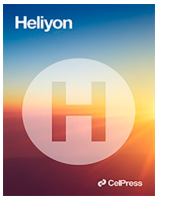
Heliyon 9 (2023) e21017

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon



University-industry collaboration as a driver of digital transformation: Types, benefits and enablers

Nina Evans [a], Andrej Miklosik [b,*], Jia Tina Du [a]

[a] UniSA: STEM, University of South Australia, Adelaide, South Australia, Australia
[b] Marketing Department, Faculty of Management, Comenius University in Bratislava, Slovakia

ARTICLE INFO

Keywords:
Digital business transformation
Innovation
University-industry collaboration
academics
practitioners

ABSTRACT

University-Industry collaboration as a driver of digital transformation ultimately depends on the engagement and relationship between individual academics and industry practitioners as partners in a trust relationship. This paper describes the personal ('lived') experiences of academics and industry practitioners. The types, benefits, and enablers of the collaboration were investigated during semi-structured face-to-face interviews with industry partners and academic staff from the Science, Technology, Engineering and Mathematics (STEM) unit at the University of Enterprise in Australia. The types of collaboration included research activities, sharing facilities and equipment, innovation and commercialisation, collaboration involving students projects, collaborative teaching and learning, and sharing facilities and equipment. The benefits of the collaboration include access to valuable resources, validation of work, learning and teaching opportunities, financial benefits, improved reputation and career progression. The enablers of collaboration have been clustered into institutional, output, framework, and relationship factors. In this paper we focus on relationship factors and institutional enablers such as stakeholder engagement. The research is represented in a UA-IP Collaboration Model indicating the types (what), benefits (why), and enablers (how) of academic-practitioner collaboration. Universities and businesses from a variety of industries can benefit from the results of the presented research.

1. Introduction

The competitive dynamics of modern organisations have changed significantly over the past few years. Businesses need to fundamentally change the way they operate, create value, and interact with stakeholders and the environment. Innovation and digital transformation are at the forefront of organisations having to adapt to the changing environment [1,2]. In this paper we refer to these changes as digital business transformation.

Organisations aspiring to drive digital business transformation and innovations often rely on collaboration between various stakeholders [3]. Collaboration between universities and industry is increasingly perceived to result in significant benefits for both parties. In recent times there has been a paradigm shift in the roles played by universities, as they are increasingly expected to forge closer relationships with industries to address the lack of time and resources [4] and commercialise their academic research outcomes [5]. The biggest challenge for all universities is to give a voice to, and engage, all stakeholders and to include the foster and support engagement between their academic staff and industry partners. This paper focuses on the types, benefits and enablers of engagement

* Corresponding author.
E-mail address: miklosik4@uniba.sk (A. Miklosik).

https://doi.org/10.1016/j.heliyon.2023.e21017
Received 23 May 2023; Received in revised form 5 October 2023; Accepted 12 October 2023
Available online 13 October 2023

between academics and industry practitioners in various industries within the STEM field, with the focus on supporting digital transformation of organisations.

Literature refers to the frequent collaboration between academia and industry as a "vehicle to enhance innovation through knowledge exchange" [6] and "a hallmark of the knowledge economy" [7]. Successful universities and their academic staff manage to combine academic excellence with industrial contacts [8]. The ability of an academic to effectively transfer knowledge to industry is key to universities achieving their mission and ambition [9]. Industry partners are also gaining a wide range of benefits from such a collaboration. Organisations utilising external resources can innovate and reduce risks associated with research and development processes [10], which are both important components of their digital transformation journey [3].

The University of Enterprise referred to in the research presented in this paper is the number one university in Australia for research impact and engagement and the university was recently ranked number one in Australia for industry research income. This university fosters innovation and brings together experts in their field to build connections with industry to generate ideas, share facilities, and solve complex challenges, including digital business transformation. This is one of the strengths as an institution. The objectives of this research is to investigate the dynamics of interactions between industry practitioners and academic staff members from the STEM academic unit of the University of Enterprise. In this paper we aim to provide rich insights into the nature of the engagement, the benefits of collaboration to both parties, and the enablers of mutually beneficial collaborative relationships. Such collaboration is at the center of digital transformation projects, however, its management can be challenging [3]. The research questions answered in this paper are as follows.

RQ1. What types of collaboration exist between academics at the University of Enterprise and their industry partners?

RQ2. What are the benefits of this collaboration for STEM academics and practitioners, with reference to digital business transformation?

RQ3. What are the enablers of such mutually beneficial collaboration?

The contribution of the research is significant. Universities and businesses from a variety of industries worldwide can benefit from the results of the presented research. Those include but are not limited to industries where expensive equipment is required for product design, development, and testing, e.g. design of electrical appliances, consumer goods, design of vehicles, batteries, etc. These are just some examples of such industries where universities can offer state-of-the-art testing facilities to their research partners.

2. Literature review

Existing literature portrays the need for academics and industry practitioners to collaborate. Organisations capable of utilisingg external resources can innovate, while reducing the risk and uncertainty that are associated with their R&D processes [10]. Businesses find it difficult to develop new innovations and cope with digital disruptions. They therefore realise the importance of gathering external knowledge from universities and public research organisations [11]. On the other hand, academics are increasingly pressured to become involved with external research, consultancy, and executive education. They are expected to generate research and commercial income, achieve international visibility, and have a positive impact on society [12]. Academics who want to progress their career must balance the time they allocate to each of these activities. This literature review is structured as follows: Its first part examines the types of collaboration between academics and practitioners through the lens of digital transformation initiatives; in the second part, we articulate the benefits of successful collaboration for both parties and in the third part, the enablers/success factors mentioned in the literature are discussed.

2.1. Types of collaboration between academics and practitioners

University-Industry collaboration is defined as "the coming together of diverse interests and people to achieve a common purpose via interactions, information sharing, and coordination of activities" [13]. The theoretical (academic) perspective and the practical (business) perspectives can be combined to reach a wider audience [14,15]. Such collaboration will only materialise if there is the perceived value to, and common goals of, the individuals and groups involved [16]. Personal objectives include publishing for academics and technical problem solving for industry practitioners [14], while their common objective is to create impact by providing solutions for society's problems [17].

The concept of 'engaged scholarship' refers to a "collaborative form of inquiry in which academics and practitioners leverage their different perspectives and competencies to co-produce knowledge about a complex problem or phenomenon" [18].

Literature discusses different types of collaboration between academics and industry practitioners, namely.

- Collaborative research and development activities that are more insightful and relevant than when academic researchers or practitioners work on a problem alone [19–22].
- Research funding, e.g. an endowment or trust fund (Santoro and Gopalakrishnan, 2000)
- Knowledge building and transfer through hiring recent graduates, personal interactions, institutional programs, and cooperative education initiatives [21,23,24].
- Technology transfer, such as product development and commercialisation activities [21].
- The exchange of tangible and intangible resources [25].
- Academic consulting [26].

- Product development and commercialisation and the creation of joint ventures, networks, consortia, and alliances [27,28].
- Joint authorship of academic journal papers and books [28].
- Joint symposia, consulting relationships, sabbaticals in industry, and action research [29].
- A university-industry collaborative approach to designing a hackathon to solve an enterprise's workplace problem [30].

2.2. Benefits of collaboration between academics and practitioners

Previous research indicates that both academics and industry practitioners benefit from collaborating through inter-organisational learning, improving innovation [31,32], tangible (e.g. funds, materials, and equipment), and intangible (e.g. technology and data) resources [25,33]. For example, a hackathon enables participants to develop their skills by investigating datasets, problems, or concepts, engage in collaborative teamwork and brainstorming, and develop algorithm and prototypes to solve real-world problems [30]. Collaboration also holds benefits for both parties on a personal level. Practitioners benefit as research helps them to gain new perspectives, learn about new technologies, develop critical competencies, and gain access to unique facilities [34]. Academics are able to publish more and establish more patents, spin-off companies, and other commercial results. Many university professors are also motivated by a desire to contribute to national competitiveness, job and wealth creation, et cetera [8].

Industry and academia use different perspectives to formulate research questions, and different methods to investigate them. Research that has both academic and commercial application, and a more productive division of tasks and responsibilities, enables each side to focus on what their institution values and rewards: academia on more fundamental academic insights, and industry on the commercialisation of new products and services. Practitioners specifically benefit by improving innovation, which is an important aspect of successful digital transformation initiatives [35], access to knowledge of highly qualified academic researchers or students, and access to expensive specialised research infrastructure [36]. Research findings can open new market opportunities and help organisations overcome technological barriers [37].

Etzkowitz and Klofsten [38] and Schartinger et al. [33] posit that universities foster links with industry partners to support learning through the preparation and improvement of instruction materials for university programs. Resources contributed by external partners have become an inevitable part of university funding [36]. Past research suggests that academia is less efficient than industry regarding commercialisation [39], so academics regard industry as a valuable source of skills, equipment, material, financial resources, and ideas [31,40]. Universities benefit from licensing or patenting income [20,36] that support them to accomplish their 'third mission' [41].

2.3. Enablers/success factors of sustainable collaboration

Literature refers to enablers or success factors of 'sustainable' industry-university collaboration. Sustainable collaboration requires active effort on both sides and "if left to themselves, the oil and water will separate again" [14]. Rybnicek and Königsgruber [36] divide success factors of university-industry collaboration into four categories, namely i) institutional factors, ii) relationship factors, iii) output factors and iv) framework factors.

Institutional factors refer to participating institutions and their availability of critical resources such as finance, time and equipment, structure, clearly defined responsibilities and roles, mutual terminology, organisational culture, as well as the willingness to change and the ability to learn about and understand one another. These factors were also discussed in the work of other researchers such as Gray et al. [24], Simpson and Seibold [22], Pamfilie et al. [42].

Framework factors refer to wider environmental aspects such as the government, legal restrictions, regulations (roles and responsibilities, confidentiality and non-disclosure agreements, Intellectual property rights), and geographical distance that determine whether communication is done face to face or online.

Output factors refer to strategies, visions, goals, plans, or expected outcomes that impact the collaboration. If the goals are compatible, the desired outcomes will be achieved. It is important to understand the other party's interests and to create a win-win situation in which the benefits are correctly balanced.

Relationship factors refer to the personal interface between an academic and the industry practitioner. Despite the different communication styles in the academic and business environments, the relationships between academics and practitioners can be positively impacted by regular interaction, continuous feedback, and mutual exchange of information through a variety of channels such as e-mails, or face-to-face and online meetings. Gray et al. [24] and Simpson and Seibold [22] agree that collaboration requires direct and transparent discussions about the research process, how partners may contribute and what each party expects. It is also important to manage conflict [18,19,22]. Both academic and practitioner knowledge should be valued and respected [29]. Commitment and trust [43,44] are vital to facilitate the sharing of knowledge. Honesty is a fundamental basis of such trust [36].

2.4. Research gap

The authors have identified gaps in the literature related to collaboration between university academics and industry practitioners. No previous research has investigated the link between university-industry collaboration and digital business transformation. This paper aims to address this gap by investigating the why, what and how of academic-practitioner collaboration in the STEM disciplines, to support digital business transformation.

2.5. Research methodology

The research follows a qualitative approach with a focus on in-depth understanding of research participants' views and perspectives [45]. This paper describes the 'lived experiences' of academic and industry partners regarding the various ways in which they collaborate with industry, as well as the benefits and enablers of such knowledge-related academia-industry collaboration. True to the nature of qualitative methods, we did not start with a well-formed hypothesis, but we conducted interviews to identify participants' experience and opinions and developed a set of recommendations based on their experience.

2.6. Research participants

The research participants consist of academics and practitioners from various industries, who participate in collaborative activies. The participants were identified and recruited through personal connections with academic colleagues and industry contacts (snowlball sampling). The sample size was not pre-specified but determined on the basis of theoretical saturation; the point in data collection when new data do not add new insights to the research questions. A randomised sample was not required as participants' perspectives are sought, not statistical significance.We conducted interviews with 16 participants for the single case study; nine academics from the STEM academic unit of the University of Enterprise and seven industry partners. The potential participants were invited in-person or via email to participate in the study. A profile of the interviewees is included in Table 1 below.

2.7. Data collection

Data were collected via personal interviews to allow in-depth exploration. The individual semi-structured open-ended interviews were conducted face-to-face, each lasting approximately 1 h. The interview protocol starts with general questions, allowing the researcher to develop rapport with participants. The questions were directed to the participant's experiences, feelings, beliefs, and convictions about the research questions [46]. Participants engaged in a discussion about personal experiences regarding collaboration. Participants' perspectives were sought rather than statistical significance. Planned (predetermined) and floating prompts (impromptu) were used to obtain further detail. Each interview was audio-recorded with permission from the participant and transcribed verbatim.

2.8. Data analysis

Giorgi and Giorgi [45] identify four characteristics of qualitative analysis, namely description (openly reading, reduction), sorting of meaningful units, search for essences (reflecting on each meaningful unit), and intentionality (based on research questions). This four-step procedure was applied to make meaning of the data. The data were analysed manually. The validity of the findings was ensured through the careful recording and continual verification of the data that the researchers undertook during the investigation.

Reliability in qualitative research refers to the stability of responses to multiple coders of data sets. We enhanced the reliability of the research by making detailed field notes and by recording the interviews and transcribing the recordings verbatim. The researchers first listened to each audio recording to develop a holistic sense of the data. The authors then individually reviewed each interview transcript to detect similarities or differences between their experience, as articulated by the interviewees.

The researchers also used their judgment to interpret the data while consciously avoiding enforcing their preconceived ideas on the data, i.e., not allowing their meanings and interpretations, i.e. bias, to influence the opinions of the interview participants. True to the nature of qualitative research, the authors did not aim to gather generalisable results.

Table 1
Interview participants.

Interviewee	Type/profile	Role	Discipline/Industry
A1	Academic	Professor	Computer Science
A2	Academic	Professor	Science
A3	Academic	Professor	Environmental Science
A4	Academic	Senior lecturer	Geology/mining
A5	Academic	Professor	Computer Science
A6	Academic	Senior research fellow	Material Science
A7	Academic	Associate professor	Computer Science
A8	Academic	Associate professor	Information Science
A9	Academic	Senior lecturer	Computer Science
P1	Practitioner	Manager	Information Technology
P2	Practitioner	Consultant, own company	Information Science
P3	Practitioner	Exploration manager	Geology/Mining
P4	Practitioner	Academic engagement manager	Engineering
P5	Practitioner	Manager	Defense
P6	Practitioner	Practitioner researcher	Utilities
P7	Practitioner	Consultant	Information Technology

2.9. Ethical considerations

Ethics approval was obtained from the Ethics Committee of the University of Enterprise. Informed written consent was obtained from participants, ensuring them of confidentiality and secure storage of the research information. Participants understood that involvement in the study was entirely voluntary and that they can withdraw from the research project at any stage without consequence to their career or personal status.

2.10. Findings

In this section, we report the viewpoints of interviewees about the types of collaboration, the benefits for academics and practitioners, and the enablers of successful and sustainable partnerships. The findings are clustered according to similar topics.

2.11. Types of collaboration

Participants identified various types of collaboration between STEM academics and practitioners. These collaborations support the digital transformation of both universities and industry. The types of collaboration have been analysed and clustered as follows:

Collaborative research: Exploring new invovative ideas, solving industry problems, grant projects, and co-publishing.

Partners collaboratively explore new innovative ideas together "from the inception, the literature review, the planning, the development of the fundamental principles such as academic integrity, ensuring uniqueness and business outcomes/business benefit, organising interviews and workshops, analysis, and writing papers" (P2) and apply knowledge to solve industry problems (P3).

Academics and practitioners co-publish in both industry-related publications and international peer-reviewed academic journals (P4, A4) and industry conferences:

> Academics also come along to these [industry] conferences and pick up the vibe that this is interesting, this is something new that we need to look at (P3).

Industry partners also provide direct links and connections for research grants such as ARC Linkage grants (A5, A6).

2.11.1. Collaboration involving students: projects, sponsorships, and internships

Collaboration in the STEM field often takes the form of academics and students writing software for a company (A1) and building and commercialising equipment (P6). Organisations make a significant commitment by taking on student interns (P1), while industry practitioners also supervise undergraduate student projects (P4).

2.11.2. Innovation and commercialisation

Industry generally lags slightly behind academia on innovation and technology "because we are out there trying to commercialise, provide products and services" (P3). A7 commented that the university can actually develop concepts cheaper than practitioners can do in-house. STEM academics also have the capability to test the industry partner's techniques and technologies for commercialisation (A3).

2.11.3. Collaborative teaching and learning

Collaboration includes the development of new university courses (P1) and co-teaching existing courses (P2, P4, P7). The university also invites specialists to run a half-day seminar about what's happening in the industry, research and development, and technology (P1).

Industry partners have the opportunity to further their academic qualifications by studying at the university, for example P7 and P1 are both enrolled in a PhD program.

Academic staff members can gain practical experience by working in the industry partner's company. A program director from the university spent six months working in the partner company and gained valuable practical experience (P1).

2.11.4. Sharing facilities

Universities have high-tech equipment that many companies do not have access to (P3). Academics also have access to other universities with which facilities are shared. A3's laboratory cannot do all the field-testing aspects, so she involves research groups at other universities in Australia and overseas, while A4's analytical work for a mining exploration company project is also done by another university.

Practitioners can share the university's research facility basically for free (A2), thereby supporting their digital business transformation efforts.

2.12. Benefits of collaboration for academics

Most applied researchers want to engage more with industry, but they don't really know how to do it (A5). The benefits of such collaboration that we found through the research, were analysed and clustered as follows.

2.13. Enhanced research impact

Industry's input into research enables a balance between applied research and basic research (A4) and results in practical output and the ability to solve 'real-world problems' (A5).

> I've always wanted products and to see my science out there in the real world and to see it valued (A4).

> We're solving things that need to be solved as opposed to just an idea (A7).

Collaboration therefore provides opportunities for validation of thinking (A2). A7 commented:

> Not reinventing the wheel is a good way of looking at it, so you're not getting stuck with assumptions that are incorrect (A7).

STEM academics benefit from having access to industry practitioners' project management capabilities. An industry partner added value by developing a formal project plan and establishing connections with senior executives of large organisations, arranging interview meetings, and managing the logistics of the project (P2). Collaboration reduces individual risk as research is less risky "if you do it carefully with the help of peers" (A7).

2.13.1. Learning opportunities

Academics learn from in-house expert industry researchers (A5) and also from industry partners' business and domain knowledge. A7 was exposed to an organisation that is a world leader and has "very accommodating technical teams with amazing expertise". Another academic had the opportunity to work in P1's company for six months:

> By sitting in the middle of an office space and hearing all the conversations flying around I think he quickly learned how business works. (P1)

An advantage of working with industry is that they tend to have tighter turnaround times, which develops time management skills as they "force academics to develop a sense of urgency and do the work quickly" (A4).

Learning how to network is important and academics can learn to be comfortable working with different people (A7). A3 learned about networking by being in enough meetings where she could see how people engage.

2.13.2. Improved teaching

Collaboration with industry leads to opportunities for academics to deliver short courses and post-graduate qualifications to industry people. On the other hand, academic teachers also benefit from industry guest lecturers who bring practical experience into the classroom (P1).

2.13.3. Financial benefits

Working with industry partners gives academics opportunities to apply for research grants and have research projects funded by the companies in a Collaborative Research Center (CRC). A5 commented that "the additional research income is helpful".

Industry partners often make financial contributions to product development. A2 has worked with an international company for 10 years and indicated that "the work has just ramped up enormously and the company made large cash contributions to the project". Industry partners also provide access to technology, expensive equipment, and data (e.g. customer data) that universities need (A5).

> Collaboration with industry practitioners enables the development of licenses, patents, and royalties, that result in financial benefits and an improved reputation for academics (A2, A6)

2.13.4. Enhanced reputation

Collaboration can positively impact an academic's career as it provides opportunities for international exposure. Doing research elsewhere in the world is useful in terms of career and reputation, as it "broadens the scope and looks good on your CV and it also means you learn more" (A4). A6 has won a lot of awards because of industry collaboration. Universities value people with both industry and academic experience (A5, A7) and it increases the chances of them being promoted:

> Because this is the 'university of enterprise', I expect doing the work with industry helps with promotion. (A4)

3. Benefits of collaboration for practitioners

3.1. Research opportunities

Collaboration with academics stimulates innovative ideas (P7), which extends the practitioner's research capability (A7) and ensures academic rigor in research activities.

The project would never have proceeded without the academic arranging the ethics approval, ensuring academic integrity and confidentiality, approved methodologies, literature reviews, and writing the articles for academic consumption. (P2)

Practitioners benefit from co-authoring papers, both in terms of reputational benefit (A4) and exposure (P2):

> The papers we have written have been picked up by some of the most influential organisations in the world. The [collaborative] research introduces you to some of the best minds in the world. It allows to present at conferences you wouldn't otherwise have been able to. (P2)

3.1.1. Teaching and learning opportunities

Industry practitioners benefit from opportunities for self-development through teaching and guest lecturing (P1, P7). Academics provide support with their learning and problem-solving. P1 commented that industry practitioners are "desperate to solve their problems, but they don't always know where to start". Collaboration with academics also stimulates innovative ideas (P7) and supports decision-making (P6), which supports their digital business transformation efforts.

Problems that cannot be investigated in real-time (in the real world) can conveniently be solved in a university laboratory (A6).

3.1.2. Financial benefits

Tax breaks help small companies to invest in research close to cost-neutral (A6). The reputational benefits of practitioners also translate to financial benefits for their company as it may increase the share price of the company (P3).

> Industry practitioners develop licenses or patents in collaboration with academics, which leads to financial benefits. A6 emphasised that it is important to discuss openly what every partner wants to get out of the patent.

Table 2
Types, benefits and enablers.

The enablers, types, and benefits of collaboration between academics and industry practitioners	
Types of collaboration	**Benefits of collaboration** **Academics**
Collaborative research	**Enhanced research impact**
Exploring new ideas, grant projects, solving industry problems, and co-publishing research	Solving real-world problems
Collaboration involving students	Validation of thinking
Projects, sponsorships, and internships	Balanced research
Innovation and commercialisation	Project management skills
Product development	**Learning opportunities**
Collaborative teaching and learning	Exposure to experts in the field
Sharing facilities	Business experience
Enablers of collaboration	Networking skills
Relationship	Time management skills
Academics build rapport before asking for money	**Improved teaching**
Industry people reach out to universities	Opportunities to offer industry courses
Passionate people	Access to guest lecturers
Understanding and respecting each other's interests	**Financial benefits**
Aligned values and mutual respect	Research income
Strong personal relationships and networks	Contribution to product development
Effective communication	Access to equipment
Flexibility, openness, and trust	Royalties from licenses and patents
Protecting current relationships	**Enhanced reputation**
Time to build a relationship	Career progression
Institutional	International exposure
Universities valuing applied research	Licensing, patenting
Drive to commercialise research outputs	Reduced risk
Constant search for collaboration opportunities	**Practitioners:**
Industry engagement skills of academic staff	**Research opportunities**
Incentivizing collaboration	Academic rigor
Stakeholder engagement	Co-authoring academic publications
One point of contact- enterprise hub	**Teaching and learning opportunities**
Output	Personal development/teaching
Academics who also have industry experience	Support with problem solving
Entrepreneurial academics	Innovation and testing innovative ideas
The industry person understands academia	**Financial benefits**
Industry is willing to be led by the university	Tax breaks
Burning platform	Share price
Investigating the right topic	**Access to resources**
Framework	Licenses, patents
Company has a research budget	World academic experts
Buy-in from management	University facilities and equipment
	Research students
	Good students in internship programs
	Credibility and reputation
	Legitimize work
	Owning IP on a patent

3.2. Access to facilities and resources

Collaboration provides businesses access to academic experts who can offer practitioners sound advice and support through their legal, management, accounting, finance, marketing, engineering, and IT capabilities (P1, P5, P7).

> I can pick up the phone and ask my academic colleagues, "Have you heard about this? Or can you recommend this"? This is all part of our service to the industry. (A7)

Academic partners provide access to university equipment:

> "Universities have some high-tech equipment that companies do not have ready access to". (P3)

Academic partners provides access to research students to undertake analysis (P3), while organisations employ students who enter through an internship program (P1).

3.2.1. Credibility and reputation

Working with academics gives practitioners an opportunity to legitimize and add a level of credibility to their work (P7). The industry partner may e.g. own the IP of a patent, with the concomitant enhanced reputation regardless of the inventor of the patent. The improved reputation of practitioners also enhances the public perception of the company (A4, P3).

3.3. Enablers of collaboration

The following enablers of academic-industry practitioner collaboration were mentioned. These enablers are summarised in Table 2 and analysed and categorised in Fig. 1.

3.3.1. Having a burning platform and therefore a need to collaborate

Universities experience a burning platform due to pressure to change their image from that of an 'ivory tower' to being partners in the economic growth of the nation, i.e to improve their own reputation and financial situation.

3.3.2. Characteristics of the partners

Partners with both academic and industry experience enable collaboration. It is important that the university partner is entrepreneurial and understand the business (P1). P6 has extensive academic and industry experience and commented: "I can tell you both sides of the story now".

According to P1, the relationship is a "personal thing" and success depends on passionate people driving it.

> The relationship between my company and the university worked because I managed it and because I had the passion to run it. (P1)

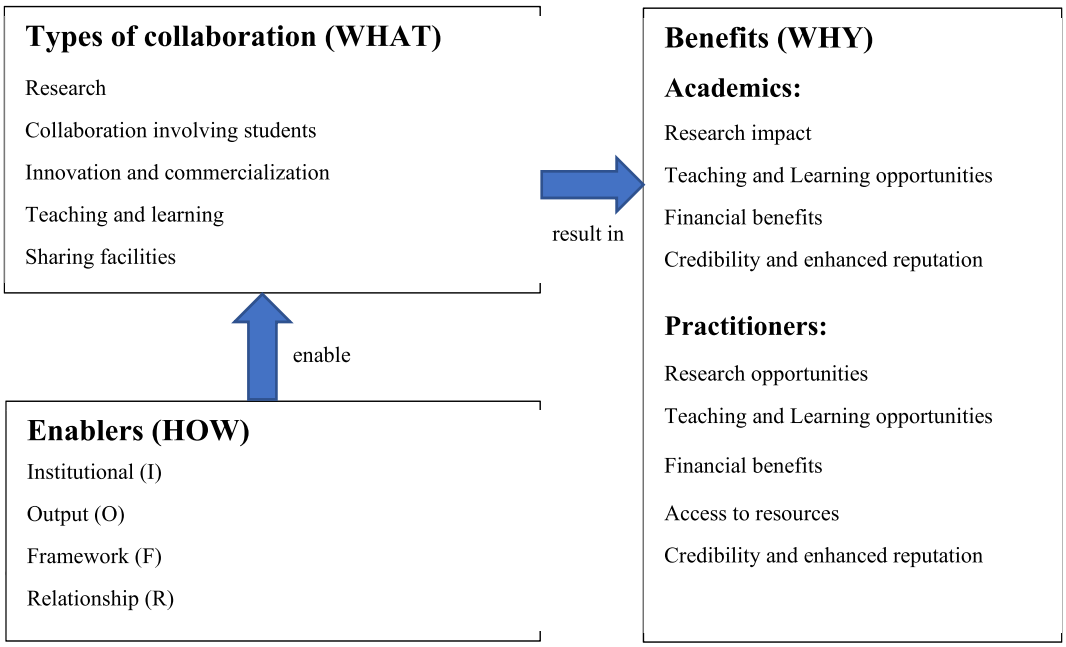


Fig. 1. The UA-IP collaboration model – what, WHY, and HOW.

3.3.3. Establishing the relationship

Academics should build rapport before asking for money. Researchers often make the mistake of asking for money before a trust relationship with the industry partner has been established. P6 said he offers to do the first part of the work for free and builds the relationship before requesting more funding. He added that "some early career researchers (ECRs) make the mistake to rush for money or funding".

Practitioners should be willing to reach out to universities to support them with their problems (A4).

3.3.4. Selecting an appropriate topic for collaboration

Not all research is equallly valuable to all stakeholders. It is important to find the right question that will be of use to practitioners, academics, and society (P1, P4).

Universities have been willing to do more applied research than before, especially in the STEM field.

Our company is very keen to continue these sorts of [applied] research avenues as they apply directly to our business model (P3).

3.3.5. Building the relationship and trust through aligned values, mutual understanding and respect

Partners should have a great deal of understanding of the interests of each party and build trust (A3, A8):

I think there was a common goal, but within that common goal is a recognition that each party has its own interests that need to be maintained. If it was a selfish collaboration, it simply wouldn't stand up (P2).

Academics should therefore be sensitive when publishing collaborative research results.

It's taken a few years but now we're at the point where my partners say that they're fully on board, because the findings are communicated in such a responsible manner (A3).

Teams work well if they celebrate each other's strengths and compensate for each other's weaknesses, but some fundamental values should be aligned.

As individuals, I don't think we would have succeeded, but together we've been able to do some astonishing stuff (P2).

Effective communication through regular meetings and conversations (P2), both in person and by videoconferencing (P9), is one of the most important enablers of collaboration. A3 believes that face-to-face contact is the "glue" for any project, as people can "see each other as a human being who's doing the best they can, who's sincere, honest, and trustworthy" (A2).

It costs more to secure new business from a new customer than to retain the relationship with an old customer.

Most industry partners will put all of their efforts into managing an existing relationship and getting existing business out of an existing customer, because the relationship is already established (P1).

Building trusting relationships between academics and industry professionals takes time and commitment from both sides (P6). An important success factor of collaboration to support digital transformation is a strong focus on people.

As much as we can talk about technology, at the end of the day collaboration is about people. You have to be honest and open, foster the relationship, build it and then look at how you can support the partner (P1).

3.3.6. Opportunities for commercialisation

Both STEM academics and industry practitioners should constantly seek opportunities for commercialisation of unique products (P3, A4).

3.3.7. Supportive leadership

Top management support for collaboration is crucial.

This does not work unless the managing director or the appropriate person understands the value and can sell the value (P1).

Organisations should support their staff to work with academics on research projects. A3 commented that large utilities have "real research budgets and experts who have been researchers most of their career", while smaller utilities don't have that.

Universities should have one single point of contact for industry to initiate a conversation.

The enabling factors we found were analysed and categorised as institutional, output, framework, or relationship factors. The findings are summarised in Table 2 below.

4. Discussion

The research described in this paper focuses on the engagement between academic and industry practitioners towards supporting digital business transformation. Our research also confirms the findings of Stejskal and Hajek [47], namely that engagement helps both academics and practitioners to achieve goals that are difficult to accomplish in isolation. It also support literature stating that engagement is earmarked by the exchange and sharing of resources, responsibilities, risks, and returns. We posit that the skills, expertise, and needs of both the business and academic sectors should be clear, academic researchers must be 'business ready', and industry practitioners should be encouraged to play an active role in establishing relationships with academic partners.

Research question 1 investigated the types of collaboration. Our findings show that at the University of Enterprise, research was the most frequently mentioned type of collaboration. The reason why most academics engage with industry is to further their research, rather than to commercialise their knowledge. This confirms the findings of D'Este and Perkmann [48] who claim that research and the resulting innovation stands out as one of the best forms of industry-academic collaboration. Such innovation is the foundation of digital transformation of both parties. Some of the previous studies suggested that academics might prefer basic research, yet most of the STEM academics at the University of Enterprise indicated that they prefer to engage in 'real-world' research that leads to tangible

business benefits. Practitioners and academic researchers should jointly develop business best practice [14,15] close the 'rig-or-relevance gap' [25,29] and support digital business transformation [1].

An important aspect of collaborative research is joint publishing. The empirical research described here found that both academics and industry practitioners value publishing together. They often co-publish in both international peer-reviewed academic journals and industry-related publications. Academics are expected to publish in high-level academic journals, and Chen et al. [14] and Cohen [37] found that involving practitioners in joint publications can increase the quality and business impact of published papers. Our research showed that, while practitioners were willing to engage in collaborative research, they were more reserved about publishing the results immediately due to confidentiality concerns, the need to maintain the IP and preserve their competitive advantage.

Other categories of collaboration that were identified include collaboration involving students, product development, knowledge sharing, and sharing of facilities. These are all presented as clusters of collaboration types between STEM academics and practitioners in Table 2, which represents a unique contribution of our research.

D'Este and Perkmann [31] identified four groups of benefits of collaboration between academics and practitioners (research question 2) for academics, namely access to funding, commercialisation, learning, and access to in-kind resources. This paper makes a contribution by clustering the benefits for academics into five groups, namely research impact, learning opportunities, improved teaching, financial benefits, and enhanced reputation (Table 2). Our study found that research impact is one of the most beneficial outcomes of collaboration between academics and practitioners. Research impact has therefore been included in our clustering of benefits, expanding the abovementioned classifications. According to Pertuze et al. [34], practitioners personally benefit as they gain new perspectives, learn about new technologies, develop critical competencies, and gain access to state-of-the-art facilities. On top of these, our research revealed that benefits for industry practitioners also include financial benefits, research benefits, and enhanced credibility and reputation (Table 2). All these are beneficial in the digital transformation of a business.

To cluster the enablers of collaboration (research question 3) found in this empirical research, the approach of Rybnicek and Königsgruber [36] was used. Each enabler was categorised as (I), (R), (O), or (F), as shown in Table 2. We have identified a few institutional (I), output (O), and framework (F) enabling factors. The interviewees' answers mostly related to the relationship factors (R), specifically the one-to-one relationship between an academic and an industry practitioner. They also referred to the institutional enablers (I), namely the important role the university can play to stimulate and support the engagement. Based on their experiences, we were able to add some relationship factors to those identified by studies mentioned in the literature review, namely the need for i) academics to build rapport before asking for money, ii) time to build relationships, iii) industry people reaching out to universities, iv) nurturing current relationships and expanding networks.

To summarise all the findings of our research, we developed a model, referred to as the UA-IP model, which diagrammatically presents the WHAT (types), WHY (benefits), and HOW (enablers) of collaboration between university academics (UA) and industry practitioners (IP). The institutional enablers (I) are a crucial component of the UA-IP model from the university perspective as their activation can guarantee that the identified types of collaboration will be supported and the benefits stated in the framework will be achieved. The model is presented in Fig. 1.

5. Conclusion

In this paper we describe the experiences of STEM academics and industry practitioners regarding collaboration types, the benefits for both parties (especially for their digital transformation) as well as the enablers of collaboration. The contributions of the paper are varied. The findings indicate that the different types of collaboration (as summarised in Table 2) provide similar, but also some unique benefits to academic and industry partners from all industries. Inter-organisational learning can be enhanced by gathering, analysing, and incorporating information obtained from research and technology transfer between collaborators, and also by absorbing and integrating external knowledge from partners. Learning capability is essential for organisations that want to embark on a digital transformation journey. Various factors can enable collaboration and we focused on the relationship and institutional enablers. As supported by the empirical research, strategic partnerships grow from initial interactions between academics and industry practitioners, such as internships, graduate employment and research collaboration, to multi-service integrated relationships. This paper contributes to both theory and practice. Universities can establish and grow these industry partnerships through effective enquiry management, enabling academic staff to find an industry partner, coordinating account management and stewardship, identifying and managing partnership opportunities and scaling, educating researchers on business and start-up activities and coordinating project-based research degrees.

The university of the Enterprise understands how it can work closely with industry by enabling and supporting the engagement between academics and practitioners in a collaborative environment. Other university and business partners can use the identified enablers, types, and benefits of collaboration between academics and industry practitioners as well as the experience from the approach of the Universituy of the Enterprise towards fostering the collaboration to guide academia-industry collaborations in the context of digital transformation.

Limitations of the study

As with any empirical study, there are limitations to our findings. Only nine STEM academics from the University of Enterprise and seven industry practitioners participated in this study. The small number of participants in the study limits the generalisability of the findings. However, the high similarity between responses from participants suggests there is no reason to believe that the results can not be generalised to the larger population or to other specialisation fields.

Future research

Future research should investigate the collaboration between STEM academics in other higher education institutions and their industry partners. The different roles within a university can be investigated to determine how university-industry collaboration can be optimised with the correct support in place. The direct contribution of university-industry collaboration to digital transformation activities should be investigated and quantified. Future research can also focus more on the commercialisation aspect of university-industry collaboration, as well as the impact of gender on the propensity to collaborate and commercialise academic research output.

Declarations

The ethics committee of the University of Enterprise approved this research. Consent to participate was given by every interviewee. The authors report there are no competing interests to declare.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Nina Evans: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Supervision, Validation, Writing – original draft, Writing – review & editing. **Andrej Miklosik:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Jia Tina Du:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This paper is an output of the research project VEGA 1/0109/23 Framework for systematisation of digital transformation in organisations with the focus on marketing and business processes.

References

[1] N. Evans, A. Miklosik, R. Bosua, A. Mahmood Ahmed Qureshi, Digital business transformation: an experience-based holistic framework, IEEE Access 10 (2022) 121930–121939, https://doi.org/10.1109/ACCESS.2022.3221984.
[2] L. Zeelie, N. Evans, Embarking on a Digital Enterprise Transformation Journey: Guiding Principles for Leaders," in *17th European Conference on Management Leadership and Governance*, 2021, pp. 447–455.
[3] C. Rocha, C. Quandt, F. Deschamps, S. Philbin, G. Cruzara, Collaborations for Digital Transformation: Case Studies of Industry 4.0 in Brazil, IEEE Transactions on Engineering Management, 2021, pp. 1–15, https://doi.org/10.1109/TEM.2021.3061396.
[4] K. Miller, M. McAdam, R. McAdam, The changing university business model: a stakeholder perspective, R&D management 44 (3) (2014) 265–287.
[5] M. Stuetzer, D.B. Audretsch, M. Obschonka, S.D. Gosling, P.J. Rentfrow, J. Potter, Entrepreneurship culture, knowledge spillovers and the growth of regions, Reg. Stud. 52 (5) (May 2018) 608–618, https://doi.org/10.1080/00343404.2017.129.
[6] R. Bekkers, I.M. Bodas Freitas, Analysing knowledge transfer channels between universities and industry: to what degree do sectors also matter? Res. Pol. 37 (10) (2008) 1837–1853 [Online]. Available: https://EconPapers.repec.org/RePEc:eee:respol:v:37:y, 2008:i:10:p:1837-1853.
[7] M. Bikard, K. Vakili, F. Teodoridis, When collaboration bridges institutions: the impact of university–industry collaboration on academic productivity, Organ. Sci. 30 (2) (2019) 426–445, https://doi.org/10.1287/orsc.2018.1235. Mar.
[8] M. Gulbrandsen, J.-C. Smeby, Industry funding and university professors' research performance, Res. Pol. 34 (6) (2005) 932–950 [Online]. Available: https://EconPapers.repec.org/RePEc:eee:respol:v:34:y, 2005:i:6:p:932-950.
[9] A. Miklosik, N. Evans, I. Hlavaty, Communicating knowledge-focus through websites of higher education institutions, J. Inf. Sci. (2021), 01655515211014475.
[10] R. Awasthy, S. Flint, R. Sankarnarayana, R.L. Jones, A framework to improve university–industry collaboration, Journal of Industry-University Collaboration 2 (1) (2020) 49–62, https://doi.org/10.1108/JIUC-0-0016.
[11] H. Chesbrough, Open innovation: a new paradigm for understanding, Open Innovation: Researching a New Paradigm (2006) 1–12.
[12] A. Alexander, D.P. Martin, C. Manolchev, K. Miller, University–industry collaboration: using meta-rules to overcome barriers to knowledge transfer, J. Technol. Tran. 45 (2) (2020) 371–392.
[13] A. Jassawalla, H. Sashittal, An examination of collaboration in high-technology new product development processes, J. Prod. Innovat. Manag. 15 (Oct. 1998) 237–254, https://doi.org/10.1111/1540-5885.1530237.
[14] C.-Y. Chen, Y.-C.J. Wu, W.-H. Wu, A sustainable collaborative research dialogue between practitioners and academics, Manag. Decis. 51 (3) (2013) 566–593.
[15] H. Schiele, S. Krummaker, Consortium benchmarking: collaborative academic–practitioner case study research, J. Bus. Res. 64 (10) (2011) 1137–1145, https://doi.org/10.1016/j.jbusres.2010.11.007.
[16] A. Lam, What motivates academic scientists to engage in research commercialization: 'Gold', 'ribbon' or 'puzzle, Res. Pol. 40 (10) (2011) 1354–1368, https://doi.org/10.1016/j.respol.2011.09.002.
[17] O. Al-Tabbaa, S. Ankrah, Social capital to facilitate 'engineered' university–industry collaboration for technology transfer: a dynamic perspective, Technol. Forecast. Soc. Change 104 (2016) 1–15, https://doi.org/10.1016/j.techfore.2015.11.027.
[18] A. Van De Ven, P. Johnson, Knowledge for theory and practice, Acad. Manag. Rev. 31 (4) (2006) 802–821.

[19] G. Bammer, Enhancing research collaborations: three key management challenges, Res. Pol. 37 (5) (2008) 875–887, https://doi.org/10.1016/j.respol.2008.03.004.

[20] A. McCabe, R. Parker, S. Cox, The Ceiling to Coproduction in University–Industry Research Collaboration, vol. 35, Higher Education Research & Development, Oct. 2015, pp. 1–15, https://doi.org/10.1080/07294360.2015.1107888.

[21] M. Santoro, S. Gopalakrishnan, The Institutionalization of knowledge transfer activities within industry–university collaborative ventures, J. Eng. Technol. Manag. 17 (Oct. 2013) 299–319, https://doi.org/10.1016/S0923-4748(00)00027-8.

[22] J. Simpson, D. Seibold, Practical engagements and Co-created research, Journal of Applied Communication Research - J APPL COMMUN RES 36 (Oct. 2008) 266–280, https://doi.org/10.1080/00909880802172285.

[23] R. Wijk, J. Jansen, M. Lyles, Social CAPITAL, knowledge transfer and outcomes: meta-analysis of a MODERATED MEDIATION model, Acad. Manag. Proc. (2009) 1–6, https://doi.org/10.5465/AMBPP.2009.44265115. Oct. 2009.

[24] D. Gray, P. Iles, S. Watson, Spanning the HRD academic-practitioner divide: bridging the gap through mode 2 research, J. Eur. Ind. Train. 35 (Oct. 2011) 247–263, https://doi.org/10.1108/03090591111120403.

[25] M. Perkmann, et al., Academic engagement and commercialization: a review of the literature on university industry relations, Research Polietj 42 (2) (2013) 423–442.

[26] M. Perkmann, K. Walsh, Engaging the scholar: three types of academic consulting and their impact on universities and industry, Res. Pol. 37 (2008) 1884–1891, https://doi.org/10.1016/j.respol.2008.07.009. Oct.

[27] E. Rasmussen, M. Wright, How can universities facilitate academic spin-offs? An entrepreneurial competency perspective, J Technol Transf 40 (5) (2015) 782–799, https://doi.org/10.1007/s10961-014-9386-3.

[28] S. Odei, Commercialization of Academic Research: Assessing the Enabling Conditions, for German Universities, Oct. 2017.

[29] J.M. Bartunek, S.L. Rynes, Academics and practitioners are alike and unlike: the paradoxes of academic–practitioner relationships, J Manage 40 (5) (Jul. 2014) 1181–1201.

[30] K.F. Yuen, A.O.M. Wong, Designing an effective hackathon via university-industry collaboration for data science education, in: IEEE International Conference on Engineering, Technology & Education (TALE), Dec. 2021, 2021, pp. 723–728, https://doi.org/10.1109/TALE52509.2021.9678826.

[31] M. Perkmann, Z. King, S. Pavelin, Engaging excellence? Effects of faculty quality on university engagement with industry, Res. Pol. 40 (4) (2011) 539–552 [Online]. Available: https://EconPapers.repec.org/RePEc:eee:respol:v:40:y, 2011:i:4:p:539-552.

[32] A. Inzelt, The evolution of university–industry–government relationships during transition, Res. Pol. 33 (6) (2004) 975–995, https://doi.org/10.1016/j.respol.2004.03.002.

[33] D. Schartinger, C. Rammer, M. Fischer, J. Frohlich, Knowledge interactions between universities and industry in Austria: sectoral patterns and determinants, Res. Pol. 31 (3) (2002) 303–328 [Online]. Available: https://EconPapers.repec.org/RePEc:eee:respol:v:31:y, 2002:i:3:p:303-328.

[34] J. Pertuze, E. Calder, E. Greitzer, W. Lucas, Best Practices for Industry-University Collaboration," MIT Sloan Manag Rev 51 (Oct. 2010) 83–90.

[35] N.A. Gomez-Cruz, J. Montes, D. Anzola, Interactions between innovation and digital transformation: a Co-word analysis, IEEE Access 10 (2022) 111607–111622, https://doi.org/10.1109/ACCESS.2022.3215552.

[36] R. Rybnicek, R. Königsgruber, What makes industry–university collaboration succeed? A systematic review of the literature, J. Bus. Econ. 89 (2) (2019) 221–250, https://doi.org/10.1007/s11573-018-0916-6.

[37] D.J. Cohen, The very separate worlds of academic and practitioner publications in human resource management: reasons for the divide and concrete solutions for bridging the gap, Acad. Manag. J. 50 (2007) 1013–1019 [Online]. Available: https://api.semanticscholar.org/CorpusID:168118291.

[38] H. Etzkowitz, M. Klofsten, The innovating region: toward a theory of knowledge based regional development, R&D Management 35 (3) (2005) 243–255.

[39] J. Stein, M. Dewatripont, P. Aghion, Academic Freedom, Private-Sector Focus, and the Process of Innovation, 2008 [Online]. Available: https://EconPapers.repec.org/RePEc:hrv:faseco:3637074.

[40] V. Tartari, S. Breschi, Set them free: scientists' evaluations of the benefits and costs of university-industry research collaboration, Ind. Corp. Change 21 (5) (2012) 1117–1147.

[41] A. Leischnig, A. Geigenmüller, Examining alliance management capabilities in university-industry collaboration, J. Technol. Tran. 45 (2018) 9–30.

[42] R. Pamfilie, S. Giusca, R. Bumbac, Academic research – a catalyst for the innovation process within companies in Romania, The AMFITEATRU ECONOMIC journal 16 (37) (2014) [Online]. Available: https://EconPapers.repec.org/RePEc:aes:amfeco:v:37:y, 2014:i:16:p:759.

[43] L. Bstieler, M. Hemmert, G. Barczak, The changing bases of mutual trust formation in inter-organizational relationships: a dyadic study of university-industry research collaborations, J. Bus. Res. 74 (2017) 47–54, https://doi.org/10.1016/j.jbusres.2017.01.006.

[44] M. Hemmert, L. Bstieler, H. Okamuro, Bridging the cultural divide: trust formation in university–industry research collaborations in the US, Japan, and South Korea, Technovation 34 (10) (2014) 605–616, https://doi.org/10.1016/j.technovation.2014.04.006.

[45] A.P. Giorgi, B.M. Giorgi, The descriptive phenomenological psychological method, in: P.M. Camic, J.E. Rhodes, L. Yardley (Eds.), Qualitative Research in Psychology: Expanding Perspectives in Methodology and Design, American Psychological Association, 2003, pp. 243–273, https://doi.org/10.1037/10595-013 [Online]. Available:.

[46] J.C. Welman, S.J. Kruger, Research Methodology for the Business and Administrative Sciences, International Thompson, 1999.

[47] J. Stejskal, P. Hajek, Measuring the effectiveness of cooperative ties in knowledge networks, in: European Conference on Knowledge Management, 2016, pp. 831–839.

[48] P. D'Este, M. Perkmann, Why do academics engage with industry? The entrepreneurial university and individual motivations, J. Technol. Tran. 36 (3) (2011) 316–339.