Bachelor Thesis

Characteristics of a successful public-private-partnership on Artificial Intelligence

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Abstract

Artificial Intelligence (AI) poses new ethical, legal, and economic challenges. To deal with these challenges, the Dutch AI Coalition (NLAIC) has proposed to build a new European public-private-partnership (PPP) on the application of AI in peace, justice, and security. This study aims to answer what characteristics AI PPPs find most important for the functioning of their organisation. Current literature about the factors influencing the success of PPPs is mostly derived from the construction industry and therefore a new PPP framework tailored to AI industry, may be helpful for policymakers and actors within AI PPPs. This study proposes such a framework by studying public documents and websites from 18 PPPs of countries within the OECD. The findings of this study include that knowledge of academics within top management, a neutral environment, (long-term) lighthouse projects, strong technical infrastructure, and ethical and legal guidelines were deemed important in addition to a selection of existing characteristics from Yuan et al. (2009, 2012).

Samenvatting

Artificial Intelligence (AI) brengt nieuwe ethische, juridische en economische uitdagingen teweeg. Om deze uitdagingen het hoofd te bieden, heeft de Nederlandse AI-coalitie (NLAIC) voorgesteld een nieuwe Europese publiek-private-samenwerking (PPS) te bouwen voor de toepassing van AI in vrede, recht, en veiligheid. Deze studie tracht te beantwoorden welke kenmerken AI PPS'en het belangrijkst vinden voor het functioneren van hun organisatie. De huidige literatuur over de factoren die het succes van PPS'en beïnvloeden, is grotendeels afkomstig van de bouwsector en daarom kan een nieuw, op de AI-industrie afgestemd, PPP-raamwerk nuttig zijn voor beleidsmakers en actoren binnen AI PPS'en. Deze studie stelt een dergelijk raamwerk voor door het bestuderen van openbare documenten en websites van 18 PPS'en van landen binnen de OESO. De bevindingen van deze studie omvatten dat wetenschappelijke achtergrond binnen het topmanagement, een neutrale omgeving, (lange termijn) 'lighthouse' projecten, sterke technische infrastructuur en ethische en juridische richtlijnen belangrijk werden geacht in combinatie met een selectie van bestaande kenmerken van Yuan et al. (2009, 2012).

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1. Introduction

The Hague is known as the home of international law and justice and a hub for security in general, as it houses numerous national and international juridical organs. Artificial Intelligence (AI) poses new opportunities and challenges in this sector. For example, legal questions arise regarding the liability of autonomous vehicles (Taeihagh & Lim, 2019) or autonomous robotic surgery (O'Sullivan et al., 2019), the harms of profiling on social welfare (Eubanks, 2018), legal decision-support systems (Greenleaf et al., 2018), or whether models trained on personal data should still legally be classified as personal data (Veale et al., 2018). The European Commission, OECD, G20, and UN have all emphasised the challenges such as economic shifts, inequalities, transitions in the labour market, and implications for democracy and human rights (European Commission, 2019; OECD, 2019; Twomey, 2020; United Nations, 2019).

The Hague has the potential to become a vibrant ecosystem for AI and security. However, policy intervention is required to encourage innovation within this region as there are still components within this system that impede innovation, such as the lack of clear policy, educated talent, and public demand for AI-solutions in security (Cloosterman et al., 2018, 2019). Public nor private organisations can tackle these problems on their own and therefore the Dutch AI Coalition (NLAIC), a 'public-private partnership' (PPP), was founded to guide Dutch policy on AI (Rijksoverheid, 2019). The PPP concept, which has its roots in the construction industry, has gained popularity as a means of stimulating innovation by providing infrastructure where academia, government, and industry together can develop knowledge, strategies, and realise goals (Etzkowitz & Zhou, 2017). The NLAIC, The Hague Data Science Initiative, and the Dutch Ministry of Justice and Security, therefore, propose to build a new European PPP that could provide strategic guidance, attract educated talent and tie the private industry to public demand in projects across multiple countries, making The Hague an international hub for AI and security. This begs the question of what characteristics are essential for this PPP to function optimally. This article will advise the NLAIC what characteristics they should keep in mind when building this new PPP.

The added value of PPPs and how they stimulate innovation has been widely researched in the construction and infrastructure industry (e.g. Brogaard, 2019; Lember et al., 2019; Liu & Liu, 2017; Roberts & Siemiatycki, 2015), but also in the agriculture (Hermans et al., 2019), tourism (Errichiello & Marasco, 2017; Mei et al., 2013), environmental (Edelenbos et al., 2011), and healthcare sector (Brogaard, 2017; Denee et al., 2012; Nissen et al., 2015; Reypens et al., 2016; Stolk, 2013). Even though there are plenty of PPPs on AI, the research on PPPs and their part in AI innovation is sparse. Since this is a rapidly evolving industry, highly dependent on recent research within its field as opposed to the construction industry which has existed for much longer and where different stakeholders are in play, it is not self-evident that the findings of previous research apply to this industry.

The societal need for a public-private common ground regarding AI and the lack of academic research on this application of PPPs lead to the research question *"what characteristics should a PPP have to stimulate innovation projects in AI?"*

This article's Theory section (2.1) will explain what framework will be used to answer this question, ending with a list of thirteen tentative propositions (2.2) that derive from this framework. The Methods section (3) will be twofold, the first elaborating how and what data is gathered (3.1), the second explaining how this data is analysed (3.2). The Results (4) are structured according to the propositions and will propose a new AI tailored PPP framework. The Conclusion (5) and Discussion (6) will wrap up this article.

2. Theory & Propositions

To answer the research question, a theoretical framework is needed that maps the characteristics of a PPP that influence its success. There are various proposed frameworks. Some including external factors (e.g. Dolla & Laishram, 2019), some including organisational design over time (e.g. Range & Etzkowitz, 2013), and others being rather high-level and abstract and therefore hard to measure (e.g. Brogaard, 2019; Liu et al., 2018). A framework with concrete and measurable defined components was preferred over more abstract ones. This leads to the choice of the framework of Yuan et al., (2009, 2012), in which they use KPIs (Key Performance Indicators) to describe the components that determine the success of a PPP. These KPIs function as the characteristics that were deemed important for the success of an AI PPP.

2.1 Framework of KPIs

It is difficult to objectively measure the causal relationship between the success of a PPP and a chosen strategy. Therefore Yuan et al. (2009) used a 'wisdom of the crowd' method, in which they surveyed 141 expert stakeholders in construction PPPs with Likert-style rating questions to identify what characteristics of a PPP they deem important. Yuan et al. (2009) distilled these answers using factor analysis into a framework of 41 KPIs (Figure 1). In addition, Yuan et al. (2009) categorised these 41 KPIs in five packages: *The perspective of physical characteristics*, *Finance and marketing*, *Innovation and learning*, *Stakeholders*, and *Process.* These 41 KPIs are the components that define the success of a PPP. Yuan et al. (2012) found that some of these KPIs were not statistically significant and these are therefore crossed out in Figure 1 for clarity. The 15 most important KPIs in this framework were also identified by taking the mean of the Likert scores (Yuan et al., 2009, 2012) and are highlighted in Figure 1 for clarity.

These 15 KPIs will help answer the research question because each KPI is a necessary characteristic of a successful PPP and offers a systematic way of analysing the characteristics and strategies of AI PPPs. We will find out if AI PPPs indeed deem the same KPIs important or have a different focus.

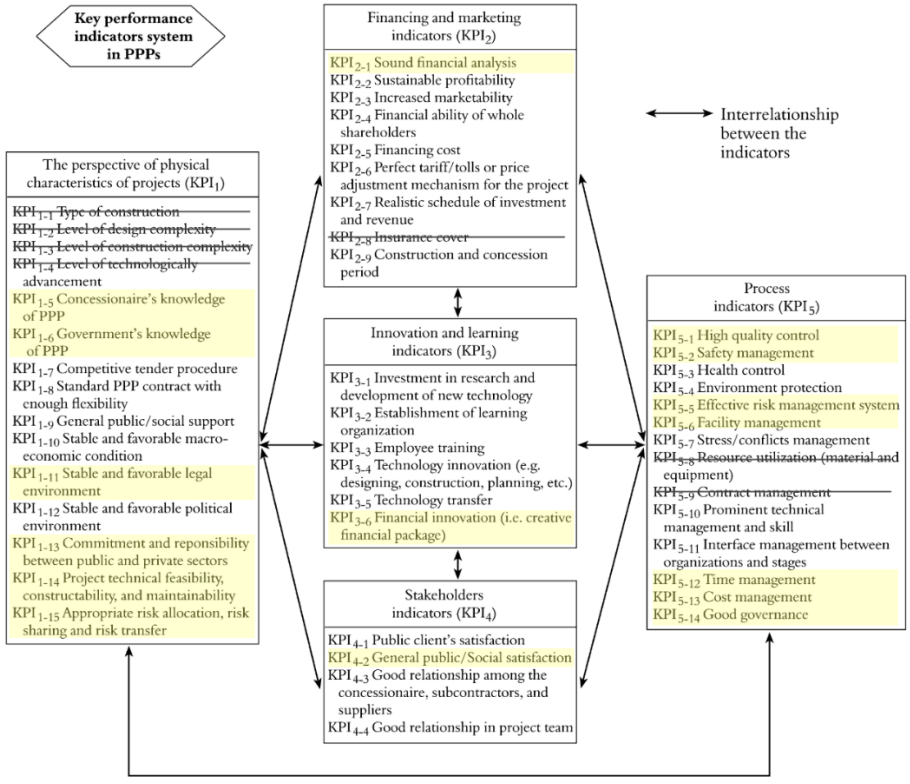

Figure 1. The framework of KPIs for the performance of PPP projects proposed by Yuan et al. (2009). Based on the confirmatory factor analysis of Yuan et al. (2012), statistically insignificant KPIs are crossed out and the 15 most important KPIs according to stakeholders are highlighted (just for this article).

2.2 Tentative Propositions

In the analysis of existing AI PPPs, we will assume that most PPPs will focus on the same KPIs that were deemed most important by Yuan et al. (2009, 2012) (the highlighted ones). This assumption will function as our null hypothesis, meaning that there are no differences in focus on KPIs between the original framework (construction industry) and the PPPs in the AI industry. Note that these are tentative propositions that do not have a unanimous agreement in the academic literature.

These tentative characteristics for creating a successful PPP are fivefold, based on each KPI package and the most important KPIs within them. The next five points elaborate on how these propositions are expected based upon the aforementioned 15 most important KPIs. The characteristics are formulated normatively as to how the AI PPP will have the most success based on previous studies. For some KPIs there is academic literature describing how a PPP can adequately deal with the KPI, this is then integrated into the characteristic. For example, P1.2 is a proposition based upon $KPI_{1\text{-}11}$ and is integrated with insights from Meyers et al. (2019).

1) *Physical characteristics*: The concessionaire's and government's knowledge of PPP ($KPI_{1\text{-}5}$, $KPI_{1\text{-}6}$) are of great importance according to the respondents of Yuan et al. (2009, 2012), therefore an AI PPP should be managed by experts who have experience in PPPs. Also, being set up as an independent legal entity will help create a stable and favourable legal environment ($KPI_{1\text{-}11}$) according to Meyers et al. (2019). Risks are clearly defined and allocated ($KPI_{1\text{-}15}$) to the party that has the best mitigation techniques to manage them (Roumboutsos & Anagnostopoulos, 2008). This leads to the first tentative propositions.

   P1.1: An AI PPP should be managed by experts who are knowledgeable of PPPs ($KPI_{1\text{-}5}$, $KPI_{1\text{-}6}$).

   P1.2: An AI PPP should be a legally independent entity ($KPI_{1\text{-}11}$), based on Meyers et al. (2019).

   P1.3: An AI PPP should have a high commitment between public and private partners ($KPI_{1\text{-}13}$).

   P1.4: An AI PPP should focus on projects with high technical feasibility ($KPI_{1\text{-}14}$).

   P1.5: An AI PPP should allocate risk to the party that has the best mitigation techniques ($KPI_{1\text{-}15}$), based on Roumboutsos & Anagnostopoulos (2008).

2) *Finance and marketing:* Regarding a sound financial analysis ($KPI_{2\text{-}1}$), a long-term strategy will be important to gain the attention of stakeholders within academia, as research often spans multiple years. For the private sector, short term gains will be important to prove the feasibility of the project. Thus, a consensus between the two must be formed. Other elements that are sometimes mentioned as important are the presence of SMEs to nurture job creation and economic growth (Stolk, 2017).

   P2.1: An AI PPP should focus on cooperation with SMEs ($KPI_{2\text{-}1}$).

   P2.2: An AI PPP should with short-term goals for proving feasibility ($KPI_{2\text{-}1}$).

   P2.3: An AI PPP should have long-term goals for the sustainability of the project ($KPI_{2\text{-}1}$).

3) *Innovation and learning:* Based on Yuan et al. (2012), stakeholders will prefer improved financial management ($KPI_{3\text{-}6}$), process management, or decision-making capabilities over an improved level of technology ($KPI_{3\text{-}1}$ and $KPI_{3\text{-}4}$) in a PPP project. This means that facilitating innovation is more important than doing R&D yourself as a PPP.

   P3: An AI PPP should focus on financial, process, and decision management ($KPI_{3\text{-}6}$) instead of improving the level of AI technologies ($KPI_{3\text{-}1}$ and $KPI_{3\text{-}4}$).

4) *Stakeholder:* The general public is a key stakeholder in a PPP and their support ($KPI_{4\text{-}2}$) determines at least some part of the success of the PPP (Hefetz & Warner, 2012; Osborne &

Strokosch, 2013). This support might be obtained by focusing on projects that have high observability in the public domain, so the public will be aware of the added value of the PPP.

P4: An AI PPP should focus on 'lighthouse' projects that show the validity of the PPP's existence and that will obtain public support (KPI_{4-2}).

Where we define a lighthouse project as a well defined, and measurable project that serves as a model for similar projects within the initiative.

5) *Process:* KPI_{5-1}, KPI_{5-2}, KPI_{5-3}, KPI_{5-4}, KPI_{5-8}, KPI_{5-9}, KPI_{5-10}, KPI_{5-12}, and KPI_{5-13} are specifically based upon other frameworks that are closely tied to the construction industry (Yuan et al., 2009), i.e. frameworks by Shen et al. (2004), Kagioglou et al. (2001), and Zhang (2006b). These are by default not translatable to the AI industry and therefore left out of this article.

   This leaves an effective risk management system (KPI_{5-5}), well-functioning facility management (KPI_{5-6}), and good governance (KPI_{5-14}) as the most important KPIs of this package. Good governance (KPI_{4-14}) is defined as strict regulation and administration by the public sector during the process to avoid significant defects when the project is transferred along with the reduction of uncertainty and risk through management of quality, safety, and process risk (Yuan et al., 2012). This leads to the three propositions of this package.

   P5.1: An AI PPP should have an effective risk management system (KPI_{5-5}).

   P5.2: An AI PPP should have well-functioning facility management (KPI_{5-6}).

   P5.3: An AI PPP should have strict regulation and administration by the public sector (KPI_{5-14}).

These thirteen propositions will provide greater insight in what from the framework of Yuan et al. (2009, 2012) applies and what does not to AI PPPs. This will then result in a more tailored framework specified to the AI industry. If there are large discrepancies between the framework based on construction and the new framework based on AI, this might beg questions whether more of these frameworks that were initially founded on the construction industry, are still meaningful in different PPP contexts. The next paragraph will explain what data is used to evaluate to what extent these propositions are in line with the views of AI PPPs.

3 Methods

3.1 Data Collection

To determine what strategies AI PPPs, implement and to what extent these correspond to the propositions, these PPPs will be studied via web searches and their public documents. The selection criteria for the PPPs to be studied are 1) located in a country that is a member of the OECD, for these countries are more similar in terms of economic playing field relative to non-OECD countries and therefore makes comparison fairer; 2) the PPP provides sufficient information in English on the internet; 3) the PPP is not a subsidiary of an already included PPP; 4) the PPP's focus is on AI and not on one of its supersets (e.g. IT or Digitisation).

The PPPs were found in threefold. The starting point being Stix (2018) since this is a reputable and elaborate workshop report by the European Commission covering most PPPs in the EU-28. Additionally, the PPPs mentioned in Hartog & Nauta (2019), since this is a report by The Hague Data Science Initiative, which is part of the formation of the proposed PPP mentioned in the introduction. Finally, web searches with keywords ("AI" OR "Artificial Intelligence") AND ("partnership" OR "public private partnership" OR "hub") AND ({country}), where all members from the OECD were used. This was necessary because some PPPs, as mentioned by Stix (2018), were still in the process of founding in 2018 and 2019. In total 74 PPPs were considered, 51 of those were excluded as a result of the selection criteria based on a quick scan. Amii, Platform Lernende Systeme, DaSCII Hub, Norwegian Open AI Lab, and PRAIRIE, which were in this initial selection, were left out due to insufficient information provided on their website. This leaves a total sample size of 18. The exact reason for exclusion is provided in the Appendix (Table A-2). Figure 2 presents an overview of the selection.

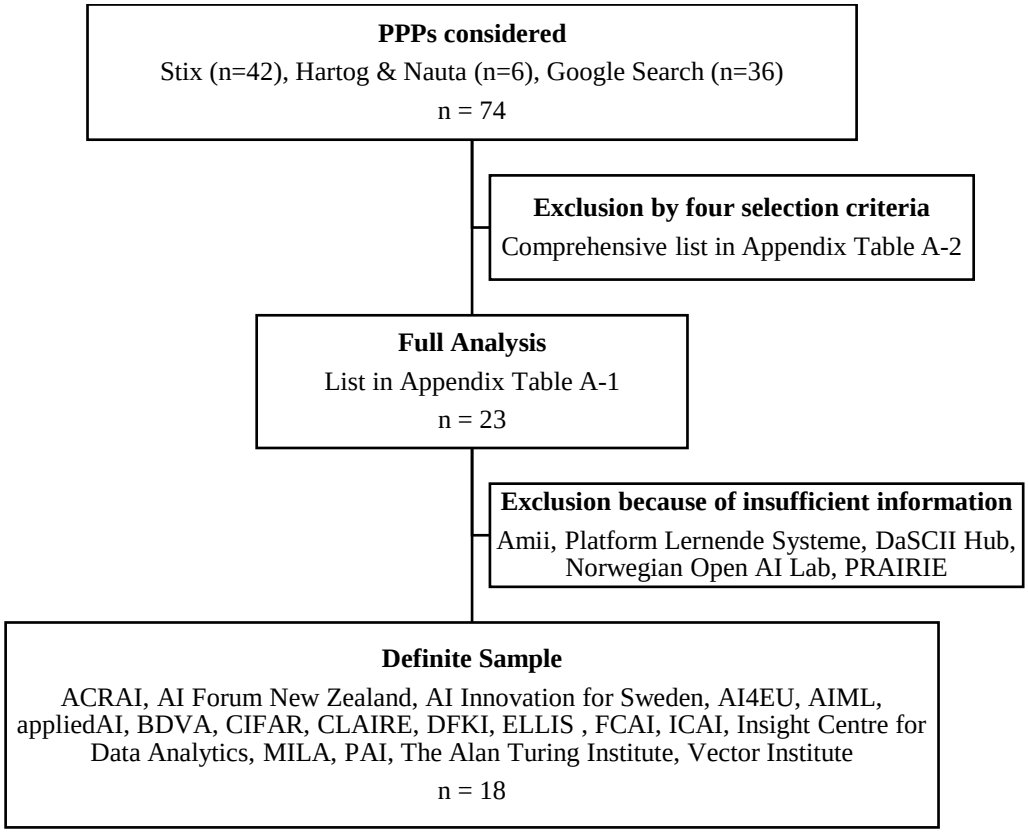

Figure 2. Sample selection.

The websites and documents that are used for each PPP are listed in the Appendix (Table A-1).

3.2 Data Analysis

The documents analysed of each PPP are provided in the Appendix. Every PPP is given a score on a five-point Likert scale showing how much the PPP agrees or disagrees with each proposition. These scores will be based on quotes from the analysed documents. This will be plotted in a matrix akin to Table 1. When a PPP explicitly states in a document or on its website that they deem valuable for their organisation what a proposition expects and they implement it, a score of 5 is given. When the PPP only implicitly confirms the proposition, for example when the PPP is legally independent (P1.2) but does not explicitly state that it deems it valuable to be independent, it receives a score of 4. Similarly, scores 1 and 2 are given when the PPP rejects the proposition. When neither applies a score of 3 is given and when it is unclear the field is left blank.

Table 1. Matrix of confirmation and rejection of the five propositions by the PPPs.

	P1.1	P1.2	P1.3	…	P5.3
ACRAI	(score 1-5)	(score 1-5)	(score 1-5)	…	(score 1-5)
AI Forum New Zealand	(score 1-5)	(score 1-5)	(score 1-5)	…	(score 1-5)
⋮	⋮	⋮	⋮	⋮	⋮
Vector Institute	(score 1-5)	(score 1-5)	(score 1-5)	…	(score 1-5)

This method has its limitations. First of all, this list is non-exhaustive, so there is no guarantee no strategies are left out because of this selection. Secondly, some PPPs offer more information about their organisation online than others. This may lead to a bias toward more outspoken PPPs. I have tried to adjust for this and to distribute the findings fairly over the PPPs. Thirdly, the data will be analysed qualitatively, which also means that I have selected what to include and what to leave out. In this selection, I gave more weight to the variety of strategies, than to their frequency, as this article aims to provide an overview of all the different strategies used and a focus on frequency would require a more quantitative method.

The results will be sectioned according to the five KPI-packages and their corresponding propositions. Each section covers the propositions in the package and lists how some PPPs agree or disagree with the proposition. It will also explain which KPI the PPP does focus on if not for the ones used for the one in the proposition. This will be illustrated by quotes from the analysed documents. The finalised version of Table 1 will be used as general guidance in these sections. The discussion section will later argue whether the five propositions are rejected or confirmed.

4. Results

In this paragraph, the results of the data analysis are presented. Table 2 at the end of this section provides an overview of all the scores given to PPP regarding the agreement with the propositions. Each section will have a concluding paragraph that states whether the characteristic is confirmed as essential for a successful PPP. Table 2 is an overview of all the propositions and whether they are confirmed or rejected. Table 2 is used to create a new framework based on Yuan et al. (2009, 2012) but tailored to the AI industry. If there are additional findings regarding a proposition, these will be incorporated in this new framework.

P1.1 Experts in Top Management

In line with the first proposition that AI PPP should be managed by experts who are knowledgeable of PPP, most PPPs choose people who have had experience in other PPPs to be in their top management, therefore receiving a score of 4 in Table 3.

Interestingly, most of the founders and leaders of all PPPs have an academic background and are currently active as researchers in the field of AI. It seems that academic background is deemed even more important than experience in PPPs. AI Innovation for Sweden even states that

> [f]ounding fellows must be members of the permanent Faculty of a major university, or in some cases senior members of the administrative staff of a major university, at the senior level (corresponding in the US to Full Professor or Tenured Associate Professor), or senior staff from industrial and national research laboratories (AI Innovation for Sweden, 2018b, p13).

Experience in PPPs seems to be a plus, but experience in academics is a prerequisite. Therefore P1.1 is confirmed, but an additional characteristic 'managements knowledge of academics' is proposed.

P1.2 Independency

Most PPPs are legally independent non-profit or not-for-profit entities and some of them explicitly state the importance of being a neutral ground for their partners (e.g. Vector Institute, appliedAI, AI Innovation for Sweden). The added value of being legally independent was not mentioned, therefore these PPPs a score of 4. A few exceptions cannot be classified as independent such as the BDVA and AI4EU which are strongly tied to the European Commission and therefore get a score of 2.

Since there is no clear consensus over this, P1.2 cannot be confirmed. However, I do propose to add 'neutral environment' as a characteristic to the framework since this was mentioned by most PPPs as important for their consortium.

P1.3 Commitment

The commitment of partners is indeed an important aspect of the PPP according to most PPPs. It is sometimes enforced with annual membership fees (e.g. BDVA, ELLIS, and Vector), or even per three years (e.g. AI Innovation for Sweden). Some of these PPPs choose to have tiers in membership where more funding comes with greater privileges and therefore makes it more appealing to have a higher commitment to the project. For example, AIML gives Intellectual Property Rights (IPR) to the party that fully funds the project. Both these tiers and IPR are a dividing subject as PAI mentions that

> [i]n order to foster an organization of open and equal collaboration, all Partner organizations are formally equal, and there are no membership tiers. No participating organization will be accorded special privileges by virtue of contributing more financially to the organization. (Partnership on AI, 2020b)

Using IPR as a way of attracting commitment is not undisputed as MILA states:

> We generally do not have contracts involving exclusivity constraints, that are too application-specific and end up tying our innovations to IP belonging to a specific company. What we do, both in terms of code and algorithmic ideas, is put them in the public domain. In other words, we do not write patents for anything we do, and we publish our research. (MILA, 2020)

Non-financial ways of enforcing commitment are also mentioned.

> ICAI labs require a serious commitment from the sponsoring organization, in terms of its ability (1) to jointly formulate research challenges, (2) to provide a meaningful environment for the PhD students to work on-site, and (3) to test and absorb the knowledge created in the lab. (ICAI, 2020)

Workshops, summer-schools, and access to a talent pool for recruitment were also mentioned by amongst others CIFAR, Vector institute, ELLIS, AI Forum New Zealand as important.

Even though there is a minority that does not actively enforce commitment, most PPPs find this an essential part of their collaboration and explicitly state so thereby receiving a score of 5. This minority also does not reject commitment, so P1.3 can be rather confidently confirmed.

P1.4 Feasibility of Projects

Even though feasibility is not the same as technological readiness or the focus on basic versus applied research, this was taken as an indicator of how much the PPP focusses on short term wins over long term projects, as the financial benefits of basic research often shows up later than of applied research (Gerbach, Sorger & Amon, 2018).

There is a great diversity in the focus of technical feasibility concerning technological readiness ranging from fundamental research to implementation. We see a spectrum of PPPs that mainly focus on cases and problems defined by their partners, and PPPs that do research solely for the advancement of knowledge of AI. ICAI, ACRAI, AI Forum New Zealand, and appliedAI for example focus primarily on applied research. ICAI works with labs funded by a partner and focussed on a problem the partner deals with. Other PPPs such as CLAIRE focus primarily on fundamental research and state that

> [u]nder the leadership of some of the top researchers in the field, this network should jointly identify fundamental research questions, discuss the most promising approaches, and help organise collaborative efforts to address them. (Hoos, Irgens, & Slusallek, 2019, p3)

Notice that CLAIRE acknowledges the feasibility of the research "…discuss the most promising approaches…", but also states its focus on fundamental research questions. This is why CLAIRE, as well as ELLIS, have a score of 2. Not because they do not find feasibility important, but because their focus is on basic research, and therefore on the advancement of science over financial gains.

appliedAI also has projects at the beginning of technological maturity by making a proof of concept (PoC) of technology to validate it in an environment.

> All technical implementations should start with a "proof of concept" that shows the technical feasibility of the use case. However, a PoC must also validate the potential for return on investment as well as scalability, usability and maintainability. We build a PoC in short sprints for you with the goal of enabling the next step: Engineering a complete AI-Solution. (Initiative for Applied Artificial Intelligence, 2020)

The BDVA takes a different stance and classifies technologies with a Technology Readiness Level (TRL). Their projects are mainly focussed on more mature technologies as 75% of their projects score more than 5 out of 9 in technological maturity (technology validated in relevant environment) (BDVA, 2019).

AI Forum New Zealand is at the end of the spectrum as it states that *"New Zealand will be a taker not a maker of AI technologies."* Therefore, they focus on the implementation of AI and not the development of it.

All PPPs took feasibility of projects seriously, therefore this proposition is also confirmed. This proposition ties into P2.2 and P2.3 with the classic trade-off between the short-term output of applied research and the long-term output of basic research (Gersbach, Sorger & Amon, 2018).

P1.5 Risk Allocation
Only a few PPPs mentioned the involved financial risk of the projects and how they mitigate it. The majority did not disclose anything about this and so this proposition cannot be answered due to the lack of sufficient data.

CIFAR interestingly review criteria starts with *"Is the research question fundamentally important and high-risk?"* (CIFAR, 2019a, p10). Possibly because they want to focus on projects that need help from the PPP and would not happen otherwise. Most PPPs did state the risk of AI regarding ethics, privacy, and legal questions but not explicitly concerning their organisation.

P1.5 can neither be confirmed nor rejected, therefore it is kept in the new framework, as it does have a substantial base in Yuan et al. (2009, 2012).

P2.1 Focus on Type of Parties in Consortium
Most PPPs describe the added value and importance of SMEs for economic development. However, only AI Forum New Zealand, AI Innovation for Sweden, AI4EU, BDVA emphasise that their collaboration is mainly focussed on start-ups and scale-ups. ELLIS says it uses fundamental research to stimulate entrepreneurial activity; *"ELLIS will perform fundamental research in modern AI, attract top international industry research labs, and spawn startups that will become major players in the future"* (ELLIS, 2020).

To illustrate the focus, BDVA has membership comprises of 28% SMEs, 16% Large Enterprise, 50% Research with the remainder public entities or non-profit (BDVA, 2019). The focus of PPPs is much more aimed towards research institutes, this is the reason why CLAIRE obtained a score of 1 since their focus is solely on research labs. Collaboration overall has its roots in research institutes and not SMEs, large corporations, or governmental organisations.

Even though most PPPs describe the added value of SMEs for economic development, the main focus of the PPPs is on research institutes, and most PPPs name SMEs as well as large corporations to be important partners. Therefore P2.1 is rejected.

P2.2 Short Term Projects
No PPP explicitly confirms the importance of short-term projects for proving the feasibility and added value of the PPP. Nonetheless, some PPPs do contract-based research such as appliedAI, DFKI, and AIML. ELLIS is the sole PPP that explicitly rejects the proposition, *"ELLIS does not aim to optimize short-term licensing income, and rather aims at sustained economic impact in Europe"* (ELLIS, 2020).

Since it seems the PPPs are somewhat indifferent to this proposition, P2.2 is rejected.

P2.3 Long Term Projects
Long term sustainability of the PPP is almost unanimously important to the PPPs. FCAI, however, does state that short term projects may pave the way for long term partnerships

> FCAI is most beneficial when the research is fundamental, long term and in strategically selected themes. This enables participation and access to core research and cooperation with best researchers in the area. Research co-operation often starts with one joint project, but it may, over time, grow into a long-term strategic partnership. (FCAI, 2020a)

The BDVA says the same; *"The budgets assigned to the projects should act as seeds for more widely implemented plans"* (BDVA, 2017, p32).

The importance of long-term projects for the sustainability of the PPP (P2.3) can therefore be confirmed. This is then considered for our new framework and will be part of 'Sound financial analysis' ($KPI_{2\text{-}1}$).

P3 Focus on Finance, Process, and Decision Management

The majority of PPPs reject the proposition that the focus should be on financial, process, and decision management (KPI3-6) instead of improving the level of AI technologies (KPI3-1, KPI3-4, KPI3-5). Most PPPs have their focus primarily on basic and applied research, which can be classified in KPI3-1, KPI3-4, KPI3-5 instead of KPI3-6.

However, BDVA, AI Forum New Zealand, and ACRAI do indeed focus more on providing financial, process, and decision management than on pure research.

For example, ACRAI's guiding principles are:

> I. creating economic framework conditions which promote innovation and technology and which ensure that the potential of RAS [Robots and Autonomous Systems] and AI are fully leveraged to ensure the competitiveness of Austrian industry;
>
> II. creating a legal framework to ensure safe use of RAS and AI for individuals and society as a whole, in compliance with the legal framework of the European Union;
>
> III. developing measures to identify, mitigate or prevent potential danger or harm to people and society caused by RAS and AI at an early stage; and
>
> IV. planning public activities to inform the public on RAS and AI and to responsibly address society's fears and concerns. (ACRAI, 2018, p5)

ACRAI does not mention improving the level of AI technologies (KPI3-1, KPI3-4, KPI3-5) itself. Similarly, the BDVA strategy is fourfold and neither mentions research as such:

> • Develop Data Innovation Recommendations: Providing guidelines and recommendations on data innovation to the industry, researchers, markets and policy makers.
>
> • Develop Ecosystem: Developing and strengthening the European Big Data Value Ecosystem.
>
> • Guiding Standards: Driving Big Data standardisation and interoperability priorities, and influencing standardisation bodies and industrial alliances.
>
> • Know-How and Skills: Improving the adoption of Big Data through the exchange of knowledge, skills and best practices. (BDVA, 2017, p17-18)

A tiny minority indeed focusses more on financial, process, and decision management as expected by P3. However, a clear majority focusses on basic and applied research in AI. The focus of an AI PPP is therefore in most cases on $KPI_{3\text{-}1}$ and $KPI_{3\text{-}4}$ instead of $KPI_{3\text{-}6}$. This is directly opposed to what we had propositioned and therefore P3 is not only rejected, but 'Investment in research and development' ($KPI_{3\text{-}1}$) and 'Technology innovation' ($KPI_{3\text{-}4}$) are added to the new framework.

P4 Lighthouse Projects

The importance of lighthouse projects was explicitly emphasised by a minority of PPPs, sometimes referred to as 'flagship projects'.

A different approach relating to P1.5 and P5.1 (allocating risk and risk management), was the use of 'sandboxes'. Many PPPs have stated the legal and ethical risks of AI projects. To still give room for experimentation FCAI, amongst others, suggests test environments in which a project can take still place in a more secure and supervised area, i.e. a sandbox.

To gain public support ($KPI_{1\text{-}9}$) as well as to create a stable legal environment ($KPI_{1\text{-}11}$, P1.2) for projects FCAI has proposed the use of MyData, a tool for individuals to manage the personal data they share and to see who is using it. According to FCAI, it is not possible to enact a separate law enabling the use of MyData for every useful public administration data resource. Therefore, they propose the sandbox model allowing the development of regulation that would enable transfer and secondary use of personal information held by the public administration, when consented by the person concerned (FCAI, 2019).

The implementation of MyData may result in greater support for larger projects such as AuroraAI, a national project that aims to offer a personalized selection of services for every citizen, filtering them

according to his or her individual needs at particular moments in life (FCAI, 2019). Thus, a sandbox model could pave the way for large lighthouse projects.

Even though not all PPPs acknowledged the benefits of lighthouse projects for public support, the added value of lighthouse, flagship, or sandbox projects was clearly stated. Therefore, this proposition is confirmed.

P5.1 Risk Management

Like P1.5, the PPPs provided insufficient insights into their risk management, therefore we are unable to draw conclusions from this.

Because of insufficient data, P5.1 can neither be confirmed nor rejected, for the same reason as P1.5, the corresponding $KPI_{5\text{-}5}$ is included in the final framework.

P5.2 Facility Management

PPPs deal differently with facility management. Many are based at the university that initially founded them. Others such as CLAIRE, ELLIS, ICAI have a more dispersed structure. ELLIS and ICAI both set up smaller research units in different locations in Europe. CLAIRE thinks of a strong infrastructure as

> […] computing, big data storage (including long-term storage and secure storage for sensitive data), and networking as well as infrastructure for maintaining joint AI platforms and services. It needs to be able to support large-scale AI research that can compete at the level of large private entities, while focusing on areas specifically relevant for Europe. (Hoos, Irgens, & Slusallek, 2019, p5)

Most PPPs already have or aim to obtain infrastructure that fosters

> […] know-how on managing data (end-to-end) for pre-commercial projects. This should include methods, storage, processing power for training algorithms, versioning and access management from IP, as well as a legal perspective. (AI Innovation for Sweden, 2018c, p3).

Only AI Forum New Zealand and ACRAI neither have nor desire such an infrastructure. Perhaps because ACRAI only has a counselling function and AI Forum New Zealand focusses on implementation rather than innovation within AI, as mentioned earlier.

Most PPPs do find a state-of-the-art-infrastructure, concerning both technical devices (computing, data storage, etc.) and for collaboration infrastructure such as conference and working environments, important for the functioning of the PPP. Therefore, P5.2 is confirmed.

P5.3 Public Regulation

Many PPPs acknowledge the importance of regulation of the application of AI. However, this applies to the industry and not to the PPP itself. There are no PPPs that emphasise the importance of public regulation within the PPP.

A recurring theme is that regulation needs to be adapted to the workings of AI. The General Data Protection Regulation (GDPR) in the EU states in Recital 71 that "*the data subject should have the right* [...] *to obtain an explanation of the decision reached*" and Article 15 "*The data subject shall have the right to obtain from the controller* […] *meaningful information about the logic involved*." (General Data Protection Regulation, 2018). AI Forum New Zealand states, that for this to be enforced, the controller first must have meaningful insight itself into the working of the AI model, and therefore progress in Explainable AI research is key for regulation.

> The GDPR is designed to address the risk of companies making unfair decisions about individuals using AI. In many cases, compliance with this regulation will depend on progress in Explainable AI research, and on uptake of Explainable AI techniques. (AI Forum New Zealand, 2018, p69)

CIFAR states another problem regarding the rigidity of regulating entities versus the rapid progress of AI technology.

> Regulatory regimes tend to be slow-moving, rigid, and overly complex for the current pace of technological advances. New models for regulatory reform should be considered to address these shortcomings in the longer term. (CIFAR, 2020, p7)

Even though most PPPs stated the importance of supervising the AI regarding legal and ethical guidelines, they did not state this about the PPP itself, therefore P5.3 cannot be confirmed. Projects within the PPP should however still comply with the same worries over ethics and legality as projects outside the PPP.

Table 3 presents a full overview of all the scores the PPPs received based on quotes akin to those above. An overview of all the confirmed and rejected propositions are also presented in Table 2.

Table 2. Confirmed and rejected propositions of this study.

Proposition	**Confirmed (C)/Rejected (R)**	**Additional Remarks**
P1.1: An AI PPP should be managed by experts who are knowledgeable of PPPs ($KPI_{1\text{-}5}$, $KPI_{1\text{-}6}$).	C	Academic background is more important
P1.2: An AI PPP should be a legally independent entity ($KPI_{1\text{-}11}$).	R	Neutrality is important, but independency is not essential
P1.3: An AI PPP should have a high commitment between public and private partners ($KPI_{1\text{-}13}$).	C	
P1.4: An AI PPP should focus on projects with high technical feasibility ($KPI_{1\text{-}14}$).	C	
P1.5: An AI PPP should allocate risk to the party that has the best mitigation techniques ($KPI_{1\text{-}15}$).	?	Insufficient data
P2.1: An AI PPP should focus on cooperation with SMEs ($KPI_{2\text{-}1}$).	R	Focus on research institutes is more frequent
P2.2: An AI PPP should with short-term goals for proving feasibility ($KPI_{2\text{-}1}$).	R	
P2.3: An AI PPP should have long-term goals for the sustainability of the project ($KPI_{2\text{-}1}$).	C	
P3: An AI PPP should focus on financial, process, and decision management ($KPI_{3\text{-}6}$) instead of improving the level of AI technologies ($KPI_{3\text{-}1}$, and $KPI_{3\text{-}4}$).	R	
P4: An AI PPP should focus on 'lighthouse' projects that show the validity of the PPP's existence and that will obtain public support ($KPI_{4\text{-}2}$).	C	
P5.1: An AI PPP should have an effective risk management system ($KPI_{5\text{-}5}$).	?	Insufficient data
P5.2: An AI PPP should have well-functioning facility management ($KPI_{5\text{-}6}$).	C	
P5.3: An AI PPP should have strict regulation and administration by the public sector ($KPI_{5\text{-}14}$).	R	Regulation of AI in general is important however

Table 3. Propositions and the scores of PPPs. Information that could not be derived is left blank. PPPs below the red line were left out of the analysis due to insufficient information on their website.

	P1.1 Experts	**P1.2** Independency	**P1.3** Commitment	**P1.4** Feasibility	**P1.5** Risk	**P2.1** SME	**P2.2** Short term	**P2.3** Long term	**P3** Focus on Finance	**P4** Lighthouse projects	**P5.1** Risk management	**P5.2** Facility	**P5.3** Public regulation
ACRAI	4	4	2	4		3	3	3	4	3		2	4
AI Forum New Zealand	3	4	4	4		5	4	3	4	4		2	4
AI Innovation for Sweden	4	4	5		3	5	3	5	1	3	3	5	4
AI4EU		2	2	3	2	5	3	3	3	4	2	3	4
AIML	4	2	4	3		3	3	3	2	3		3	3
Alan Turing Institute	4	4	2	4	4	4	4	3	2	3	4	4	3
appliedAI	4	2		5		3	4	4	3	3		3	3
BDVA	4	1	5	4		5	4	5	4	5		5	4
CIFAR	5	4	4	3		3	4	4	1	3		5	3
CLAIRE	4	4	3	2	3	1	4	4	1	4	3	5	3
DFKI	3	4	3	3	3	3	4	4	3	4	3	5	3
ELLIS	4	4	5	2	3	4	1	5	1	3	3	5	3
FCAI	4	4	5	3		3	4	5	2	5		3	4
ICAI	4	4	5	4	3	3	3	3	4	3	3	4	3
Insight Centre for Data Analytics	4	3	4	4		3	3	4	1	3		4	3
MILA	4	4	4	3		3	3	5	2	3		4	3
Partnership on AI	4	4	3	3		3	3	3	3	3		3	4
Vector Institute	3	4	3	3		3	3	4	2	3		5	4
Amii	4	4	3	3		3			1			3	
DaSCII Hub	3	4		3		5			2			3	
Lernende Systemen	4	5		3		3							
Norwegian Open AI Lab	4	2	3	4		3						4	
PRAIRIE	3	2		3		2			4				

AI Tailored PPP Framework

Based on the aforementioned conclusions in Table 2, Figure 3 proposes a framework for the essential characteristics for a successful AI PPP adapted from Yuan et al. (2009, 2012) and the results of this study.

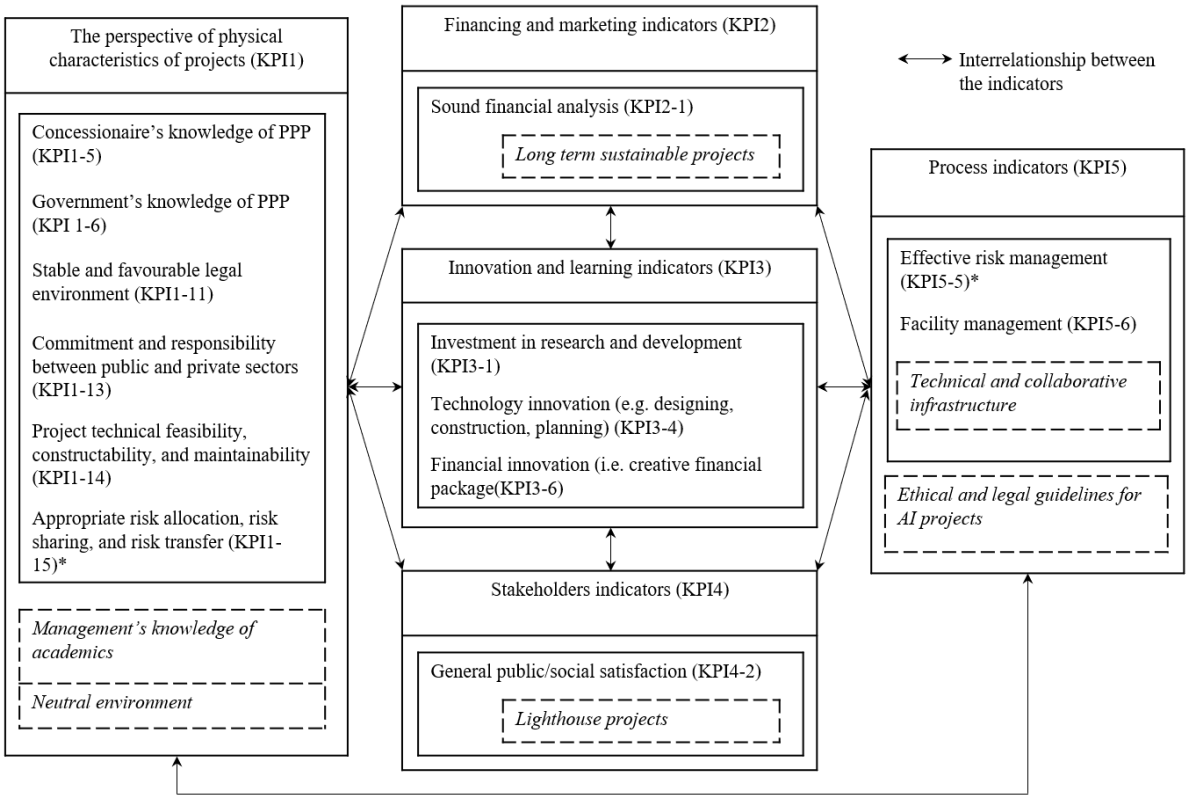

*Figure 3. Proposed PPP framework of essential characteristics based on Yuan et al. (2009, 2012) and tailored to the AI industry. Dotted lines are additional proposed characteristics based on the results of this article. *are included but could not be confirmed nor rejected by this article.*

5. Conclusion

The goal of this article was to identify the characteristics that determine the success of an AI PPP. These characteristics are shown in the newly proposed framework for AI PPPs in Figure 3. Overall, the 18 PPPs that were considered have a much greater focus on basic research and R&D in general than PPPs in the construction industry, upon which the original framework was based. Knowledge of academics within top management, a neutral environment, (long-term) lighthouse projects, strong technical infrastructure, and ethical and legal guidelines were deemed important characteristics in addition to a selection of existing characteristics from Yuan et al. (2009, 2012). Perhaps the most interesting finding is that AI PPPs innovate themselves via applied or basic research, whereas PPPs from the original framework tended to stimulate other actors to innovate.

The fact that different KPIs were important to the AI industry than to construction industry and vice versa, may indicate that this goes for other industries as well. Current PPP literature and frameworks still have strong ties to the construction industry (e.g. Brogaard, 2019; Dolla & Laishram, 2019; Liu et al., 2018; Range & Etzkowitz, 2013). However, nowadays PPPs are adopted in a myriad of other industries. To still provide a sensible framework for a different industry, we must tailor it as we did in this study. Certainly, a framework that fits all industries is more desirable than many tailored ones, but it begs the question of whether such a framework is so abstract that it would fail to provide any meaningful insights.

This article was also written to advise the NLAIC, Data Science Initiative, and The Dutch Ministry of Justice and Security in their efforts to build a new PPP on the application of AI in peace, justice, and security. From this study, we can conclude that their focus should be fairly research oriented, meaning actively innovating and doing R&D as opposed to (e.g. financially) stimulating others to innovate. Partnering with many universities or other research institute is therefore advisable. Also attaining people with technical knowledge in this field should help the new PPP be competitive.

6. Discussion

This study has its limitations. The data from websites and public documents was sparse, where factual information was easier to obtain than opinions and considerations about strategies and the choice for one strategy over the other. It might have been more fruitful to have conducted interviews with the PPPs that were studied to gain more inside information about the workings of the organisation.

The use of Likert-scores also has its limitations, as it is not always possible to fully turn the nuances of a quote into a score. Table 3 presenting the Likert-scores should therefore be taken as an overview. Actual conclusions were drawn more directly from the quotes.

It is also debatable whether the sample is representative as this study focussed mostly on Western OECD countries because these provided enough information in English on their websites. It is not unthinkable that non-Western countries will have different approaches. Even so, PPPs did not provide many more insights after about five were studied. Therefore, it is credible that data saturation was still reached.

Furthermore, this study focussed on providing insight into the variety of stances of AI PPPs where a ‘wisdom of the crowd’ method was used to answer what characteristics are essential for an AI PPP. It might be interesting to come up with a way of grading these PPPs on their level of success and analysing what characteristics correlate with that, for it is not necessarily the case that what most PPPs choose to do is indeed the best option. This was not implemented in this study because it adds potential extra bias of the grader and the dilemma of determining what constitutes a successful PPP.

Conflict of interest

This article was written partly as advice for the Dutch AI Coalition (NLAIC). For this reason, the NLAIC was not considered in the study itself as a source of data.

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10. Appendix

Table A-1. The selected PPPs and the website and documents used to analyse them.

PPP	Full Name	Location(s)	Website	Additional Documents
ACRAI	Austrian Council on Robotics and Artificial Intelligence	Austria	https://www.acrai.at/en/home/	(Austraian Council on Robotics and Artificial Intelligence, 2018)
AI Forum New Zealand	AI Forum New Zealand	New Zealand	https://aiforum.org.nz	(AI Forum New Zealand, 2018, 2019, 2020; Glass, 2019)
AI Innovation for Sweden	AI Innovation for Sweden	Sweden	https://www.ai.se/en	(Innovation for Sweden, 2018a, 2018b, 2018c, 2020a, 2020b; Nordlund, 2018)
AI4EU	AI4EU	Europe	https://www.ai4eu.eu	(AI4EU, 2019a, 2019b, 2019c, 2019d)
AIML	Australia Institute for Machine Learning	Australia	https://www.adelaide.edu.au/aiml/	(Australian Institute for Machine Learning, 2018, 2019a, 2019b, 2019c)
Amii	Alberta Machine Intelligence Institute	Canada	https://www.amii.ca	(Amii, 2020a, 2020b)
appliedAI	Institute for Applied Aritificial Intelligence	Germany	https://www.appliedai.de	(Initiative for Applied Artificial Intelligence, 2020)
BDVA	Big Data Value Association	Europe	http://www.bdva.eu	(Big Data Value Association, 2017, 2018, 2019a, 2019b, 2019c, 2020; Big Data Value Association & euRobotics, 2019)
CIFAR	Canadian Institute for Advanced Research	Canada	https://www.cifar.ca	(CIFAR, 2019a, 2019b, 2020; Villeneuve, Boskovic & Barron, 2019)
CLAIRE	Confederation of Laboratories for Artificial Intelligence Research in Europe	Europe	https://claire-ai.org	(Hoos, Irgens & Slusallek, 2018)
DaSCII Hub	Andalusian Research Institute in Data Science and Computational Intelligence	Spain	https://dasci.es	
DFKI	Deutsches Forschungszentrum für Künstliche Intelligenz	Germany	https://www.dfki.de/en/web/	(DFKI, 2020)
ELLIS	European Laboratory for Learning and Intelligent Systems	Europe	https://ellis.eu	(ELLIS, 2020)
FCAI	Finnish Center for Artificial Intelligence	Finland	https://fcai.fi	(FCAI, 2020a, 2020b; Ministry of Economic Affairs and Employment of Finland, 2019)
ICAI	The Innovation Center for Artificial Intelligence	Netherlands	https://icai.ai	(ICAI, 2020)
Insight Centre for Data Analytics	Insight Centre for Data Analytics	Ireland	https://www.insight-centre.org	(Insight Centre for Data Analytics, 2017; Namee, O'Connor & Smeaton, 2016)
MILA	Montreal Institute for Learning Algorithms	Canada	https://mila.quebec/en/	(MILA, 2019, 2020)
Norwegian Open AI Lab	Norwegian Open AI Lab	Norway	https://www.ntnu.edu/ailab	
PAI	Partnership on AI	USA	https://www.partnershiponai.org	(Partnership on AI, 2020a, 2020b)
Platform Lernende Systeme	Platform Lernende Systeme	Germany	https://www.plattform-lernende-systeme.de/home-en.html	(Platform Lernende Systeme, 2020)
PRAIRIE	ParRis Artificial Intelligence Research InstitutE	France	https://prairie-institute.fr	
The Alan Turing Institute	The Alan Turing Institute	UK	https://www.turing.ac.uk	(The Alan Turing Institute, 2015, 2018, 2019)
Vector Institute	Vector Institute	Canada	https://vectorinstitute.ai	(Vector Institute, 2019a, 2019b, 2019c)

Table A-2. Excluded PPPs and the reasons for exclusion.

PPP	Location(s)	Reason for exclusion
ACIA (Catalan AI Association)	Spain	Insufficient information on Website
ADAPT	Ireland	Insufficient focus on AI
AER (Spanish Robotics and Automation Association)	Spain	Insufficient focus on AI
BCS SGAI	UK	Insufficient information on Website
Benelux Association for Artificial Intelligence (BNVKI)	Benelux	Insufficient information on Website
CeADAR	Ireland	Insufficient information on Website
Connect	Ireland	Insufficient focus on AI
Cyber Valley	Germany	Insufficient information on Website
Czech Society for Artificial Intelligence	Czech Republic	Insufficient information on Website
Danish Centre for Applied Artificial Intelligence	Denmark	Insufficient information on Website
Digital.Swiss	Switzerland	Insufficient focus on AI
ECSEL	Austria	Insufficient focus on AI
France is AI	France	Insufficient information on Website
Fraunhofer Institute for Intelligent Analysis and Information Systems	Germany	Insufficient information on Website
HISPAROB (Spanish Platform on Robotics)	Spain	Insufficient focus on AI
Icelandic Institute for Intelligent Machines (IIIM)	Iceland	Insufficient information on Website
ICHEC	Ireland	Insufficient focus on AI
ICT of the Future	Austria	Insufficient focus on AI
Innovris Team Up	Belgium	Insufficient focus on AI
Interdisciplinary Lab for Intelligent and Adaptive Systems	Luxembourg	Insufficient information on Website
KI.NRW	Germany	Insufficient information on Website
Max-Planck-Institutes for Intelligent Systems, and Informatics,	Germany	Insufficient information on Website
Mindfire	Switzerland	Insufficient focus on AI
ML2R	Germany	Insufficient information on Website
Mobility of the Future	Austria	Insufficient focus on AI
NORA	Norway	Insufficient information on Website
Nordic AI Institute	Scandinavia	Insufficient information on Website
Odense robotics cluster	Denmark	Insufficient focus on AI
Production of the future	Austria	Insufficient focus on AI
RIAAA	Mexico	Only a conference
RISE AI	Sweden	Insufficient information on Website
SCIENCE AI Centre	Denmark	Insufficient information on Website
SEIDROB (Spanish Society for R&D in Robotics)	Spain	Insufficient focus on AI
Silo.ai	Finland	More a private company than PPP
Society for the Study of Artificial Intelligence and Simulation of Behaviour (AISB)	UK	Insufficient information on Website
Swedish AI Council	Sweden	Insufficient information on Website
Swedish AI Society	Sweden	Insufficient information on Website
Swiss Cognitive	Switzerland	Insufficient information on Website
Swiss Group for Artificial Intelligence and Cognitive Science (SGAICO)	Switzerland	Insufficient information on Website
Telenor-NTNU AI Lab	Norway	Is curently Norwegian Open AI Lab
The Artificial Intelligence Association of Ireland (AIAI)	Ireland	Insufficient information on Website
The Austrian Society for Artificial Intelligence (OEGAI)	Austria	Insufficient information on Website
The European Association for Artificial Intelligence (EurAI)	Europe	Insufficient information on Website
The Italian Association for AI (AI*IA)	Italy	Insufficient information provided in English
The Polish Artificial Intelligence Society (PSSI)	Poland	Insufficient information provided in English
The Portuguese Association for Artificial Intelligence (APPIA)	Portugal	Insufficient information provided in English
The Romanian Association for Artificial Intelligence (ARIA)	Romania	Insufficient information on Website
The Slovak Research Center for Artificial Intelligence (slovak.AI)	Slovakia	Insufficient information on Website
The Slovenian Artificial Intelligence Society (SLAIS)	Slovenia	Insufficient information provided in English
The Spanish Association for Artificial Intelligence (AEPIA)	Spain	Insufficient information provided in English
Tyndal	Ireland	Insufficient focus on AI
Wallenberg AI, Autonomous Systems and Software Program (WASP)	Sweden	Insufficient information on Website