05	
RMSEA	0.060	<0.08	MacCallum et al. (1996)

Figure 5.2. The measurement model

Table 5.5. Standardized Regression Weights

			Estimate
Sat3	<---	Satisfaction	.702
Sat2	<---	Satisfaction	.813
Sat1	<---	Satisfaction	.812
PercUseful4	<---	Usefulness	.608
PercUseful3	<---	Usefulness	.617
PercUseful1	<---	Usefulness	.729
Interact10	<---	Interactivity	.751
Interact9	<---	Interactivity	.604
Interact8	<---	Interactivity	.590
Interact7	<---	Interactivity	.588
Particip6	<---	ParticipatoryCh	.772
Particip5	<---	ParticipatoryCh	.784
Particip4	<---	ParticipatoryCh	.774
Particip3	<---	ParticipatoryCh	.654
Particip2	<---	ParticipatoryCh	.710
Particip1	<---	ParticipatoryCh	.672
Transp5	<---	Tranparency	.549
Transp4	<---	Tranparency	.701
Transp3	<---	Tranparency	.533



The measurement model was then assessed for validity. Presented in the Table 5.6 statistics show that the Critical Reliability values met the requirement of 0.6 threshold (Fornell & Larcker, 1981). However, values of AVE suggested the need for adjustments in 3 constructs – Usefulness (AVE=0.446), Interactivity (AVE=0.384) and Transparency (AVE=0.360). Attempts to improve validity of those constructs has been made. However, none of the possible adjustments in the construct resulted in the AVE improvement. As the corrective measures led to decreasing validity and when AVE is below 0.5 threshold, but CR>0.6, CR alone can be used to conclude that the convergent validity of the construct is adequate (Fornell & Larcker, 1981; Malhotra & Dash, 2011, p.702), the model presented in figure 5.2 has been established as the valid measurement model (see Figure 5.3 and Table 5.6).

Table 5.6. Validity test values

	CR	AVE
Usefulness	0.702	0.446
Interactivity	0.711	0.384
Transparency	0.669	0.360
ParticipatoryCh	0.873	0.534
Satisfaction	0.811	0.590

Structural model and path analysis

After establishing final measurement model, structural model has been established and analysed using AMOS 21 and Excel 2010. The structural model fit was validated using measures previously applied in the scope of measurement model fit analysis (see Table 5.4). The obtained fit indices, CMIN/DF=1.314, CFI=0.941, PCLOSE=0.325 and RMSEA=0.056, provided evidence of a good fit. Therefore, path analysis was conducted to verify the established hypotheses. The estimated path coefficients reviled significant relations between endogenous latent variables within the structural model. While no high significance was defined between the Transparency and Usefulness, the significance has been confirmed at the 0.01 confidence level (P=0.005) (see Table 5.7).

Table 5.7. Standardized Regression Weights and significance

			Estimate	P
			Estimate	
Transparency	<---	Participatory	.657	***
Usefulness	<---	Interactivity	.580	***
Usefulness	<---	Transparency	.543	* [2]
Satisfaction	<---	Usefulness	.696	***
Interact10	<---	Interactivity	.769	[1]
Interact9	<---	Interactivity	.599	***
Interact8	<---	Interactivity	.581	***
Interact7	<---	Interactivity	.541	***
Transp5	<---	Transparency	.553	[1]
Transp4	<---	Transparency	.705	***
Transp3	<---	Transparency	.538	***
Particip4	<---	Participatory	.778	[1]
Particip3	<---	Participatory	.661	***
Particip2	<---	Participatory	.702	***
Particip1	<---	Participatory	.675	***
PercUseful4	<---	Usefulness	.550	[1]
PercUseful3	<---	Usefulness	.589	***
PercUseful1	<---	Usefulness	.678	***
Sat3	<---	Satisfaction	.696	[1]
Sat2	<---	Satisfaction	.798	***
Sat1	<---	Satisfaction	.802	***
Particip5	<---	Participatory	.782	***
Particip6	<---	Participatory	.769	***

*confidence level 0.01; *** confidence level 0.005

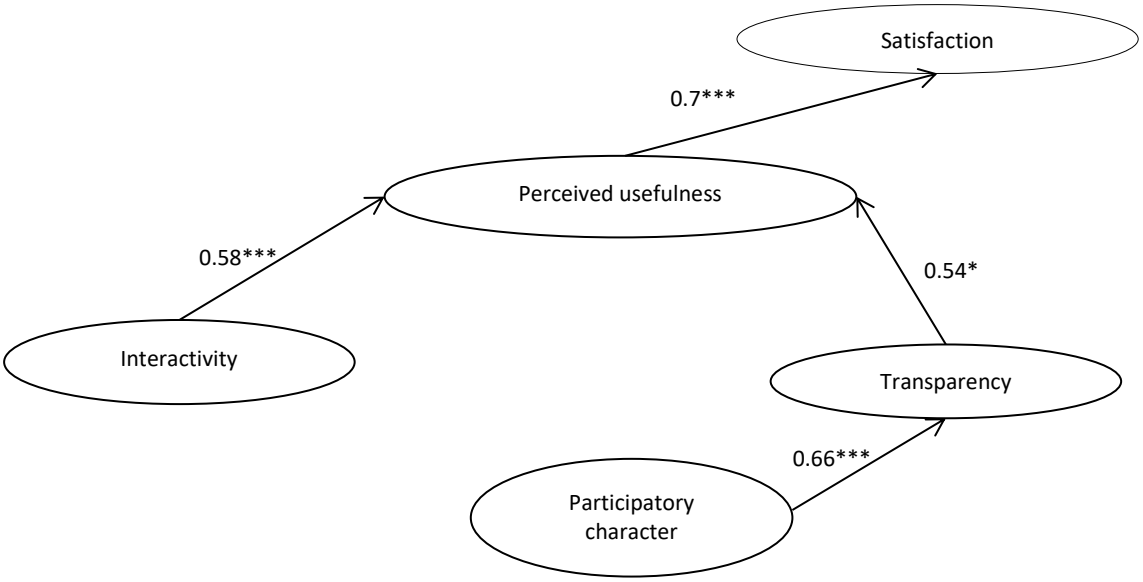
[2] the reported p-value was reported at the higher boarder level of the confidence interval p= 0.05

[1] marker variable/reference item for measurement

Following the established hypothesis the model has confirmed that in the context of cross-organisational communication for innovation transparency (β=0.54) and interactivity (β=0.58) directly and positively influence the usefulness of the system for communication across different types of organisations. That leads to positive verification of hypothesis H1 and H3.

The results allow to positively verify hypothesis H2a and H2b, showing that mechanisms for participations positively impact perceived usefulness indirectly by contributing to transparency of communication within the system (ß=0.66). As expected, the perceived usefulness of the system for cross-organisational communication is positively related with users satisfaction (ß=0.7), leading to positive verification of hypothesis H4.

Figure 5.3. Hypothesis testing results: structural equation model (*p<0.01; ***p<0.001)



5.5. Discussion of results

In the first place, our data analyses show that while respondents across all organisational spheres consider cross-organisational collaboration important, with the exception of governmental organisations, all groups accredit the highest importance to collaboration within its particular helix. That may suggest that gaps in priorities, incentives, cultures or language can be still considered relevant by agents already involved in cross-organisational communication beyond its informal and formalisation stage.

The obtained SEM results suggest that specific system features may contribute to bypassing those barriers between organisations. The outputs imply that satisfaction within the usage of AdminProject in the scope of cross-organisational communication is based on its usefulness in that scope. It is resulting from its functions providing transparency, participatory character and interactivity. In the specific system, the transparency is ensured by open unrestricted access of all project participants to all information and their ability to freely provide contributions. In that way it enables transparent two-way communication and greater and more equal opportunities to participate in decision making process independently from

participants organisational association or status. Such aspects contribute to building innovative atmosphere that encourages individual willingness to collaborate and engage in experimental activities (Kim & Jang, 2019). In accordance with literature, our empirical results suggest that such transparency mechanism can stimulate quality of cross-organisational communication by providing effective inclusive space for information and deliberation and increasing credibility of individuals and organisations (Kim & Lee, 2012; Men, 2014). Well-established system with participatory decision making procedures and other collective rituals provides culture leading to trust establishment and broader openness to accept risk and uncertainty for a collective objective of innovating (Kim & Jang, 2019). AdminProject transparency system allows unrestricted access of all to overall communication and all modules enhancing users believe that they have access to everything they need to know which is requirement to obtain benefits of transparency (Rawlins, 2008). However, transparency is not only concerned with increase of information flow, but also with improved understanding and credibility (Men, 2014). Hence, obtaining transparency is rarely one side process, but requires engagement of stakeholders (Men, 2014). Transparency mechanism is strongly emphasized by availability of active participation mechanism allowing dialogic communication including acquiring, distributing, creating ideas and knowledge, engaging in feedback loops, but also obtaining support and space for looking for shared understanding and consensus (Kim & Lee, 2012; Kim & Jang, 2019; Rawlings, 2008). Such participating mechanism represented in AdminProject by such functions as unrestricted ability to establish and contribute to discussion panels, all participants available management documents or file storing system. Broad feedback mechanisms available across different functions provide ability to evaluate, provide and request feedback, hence accountability mechanism that motivates improvements and reinforces specific behaviours (Rawlins, 2008). It contributes to mutual understanding, motivates more frequent participation and provide easiness of communication (Kim & Lee, 2012; Men, 2014). The transparency and inclusive character of groupware communication supports building trust and understanding recognised as bridging mechanisms for the top U-I communication barriers (Plewa et al., 2013b; Ju et al., 2016). Jahansoozi (2006) argues that in case of crisis of trust between organisations transparency is the relational condition that promotes cooperation and commitment, therefore an effective transparency mechanism can mediate organisational barriers even in the lack of trust.

Our results empirically confirm the stimulating character of cross-organisational communication transparency and participatory character on perceived usefulness of groupware for communication across actors from across organisational helixes and suggest those mechanisms' positive impact on overcoming barriers to such a communication by encouraging positive beliefs and behaviours. However, the significance of relation between transparency and perceived usefulness was not highly significant. Low significance of transparency can be related with the fact that it is only partially dependant from the existing mechanisms for communication and partially from users' behaviour and their ability to apply

it accordingly, i.e. providing relevant and complete information (Klaidman & Beauchamp, 1987). That suggests the high importance of proper training of the users regarding effective use of the available tools and their openness to adopt established within the system protocol standards (Pendergast & Hayne, 1999). That can require proper encouragement of individuals at the organisational interface from the side of organisational leaders (Kim & Jang, 2019). The tries to be transparent are also often lost due to the lack of confidence in the quality of provided into the system information (Rawlins, 2008). That shows that the positive effects of transparency mechanisms can be hindered by the improper usage of the provided tools. Hence, importance of tools the process literacy.

Meanwhile, as suggested by previous literature, the system itself can be a predictor of the groupware usefulness for cross-organisational communication. Embedded interactivity allowing on-demand access to information in organised way can help users to access the information according their availability and time line requiring for processing obtained information. That can positively contribute to decreasing faced in the scope of international collaborative projects cognitive, procedure and time differences. The system interactivity may positively contribute to increased attention and involvement and perceived ease of use (Chang & Wang, 2008).

Furthermore, as expected, the model shows that the observed perceived usefulness for cross-organisational communication positively influence emotional reactions related to the process - the users satisfaction (Lin, 2008; Boe et al., 2015). Therefore, the model suggests that satisfaction with the use of AdminProject in the scope of its use as a cross-organisational communication tools based on its usefulness in that scope and indirectly by functions providing transparency, participatory character and interactivity will result in 1/ positive emotional reaction related with the collaborative experience, 2/ by providing mechanisms for transparency, participatory character and interactivity it may positively contribute to overcoming typical barriers to cross-organisational communication.

5.6. Conclusions

The study empirically verifies that system characteristics and mechanisms, and specifically mechanisms enabling transparency, participatory communication and interactivity, can positively influence communication across organisational boarder stimulating positive emotional reactions among users (Lin, 2008; Boe et al., 2015). Following the discussion of results, it can positively contribute to the overall attitude toward cross-organisational communication. The specific mechanisms may impact the individuals' beliefs and behaviours which may contribute to overcoming barriers to cross-organisational communication.

Our study analysed currently existing system designed in the first place to fulfil management needs of organisations engaged in cross organisational collaboration. Despite lack of main

focus of the system on fostering cross-organisational collaboration, embedded in the system basic solutions for providing transparency, participatory character and interactivity has shown to have enabling character for cross-organisational communication. That clearly shows significant potential of such groupware to provide effective mechanism for bridging organisational gaps within communication for innovation and stimulate collaborative innovation. The enabling character of the solution for overcoming barriers between organisations was associated with providing equal opportunity to participate in decision making process, ability to share, access and openly discuss information independently from the status or organisational affiliation and facilitating obtaining and providing fast feedback. Such functions were shown to be relevant and should be in the future included in solutions for cross organisational communication. However, potential of integrating further solutions to optimize that effects like i.e. typically communication oriented solutions for interaction and information sharing should be further analysed to understand how potential of groupware platforms can be fully taken advantage of to improve cross-organisational communication for innovation. Embedding effective systems for transparency and participatory approach may support building innovation culture on the interface between organisations. However, the role of the available system literacy to generate expected impact and respect for internal protocol is underlined by the study.

The study to our knowledge as first approaching the topic of computer mediated communication (CMC) specifically designed for needs of collaboration between different types of organisations for innovation face number of limitations. In the first place the limited sample limits the possibility for an extensive model that could account for a broad range of factors. Among others the relation between behavioural factors as trust or relation enhancement, system characteristics, usefulness and user satisfaction could not be tested due to the sample size limitations. Direct inclusion of specific barriers faced in the scope of cross-organisational communication, as well as those related with international scope of the communication within analysed system would be expected to be of importance for further models. Further studies therefore should look into integration of those different perspectives and possible links postulated in the literature. Moreover, as the system identified in the scope of the study provides one specific solution, a comparative study of other solutions and their comparison could strongly contribute to obtaining in-depth understanding of the topic.

5.7. Appendixes

Table 5.8. List of removed items

Items
Interactivity (1 = strongly disagree to 7 = strongly agree)
i5. The Admin project enables obtaining responses fast
i6. The Admin project enables providing responses fast
Transparency (1 = strongly disagree to 7 = strongly agree)
TRN1: Using Admin project communication between collaborating organisations has been more transparent. TRN2: Using Admin project decreased the amount of information provided exclusively to some engaged partners.
Perceived usefulness (1=strongly disagree, 7= strongly agree)
PerU2 – Use of Admin project helps me exchange information within collaborative projects

Chapter 6

Final considerations

The dissertation studies the methods to support university-industry (U-I) communication for innovation. The initial systematic literature review (Chapter 1) results in analysis of studied in the literature communication tools and their application or requirements to overcome the existing barriers to U-I communication. The review reviled not only a strong need for improving the U-I communication channels and supporting measures, but also significant gaps in knowledge how communication could effectively bridge gaps between university and industry. The study shows that there are significant gaps in understanding how to enable and foster U-I communication for innovation on both micro and macro level. However, it suggests that only a proper integration of complementary tools and measures can generate optimal benefits from investments in research and development on global scale.

Therefore, as to provide sustainable solutions for long term U-I communication effective interventions at both of those levels are necessary, we follow with analysing within the empirical part of the study in the first place how governments can support U-I communication to generate economic growth and innovation followed by analysis of how such communication can be effectively facilitated within an ICT environment.

Our study of impact of U-I communication on economic growth within Chapter 2 shows that despite postulated impact of U-I communication on economic growth there is no empirical evidence of such a benefit at macro level at any level of economic development. Therefore, despite significant investments in policy tools supporting U-I communication for innovation in many economies, the results remain insignificant. It shows that currently applied methodologies are inefficient and there is a strong need to look for better solutions to make U-I communication for innovation more relevant and effective. The research empirically shows that macro-level facilitation including among others policy measures aiming at increasing quality of research institutions or level of private R&D investments are necessary, but should be carefully designed to the specific needs of the region rather than transferred from different contexts. Furthermore, while policies encouraging improvements in the perceived quality of research institutions and private R&D investments matter across all development levels, for lower development levels the staff training related with absorptive capacity is relevant. Our results underline as well the role of proper innovation system in place which depending on its design can have both enabling and hindering impact on U-I

communication. Therefore, supporting U-I communication will require intelligent policy making. Meanwhile, while the results are at the current state not conclusive, the empirical results of the study may suggest that U-I communication could serve as a relevant strategy to decrease negative impact of economic recession. That would further increase the possible benefits of making effective U-I communication for innovation a strategic objective at the level of whole economy.

While a systemic change aiming at removing macro-level barriers to U-I communication would be a significant engine for increasing U-I communication for innovation, there is no signs that governments are currently working on radical changes in that matter (i.e. switching from academic-publication centered to science-to-industry communication oriented performance review systems of academics and universities). In that scope involved stakeholders should focus on looking at alternative/complementary tools and measures that are available for them to overcome the exiting obstacle to U-I communication and incrementally build a system and culture for U-I communication. The analysed body of literature suggest that especially social and behavioural factors, show transversal potential to bridge gaps to U-I communication. Especially relation building oriented mechanisms are commonly associated with mediating effect on U-I communication gap. High level conclusions that could be drawn on the base of existing literature suggest that to obtain numerous postulated in the literature benefits from U-I communication for innovation, communication mechanisms should be designed that:

- Will allow open and professional communication supporting collaborative culture and quest for consensus;

- Are strictly adapted to specific needs of stakeholders engaged in the communication;

- Integrate complementary communication solutions or provide their characteristic to bridge existing communication barriers.

Based on the systematic literature review, majority of proposed mechanisms refers to in-person interaction based tools as the mechanism of main importance for bridging U-I communication gap and improving U-I communication for innovation. However, new challenges call for inclusion of more complex means that could respond to modern challenges and opportunities. Among others, fast development of ICT technologies resulted in increasing dispersion of knowledge and increased ability to access it, hence, to maximally benefit from existing pool of knowledge. Therefore, limiting the U-I communication strategies to local networks and clusters commonly studied in the scope of literature on U-I communication could be counterproductive as valuable innovation resources can be accessed beyond allowing to significantly increase access to knowledge resources.

However, recent studies analysing long distant U-I communication for innovation were not identified. Therefore, following the empirical analysis of macro-level tools, in Chapter 4 followed by Chapter 5, we analyse whether computer mediated communication (CMC) tools could not only enable long distant U-I communication, but also facilitate bridging U-I communication barriers by similar means as in-person interactions. Based on the assumptions drawn from systematic literature review, we identified a specific groupware solution specifically designed for the needs of stakeholders engaged in cross-organisational communication for innovation under Erasmus+ strategic partnerships. Analysis of that solution allowed us to see whether specific groupware solutions can complement the macro tools by supporting professional communication, collaborative culture and quest for consensus and provide characteristics that will help bridging existing communicational barriers. In the process we showed within the Chapter 4 that specific groupware solutions can positively impact cross-organisational communication across both organisational and geographic barriers by providing not only technical, but social usefulness.

While the specific system ability to enhance relationships was not confirmed, the social usefulness was related with its ability to establish a relationship in the first place by building awareness and familiarity between partners. The study shows that despite the analysed system non-direct focus on communication, the system includes characteristics of social mechanisms that are relevant for fostering positive behavioural intentions toward cross-organisational communication. Therefore, as the initial study results reviled the potential of groupware solutions for decreasing cross-organisational communication barriers and fostering positive attitudes towards cross-organisational communication and collaboration for innovation, we follow the study within Chapter 5 with analysis of specific system mechanisms that would be relevant in the process. Following the postulated in the literature characteristic, we found that mechanisms supporting transparency, participatory communication and interactivity can positively influence communication across organisational boarders stimulating positive emotional reaction among users. All in all, it empirically shows that specifically designed for the needs of cross-organisational collaboration CMC can provide not only physical space for communication, but also a social environment in which engaged individuals can in a professional way embed in a quest for consensus. While, following the results, such an environment may provide facilitation means for overcoming barriers to cross-organisational communication, the individuals relational skills (while as postulated in the literature in a more simplified form) (Pendergast & Hayne 1999; Santoro & Saparito, 2003), will still be of high relevance for an effective communication.

Altogether, the thesis shows that a complex strategy with involvement on multiple level is required to reach relevant for economic growth and innovativeness level of U-I communication. Optimal capitalisation on innovation potential within the university and industry sector will require not only active involvement of agents from those spheres, but also

other stakeholders from innovation environment such as government, but also enabling technologies. While university and industry are the main agents responsible for generation of knowledge and innovation, understanding of a broader context (including governments, support organisations as well as environmental factors as existing technology) is necessary to define optimal strategies for optimising U-I communication for innovation.

Limitations and future lines of research

The topic of how support effective U-I communication for innovation and related with it issues has a broad scope. Taking into account the extensive gaps in understanding how to provide effective countermeasures to overlapping at micro-, meso and macro-level issues reflecting in poor U-I communication for innovation, providing comprehensive answer to how specifically design such strategy responding to specific stakeholders needs and different socio-economic conditions will require broad number of practically oriented studies. Those especially regard comparative studies of applicability and effectiveness of specific measures in different contexts and socio-economic conditions. Especially analysis how interaction between measures applied at micro, meso and macro level interact and complement or conflict will be relevant. The resulting practically oriented knowledge will be required to provide decision makers base for well-informed decisions how to design an effective strategy for supporting U-I communication. Such a strategy needs to respond to the needs of stakeholders and socio-economic context. While our study contributes to this discussion, the study faced a number of limitations. First, of all the size of the study allowed us to address a highly limited number of gaps that will need to be addressed to allow knowledge-based strategy design of U-I communication system. Second of all, our study of macro effects of U-I communication is based on the perceived U-I collaboration data collected by World Bank. While the perceived character of the data can reflect not only the strict collaboration, but also its communication and dissemination aspects, a data objectively reflecting the level of U-I communication for innovation could not be identified. That together with limitations of the data in time led to the study data limitation. Furthermore, we analysed a specific system for cross-organisational communication that can contribute to lowering barriers to U-I communication. Limiting to the single system can influence the results by relating them to the specific design. Also the specific available user number limited especially by access issues related with The General Data Protection Regulation (GDRP) decreased our opportunity to analyse the system related predictors impact on cross-organisational communication to a few factors and did not allow us to approach the topic in a highly integrated way. Therefore, further studies should look to validate and extend our findings. Especially, comparing alternative systems and their impact could bring additional contribution. Furthermore, our study focuses on quantitative analysis and should be further substantiate with in-depth qualitative analysis. The area of U-I communication especially suffers lack of studies of supporting ICT tools and strategies. For that reason, our study should be complemented by

further research in the area. In the study we also looked into international level of U-I communication which is rarely addressed in the literature. Our study shows that such a communication occurs between universities and industry and could also bring further benefits. However, understanding of trade-offs between international and national/regional dimension should be better understood to effectively integrate it in U-I communication support strategies (Leydesdorff, Park & Lengyel, 2013).

The thesis, based on the outputs of Chapter 3, provides direct contributions in the form of empirical evidence of lack of critical mass of effective U-I communication for innovation across all the development levels. It identifies specific policy directions that should be considered prioritary at each of the development levels. Our study also suggest a potential of U-I communication to mediate negative effects of economic downturns, which should be further studied. Within chapters 4 and 5, we show the potential of groupware solutions to build social capital and identify specific functionalities that may enable overcoming barriers to cross organisational communication with U-I engagement. With those studies we contribute to lacking quantitative studies in the area. Our quantitative study of the groupware platform is to our knowledge a first quantitative study of ICT tools in the scope of European cro-organisational communication with U-I involvement. However, our study by integrating the fragmented knowledge regarding barriers, tools and factors of U-I communication allows also to extract broader significance of the knowledge previously in existence. It allowed us to extract from one side a more practice oriented framework for decision making, but, as the knowledge is highly incomplete, probably more importantly, also the guidelines for the research regarding specific directions requiring further studies to obtain a comprehensive knowledge base on the topic. As highly integrated knowledge on the topic and its popularisation will be required to reach satisfactory level and quality of U-I communication for innovation, we hope that our research will contribute to further valueable contributions in that area.

Annexes

Annex 1.
Admin project - research questionnaire

Admin project - research questionnaire

This survey aims to determine your attitude towards use of Admin Project as a tool for communicating within collaboration projects including different types of organisations. Below we present a set of questions that will help us understand the importance of different IT system characteristics for your engagement in cross-organisational collaboration and your willingness to continue use the system for future collaborative projects.

We kindly ask you to provide honest answers. That will benefit all users and allow developers and researchers to provide best communication tools for your needs.

The survey will take about 10 to 15 min of your time.

Thank you in advance for your contribution.

Please note that all the responses are anonymous and will be used as aggregated data for statistic purpose only.

*Required

Part 1. Organisational information

1. In the scope of my work with Admin project I am representing: *
Mark only one oval.

Higher education or academic organisation
Private company
NGO (non-governmental organisations)
Governmental organisation
Other:

2. Size of the organization (number of employees)
Mark only one oval.

< 10
10 - 100
101 - 500
> 500

3. I have worked with Admin Project for: *
Mark only one oval.

less than 6 months
6 to 11 months
1 year to 2 years
more than 2 years, less than 5
more than 5 years

4.Number of projects I have been involved that used Admin Project: *
_____

Part 2. Personal information

5. Academic qualifications (please choose the maximum level obtained)
Mark only one oval.

Secondary education or below
Higher education - Bachelor, Engineer or Master Degree
Higher education - PhD Degree

6. Age
Mark only one oval.

18 to 29
30 to 39
40 to 49
50 or above

7. Gender
Mark only one oval.

Female
Male

8. I have professional experience (more than 6 months) of:
Tick all that apply.

working in higher education or academic organisation
working in industry (private companies)
working within public sector
working within private sector
working abroad
studying abroad

9. Country of residence
_____

Part 3. Your experience with Admin Project

10. Do you agree or disagree with the following statements? *
Mark only one oval per row.

	Strongly disagree	Disagree	Slightly disagree	Neither agree or disagree	Slightly agree	Agree	Strongly agree
(a) Admin project enables two-way communication (including providing information as well as feedback to information)	o	o	o	o	o	o	o
(b) Admin project enables providing information to partners independently from they availability at the moment	o	o	o	o	o	o	o
(c) Admin project enables interpersonal interaction	o	o	o	o	o	o	o
(d) Admin project enables conversation	o	o	o	o	o	o	o
(e) Admin project enables obtaining responses fast	o	o	o	o	o	o	o
(f) Admin project enables providing responses fast	o	o	o	o	o	o	o
(g) Admin project enables fast feedback	o	o	o	o	o	o	o
(h) Admin project provides forum for variety of content	o	o	o	o	o	o	o
(i) Admin project helps me keep engaged in discussions	o	o	o	o	o	o	o
(j) Admin project makes it easy to find what I want	o	o	o	o	o	o	o
(k) Using Admin project encourages asking for feedback from people like me about the quality of information/work/outputs.	o	o	o	o	o	o	o
(l) Using Admin project encourages involving	o	o	o	o	o	o	o

	Strongly disagree	Disagree	Slightly disagree	Neither agree or disagree	Slightly agree	Agree	Strongly agree
others to help identify the information I need.							
(m) Using Admin project encourages sharing detailed information with all partners.	o	o	o	o	o	o	o
(n) Admin Project makes it easy to find the information people like me need.	o	o	o	o	o	o	o
(o) Using Admin project encourages to ask opinions of others before making decisions.	o	o	o	o	o	o	o
(p) Admin project helps us to understand who are our partners and what are they needs.	o	o	o	o	o	o	o

11. Do you agree or disagree with the following statements?
Mark only one oval per row.

	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
(a) Use of Admin project improves the quality of communication with other organisations	o	o	o	o	o	o	o
(b) Use of Admin project helps me exchange information within collaborative projects	o	o	o	o	o	o	o
(c) Use of Admin	o	o	o	o	o	o	o

	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
project enhances effectiveness of communication with other organisations							
(d) Overall, use of Admin project is useful for communication within collaborative projects	o	o	o	o	o	o	o
(e) Learning to operate Admin Project is easy for me	o	o	o	o	o	o	o
(f) It is easy to get Admin Project to do what I want to do	o	o	o	o	o	o	o
(g) I have no trouble communicating in Admin Project	o	o	o	o	o	o	o
(h) Overall, it will be easy to use Admin Project	o	o	o	o	o	o	o
(i) I intend to give priority to using Admin Project for communication within collaborative	o	o	o	o	o	o	o

	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
projects.							
(j) I think using Admin Project for communication within the collaborative projects is the right choice.	o	o	o	o	o	o	o
(k) I intend to increase the usage of Admin Project for communication within collaborative projects.	o	o	o	o	o	o	o
(l) I will strongly recommend others to use Admin Project for communication within collaborative projects.	o	o	o	o	o	o	o
(m) It is worth to use Admin Project for communication within collaborative projects.	o	o	o	o	o	o	o

12. Do you disagree or agree with the following statements?
Mark only one oval per row.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
(a) Using Admin project communication between collaborating organisations has been more transparent.	o	o	o	o	o
(b) Using Admin project decreased the amount of information provided exclusively to some engaged partners.	o	o	o	o	o
(c) Admin project promotes two-way communication between partners.	o	o	o	o	o
(d) Admin project has provided greater opportunities to participate in decision making process.	o	o	o	o	o
(e) Admin project has provided with an equal opportunity to participate in decision making process.	o	o	o	o	o
(f) I think in Admin Project I can find accurate and credible information.	o	o	o	o	o
(g) I think in Admin project I can find a complete set of	o	o	o	o	o

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
information.					
(h) Admin project provides me with all the information I need.	o	o	o	o	o
(i) Overall, I am satisfied with the information quality within Admin	o	o	o	o	o

13. Do you disagree or agree with the following statements?
Mark only one oval per row.

	Strong disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
(a) The Admin project platform operates reliably.	o	o	o	o	o
(b) I think the Admin platform allows me to operate specific features I need conveniently.	o	o	o	o	o
(c) I think the system architecture of Admin project is logical.	o	o	o	o	o
(d) The platform functions can be adapted to meet a variety of needs.	o	o	o	o	o
(e) I think Admin project makes me saving a lot of time	o	o	o	o	o

	Strong disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
required to manage communication in collaborative projects					
(f) I think Admin project makes it more convenient to communicate within cross organisations collaboration.	o	o	o	o	o
(g) I think in Admin project searching for information according to my current needs makes it easier to find information than within projects managed without Admin project.	o	o	o	o	o
(h) I think Admin project assists me to handle communication needs within my projects more conveniently.	o	o	o	o	o
(i) I think Admin project makes it easier to collect information.	o	o	o	o	o

14. Do you agree or disagree with the following statements?
Mark only one oval per row.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
(a) Using Admin project helps me to obtain respect from other virtual team members.	o	o	o	o	o
(b) Using admin project improves how I am perceived by the other virtual team members.	o	o	o	o	o
(c) Using admin project gives me the opportunity to recommend ideas to other virtual team members.	o	o	o	o	o
(d) Using admin project helps me to form warm relationships with other virtual team members.	o	o	o	o	o
(e) I feel very confident about the value that the other Admin project users provide	o	o	o	o	o
(f) The other Admin Project users have specialized capabilities that can add to the conversation	o	o	o	o	o
(g) Admin project users are concerned about what is important to others.	o	o	o	o	o

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
(h) Admin project users will do everything within their capacity to help others.	o	o	o	o	o
(i) Admin project users try hard to be fair in dealing with each other.	o	o	o	o	o
(j) The Admin Project users are concerned with what is important to others	o	o	o	o	o
(k) I am satisfied with my communication via Admin Project	o	o	o	o	o
(l) The functions within Admin project meet my needs for communication within collaborative projects	o	o	o	o	o
(m) Overall, I am satisfied with Admin project	o	o	o	o	o

Do you agree or disagree with the following statements?
15. With Admin Project based communication:
Mark only one oval per row.

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
- I was able to understand the point of view of the others	o	o	o	o	o	o

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
- I could make myself heard	o	o	o	o	o	o
- the others showed interest in my opinions	o	o	o	o	o	o
- I could follow the flow of conversation	o	o	o	o	o	o
- the others referred to me	o	o	o	o	o	o

16. The use of Admin project has intensified my relation with partners in projects

Do you agree or disagree with the statement? (1 = strongly disagree; 6 = neither agree nor disagree; 11 = strongly disagree)

Mark only one oval.

1 - Strongly disagree
2
3
4
5
6 - Neither agree or disagree
7
8
9
10
11 - Strongly agree

17. The use of Admin project improved relationships among partners

Do you agree or disagree with the statement? (1 = strongly disagree; 6 = neither agree nor disagree; 11 = strongly disagree)

Mark only one oval.

0 - Strongly disagree
1
2
3
4
5 - Neither agree nor disagree
6
7
8
9
10 - Strongly agree

18. I believe it is important to organisations like mine to increase collaboration with

Mark only one oval per row.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Higher education or academic organisation	o	o	o	o	o
Private companies	o	o	o	o	o
NGO (non-governmental organisations)	o	o	o	o	o
Governmental organisations	o	o	o	o	o

Thank you for your participation.

If you would like to receive the research results please enter your email below:

_____

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