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Key elements for promoting public-private partnerships in research and innovation

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ABSTRACT

Public-private partnerships have been widely applied in financing infrastructure development with mixed results. Research calls to extend public-private partnerships to research and innovation to foster strategic linkages between research and industry have been increasing. This study seeks to investigate key elements for promoting public-private partnerships in research and innovation using evidence from research institutions. The research study followed an explorative design, and 19 purposefully selected respondents from research and development institutions and universities were interviewed. The findings reveal different forms of research collaboration through memoranda of understanding. The best practices for promoting public-private partnerships in research and innovation are enhancing the attractiveness of the partnering institutions and establishing innovation hubs and intellectual property policies. The elements for effectively implementing public-private partnerships in research and innovation include a supportive regulatory framework, joint financing of research equipment and tax incentives for research equipment. Priority sectors for promoting public-private partnerships in research and innovation include energy, agriculture, waste management, engineering and technology and environmental sustainability. This study is one of the first to investigate the key elements for promoting public-private partnerships in research and innovation as a mechanism for funding high-impact research in the context of a developing country. Furthermore, the key elements can guide countries wishing to develop frameworks for promoting public-private partnerships in research and innovation.

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1. Introduction

The competitive advantage of an organisation and the long-term economic prosperity of a nation are both attributed to innovation. As an illustration, the United Nations 2030 Agenda for Sustainable Development (SDG number 9) and the African Union Agenda 2063 highlight that regardless of a country's level of development, investment in infrastructure and innovation is necessary to spur economic growth and development (Dosso et al., 2022). Research shows that innovation is critical to long-term economic growth (Daghar et al., 2021; Issau et al., 2021; Koschatzky, 2017). Similarly, Liguori et al. (2024) highlight the critical role of entrepreneurship and innovation in addressing many challenges, such as economic, environmental, and human conflicts and employment growth. Buchana and Sithole (2022) reiterate the value of research and innovation in tackling global issues, such as food security, livelihoods and poverty alleviation, environmental sustainability, biodiversity, and climate change, which is widely acknowledged worldwide. Liguori et al. (2024), however, stress that companies must create an innovation strategy and engage in deliberate innovative initiatives to maximise the advantages of innovation.

One of the significant challenges of implementing high-level, high-impact research is funding. There are different models of funding research and innovation leading to commercialisation. Consequently,

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different funding research and innovation models are being explored in different jurisdictions. These include the triple helix model (Rieu, 2014), Smart Specialisation frameworks (Oyelaran-Oyeyinka et al., 2018) and Public-Private Partnerships (PPPs) in Research and Innovation (Merigó et al., 2016).

For example, Smart specialisation was explored by Dosso et al. (2022) to show how Côte d'Ivoire is leveraging an innovation-led territorial approach. The smart specialisation conceptual framework has recently emphasised the significance of innovation and its diffusion in the entrepreneurial sector (Mascarenhas et al., 2021). Asheim (2018) argues that smart specialisation promotes regional industrial diversification and future competitiveness, leading to economic growth and new job generation through a regional innovation systems approach. Furthermore, Gachie (2020) investigated how the triple helix can foster innovation and proposed an integrated model for how government, industry, and academia can interact to enhance innovation and commercialisation.

Practitioners and researchers have defined PPPs differently depending on the model, region, and country. For example, Osei-Kyei and Chan (2021), through Ireland's Infrastructure and Public Private Partnership Section, define a PPP as 'a partnership between the public and private sector to deliver a project or service traditionally provided by the public sector'. The National Council for Public-Private Partnerships of the USA define PPP as 'a contractual arrangement between a public sector agency and a for-profit private sector concern, whereby resources and risks are shared for delivery of a public service or development of public infrastructure' (Akintoye et al., 2015). Hammond et al. (2022) argue that PPPs can take on many contractual and operational forms. However, generally, it entails private sector actors financing the development of assets (often infrastructure) tied to a role in providing public services over a certain period. Despite not having a unified definition, PPPs share common characteristics. The common features of PPPs involve the interaction or partnership between the public and private sectors. The public could be a government ministry, state-owned enterprise or local authority. Meanwhile, private companies could involve a consortium or any other private investor. In a PPP partnership, each side contributes specific resources to the venture. The collaboration also involves a concession agreement spanning over 10 years (Osei-Kyei & Chan, 2021). Castelblanco et al. (2023) argue that PPP concessions can span from 10 to 99 years, with most ranging from 20 to 30 years. The duration also seriously impacts project risks, revenue and the general viability of a PPP.

The PPP concept has been extended to other sectors, such as research and innovation (RI). Like the construction sector, PPPs in RI are also characterised by long-term institutional and strategic collaboration spanning 3 to 10 years to achieve complementary goals through jointly operated interdisciplinary research activities (Koschatzky, 2017; Meissner, 2019). However, despite heightened calls to extend PPPs in RI to fund high-value research leading to innovation commercialisation, implementation is still limited globally (Carbonara & Pellegrino, 2020; Vallejo et al., 2020). Furthermore, there is potential for implementing high-value RI in science and technology. Notwithstanding, PPPs in RI have been implemented between universities and industry in developed nations such as Germany, the United States of America and Italy, albeit to a lesser extent (Koschatzky, 2017; OECD, 2016). In Africa, some RIs in health and agriculture could be candidates for PPPs in RI (Oyelaran-Oyeyinka et al., 2018). However, actualisation is hampered by various contextual factors.

The research ecosystem in Zambia focuses on the interaction of the government through research and development institutions, public universities and innovation commercialisation institutions (National Science & Technology Council, 2022). For example, the National Science and Technology Council manages the strategic research fund for science, technology and innovation research. The National Institute for Scientific and Industrial Research and similar institutions oversee research and development, and the National Technology Business Centre oversees commercialisation. Despite this interaction in the national research and innovation ecosystem, the government laments that limited RI has compounded the low rate of industrialisation and diversification in Zambia (Eighth National Development Plan (8NDP), 2022). The government acknowledges the need to promote science, technology and innovation research as a catalyst for digital transformation and innovation (8NDP, 2022).

Therefore, the National Science and Technology Council of Zambia initiated and supported this research as part of the broad agenda for supporting research innovation and entrepreneurship (National Science & Technology Council, 2022). The National Science and Technology Council

acknowledges the significance of PPPs in RI and developing strategic links between research and industry, particularly in light of the growing emphasis on research for impact to refine the science, technology and innovation development and commercialisation agenda (National Science & Technology Council, 2022).

Despite the recognition and efforts towards advancing this funding model, sparse studies have proposed mechanisms for promoting PPPs in RI. Furthermore, research on PPPs is still in its infancy in prior literature and revolves around financing infrastructure projects (Muleya et al., 2020). This study makes two contributions. Firstly, to establish key elements (i.e. enablers which include best practices of PPPs in RI, elements for effective implementation of PPP in RI, platforms for engagement, priority sectors for PPPs in RI) for promoting PPPs in RI as a mechanism for funding high-impact research. This is against the need to explore alternative sustainable sources for financing high-value and high-impact research. However, many challenges or risks can impede the promotion of PPP in RI. Consequently, the second contribution highlights the main challenges (barriers) for implementing PPP in RI, which the public and private partners need to address. This study makes the two contributions by addressing the following research questions:

RQ 1: What are the key elements (i.e. enablers which include best practices of PPPs in RI, elements for effective promoting PPP in RI, platforms for engagement, priority sectors for PPPs in RI) for promoting PPPs in RI as a mechanism for funding high-impact research?

RQ 2: What are the main challenges (barriers) to promoting PPP in RI?

2. Literature review

2.1. PPPs in RI

The original concept of PPP was developed as a financing strategy for physical infrastructures such as roads, bridges, health facilities, housing complexes and power stations (Banji et al., 2018). Banji et al. (2018) argue that the period between 2008 and 2018 experienced the extension of the PPP concept to other sectors of the economy, such as supply partnerships, new product development, research partnerships designed to support innovation, concept development and system strategy. A study by Bolo et al. (2021) clearly outlined that PPPs in RI deliver an excellent outcome for what is termed as co-creation, flow and exchange of knowledge of associated products and services with the private sector.

Unlike other research collaborations, PPP in RI provides legal structure and institutional arrangements to pool resources and gather critical mass by sharing share risk, reward, and responsibility for high-impact research (Carbonara & Pellegrino, 2020; Vallejo et al., 2020). While PPP in RI has been around in most developed nations, albeit to a limited extent (Akhmetshina & Mustafin, 2015), Africa has lagged in this area (Oyelaran-Oyeyinka et al., 2018). Hence, there are heightened calls to enhance research and development of key elements for promoting PPP in RI in Africa (Oyelaran-Oyeyinka et al., 2018) and Zambia in particular. The success of such partnerships requires critical elements to be in place and the implementation of best practices while addressing institutional and regulatory challenges (Moy, 2015; Vallejo et al., 2020).

2.2. Key elements for promoting PPP in RI

The literature focuses on key elements (these are enablers, which include best practices of PPPs in RI, elements for effective implementation of PPP in RI, nature of collaboration to support PPP in RI, priority sectors for PPPs in RI) and challenges related to promoting PPP in RI in a developing country context.

According to Chardine-Baumann and Botta-Genoulaz (2014), best practices encompass any practice that has proved its value if used efficiently in an organisation and can be applied in other similar organisations. Best practices can also produce significant performance gains over time when properly applied. Best practices in promoting PPP in RI include joint publication in RI, investment in research and development, and international collaboration (Choi et al., 2020; Liu et al., 2021; Merigó et al., 2016; Niu, 2014). Evans et al. (2015) identified intellectual property and talent identification (residents in research,

engineering and technological professions, and associated science professions) as key in supporting PPP in RI. Similarly, Carbonara and Pellegrino (2020) argue that understanding the innovation process and its drivers requires identifying innovation determinants in multipurpose technologies and high-value-added industries, universities and research institutes. Likewise, close collaborations between contractors and suppliers are critical for RI among SMEs, especially industrial clusters (Carbonara & Pellegrino, 2020; Issau et al., 2021).

Furthermore, universities and public research institutes should be entrepreneurial and establish linkages with the private sector (Caulfield et al., 2012). Koschatzky (2017), Oyelaran-Oyeyinka et al. (2018) and Rukanyangira and Oidu (2021) emphasise the importance of strong and active PPP collaboration between universities and industry on many fronts of interaction in RI. The correlation between education and entrepreneurship mindset is hypothetically high (Liguori et al., 2024) and worth investigating in implementing such collaborations. This is particularly important for many African institutions that need more research from external funding (Fatumo et al., 2022).

Furthermore, best practices would require leveraging technology development (Carbonara & Pellegrino, 2020), solid waste management (Water Sanitation for the Urban Poor, 2017) and climate change, biodiversity and food security (Trotsenko & Slukin, 2020) as specific priority sectors for implementing PPP in RI. Additionally, Bolo et al. (2021) highlight some case studies of RI in Uganda and Malawi. Some projects include bakery products from maize germ and bran, cocoa waste conversion to resourceful material, solar-powered technologies and biogas as typical RI priority subsectors. Carbonara and Pellegrino (2020) add that sectors where general collaborations were taking place included transport (roads, rail, airports, ports, light rail, bridges and tunnels) and Social Infrastructure (healthcare, schools, prisons, defence, social housing, accommodation, and street lighting).

Effective PPP in RI should build relevant RI capabilities, improve collaborations between national innovation systems and provide compatible incentives to all stakeholders (OECD, 2016). Similarly, Oyelaran-Oyeyinka et al. (2018) argue that geographical and social proximity is critical to effective PPP in RI. Proximity enhances communication and trust among partners. This is because industry, universities and economic agents must innovate in collaboration (Ma et al., 2019). The arguments are also corroborated by Koschatzky (2017), who argues that spatial and social proximity impacts innovation due to closer interactions and sharing of tacit knowledge.

Furthermore, the complementarity of skills among partners is also a critical enabler of PPP in RI collaboration (Trotsenko & Slukin, 2020). For example, inter-disciplinary PPPs in RI that gather experts from research and technology disciplines and leverage more comprehensive industry actors such as entrepreneurs, private financial institutions and private technology intermediaries are likely to succeed (OECD, 2016). Additionally, PPPs in RI need a robust governing constituency and a clear legal framework to enhance implementation and accountability (Akhmetshina & Mustafin, 2015). Moreover, in many cases, the success of PPPs also depends on tax incentives, performance-based funding (and metrics), reward systems for researchers, and intellectual property legislation (OECD, 2016). For example, e Colombo and da Cruz (2023) found a positive causal impact of tax incentives on business innovation in Brazil.

However, many challenges (barriers) impede the promotion of PPPs in RI. Research in PPP in RI is still a relatively new field compared to PPP in infrastructure development (Vallejo et al., 2020). However, despite its infancy, global studies have highlighted several challenges that underpin the implementation of PPP in RI. For example, the EU (2018) policy brief acknowledges that lack of skills, limited funding and lack of international orientation are serious barriers to implementing PPP in RI. Furthermore, Koschatzky (2017) argues that a lack of absorptive capacity and power asymmetries also negatively impact collaborations. Oyelaran-Oyeyinka et al. (2018) highlight challenges from contextual factors such as weak regulatory, financial, and institutional frameworks supporting private sector involvement. Particularly in Africa, private sector funding remains low, and engagements are scanty, hindering strategic and high-impact research collaborations (Oyelaran-Oyeyinka et al., 2018; Vallejo et al., 2020).

Partnerships among research institutions, universities, and industries can solve challenges, develop new markets, and generate value through collaboration (Trotsenko & Slukin, 2020). Besides, Vallejo et al. (2020) argue that PPP in RI is an instrument that can be used to leverage the experience and funds of the private sector for RI, thereby creating jobs, upgrading skills, improving delivery, and increasing the

quality of performance. Studies show that most benefits of PPP in RI are skewed toward the public sector (Carbonara & Pellegrino, 2020; Vallejo et al., 2020). However, the private sector also enjoys significant benefits from collaboration with public sector research institutions, such as low market risks, access to local material, and trial of new technology with greater protection of intellectual property rights (Trotsenko & Slukin, 2020).

3. Research methods

3.1. Research design

The research followed an explorative research design (Creswell, 2014). Bryman (2012) argues that an exploratory design works well on topics with little prior research. This was necessitated by the fact that the subject matter is relatively new to the Zambian context. To develop the research instruments, researchers conducted an extensive literature review to understand the key elements (i.e. enablers, which include best practices of PPPs in RI, elements for effective implementation of PPP in RI, platforms for engagement, priority sectors for PPPs in RI) and challenges for impeding the promotion of PPPs in RI.

Furthermore, since PPP in RI is a new subject, researchers conducted a research-needs assessment to understand the subject matter and the respondents who were better vested with the knowledge to provide information on the topic. The research needs assessment was conducted in May 2022.

Verbal consent was obtained to interview the indicated respondents during the study needs assessment because they were dispersed in the 5 provinces of Zambia. For instance, respondents were made aware that participating in the interview was voluntary and that by doing so, they gave the researcher permission to use their responses. Respondents were also told that there was no financial benefit to participating in the study and that they could leave without facing any repercussions. It was promised that responses would remain anonymous and that the findings would only be presented in aggregate form, meaning that no individual would be identified in the responses. Respondents were also informed that participating in the study would not exceed 40 minutes.

After that, the interview protocol was developed. A total of fifteen questions were used. These comprised of the following parts: Part 1 was an introduction, part 2 looked at the general nature of collaborations in RI, part 3 addressed the best practices in PPPs in RI, this was followed by part 4, which the elements for effective promoting PPPs in RI and part 5 investigated the challenges and outcomes of using PPPs in RI. After that, the interview protocol was piloted to enhance its validity. Each research team member piloted the protocols with two respondents and suggested amendments to the interview protocol.

We used a purposive sampling of experts from research and development institutions and universities to address the research question. Nineteen (19) respondents were interviewed based on their expertise in RI, as summarised in Table 1. Structured interviews with the respondents were conducted in September 2022. Each interview lasted, on average, 30 minutes. Eight assistant researchers (Post Graduate Students) were engaged in transcribing the interviews before the thematic analysis. The ethics committee of the Copperbelt University approved the interview protocol.

3.2. Demographic profile of interviewed respondents

Table 1 presents the profile of respondents interviewed during the study. Most respondents held senior positions and many years of service in their organisations. This, therefore, adds to the quality of the information received. Furthermore, the interview covered organisations in research and development and universities considered knowledge-generating centres.

3.3. Data analysis and findings

The research draws on the thematic (semantic) analysis approach to address the research question. The thematic analysis focuses on the explicit meanings that respondents communicated through ideas and perspectives on the subject matter (Clarke et al., 2015). Clarke and Braun (2017) argue that this method helps identify, analyse, and interpret themes, meanings and patterns from the data. The method has

Table 1. Respondent profiles-interviews.

Respondent	Position	Sector	Experience
R1	Deputy CEO	Private Health Research and Diagnosis Institution	Over 30 years
R2	Director of Research and Innovation	Public University	Over 20 years
R3	Deputy Director	Public Agriculture Research and Development	Over 15 years
R4	Deputy Director	Public Sector Research and Development Institution	Over 20 years
R5	Director of Research and Innovation	Public University	Over 20 years
R6	Manager Technology and commercialisation	Public Organisation for Research Commercialisation	Over 15 years
R7	Assistant Director of Research and Innovation	Public University	Over 20 years
R8	Deputy Vice-Chancellor	Private University	Over 20 years
R9	Head of Research	Private University	Over 5 years
R10	Director of Research and Innovation	Private University	Over 15 years
R11	Vice Chancellor	Private University	Over 20 years
R12	Head of Research	Private University	Over 10 years
R13	Head of Research	Private University	Over 5 years
R14	Head of Engineering and Innovation	Public Manufacturing Company	Over 10 years
R15	Head of Standards and Research Unit	Public Authority for Higher Education	Over 10 years
R16	Deputy Director	Public Authority for Medical Research	Over 10 years
R17	Director	Private Research and Engineering Company	Over 35 years
R18	Research Coordinator	Private University	Over 10 years
R19	Research Manager	Public Procurement Authority	Over 10 years

been widely applied due to its flexibility in identifying and interpreting key salient features of the data (Braun & Clarke, 2012), as guided by the research questions.

Thematic analysis followed a four-stage process suggested by Vaismoradi et al. (2016) involving initialisation, construction, rectification and finalisation. For example, in the initialisation, transcripts were read several times while highlighting the meanings of key statements. This was followed by coding and observing for abstractions in the respondent discussion. Secondly, codes were classified based on the research question, compared and labelled in the construction phase. Thirdly, at the rectification stage, codes were combined into themes to establish knowledge, and finally, a detailed consolidated write-up relating themes to a broader story was conducted.

Direct quote responses from selected respondents were utilised to enhance the analysis as a standard norm in qualitative data analysis.

3.4.1. Platforms for engagement

There was a consensus among research and development institutions and universities that they collaborate with different stakeholders at different levels, as demonstrated below:

We partner with the Ministry of Health to deliver targeted solutions, and we are also doing research. Our research is supported by a reasonably big ISO-certified laboratory in Kalingalinga, where we do most of our biomedical work. [R1].

Furthermore, signed Memoranda of Understanding (MOUs) are the most common form of collaboration by all respondents at local and international levels. There was a consensus from respondents that MOUs exist in different forms with local and international partners, as summarised below:

The Directorate has developed an MOU with the Mahatma Gandhi Institute of Rural Industrialisation. It is for us to establish innovation hubs. Furthermore, this innovation hub is to take advantage of the Micro, Small and Medium Enterprises (MSMEs) in Zambia. [R5].

3.4.2. Best practices of PPPs in RI locally

The findings revealed that all the institutions interviewed needed a dedicated policy framework on PPP in RI. This can be attributed to the low engagement in PPP in RI because there is neither guide nor driver to direct the activities in this area, as indicated below:

Universities must have structures that permit them to interact with the outside world. We need a technology transfer office that can be used to interact with the industry. Hence the technology transfer office is needed as soon as possible. We currently do not have those structures and policies [R7].

Other universities (public and private) do not have strong PPP relationships, practices or policies in RI. This presents a gap that needs to be closed up. The evidence of missing policies, practices and engagement on RI between training and research institutions is very significant.

We need to establish a grant office to manage and source research grants. This office also will assist with interaction with donors [R7].

All other public and private universities only intended to establish these linkages but needed tangible activities. These outcomes show the need to develop a framework to promote PPP in RI in research and development institutions and universities.

We want to have strong links with the other universities because the strengths of different universities differ, so we would like to ride on the strengths of other colleagues to ensure that we handle collaborative research, which we want to encourage [R8].

Some of the projects include local innovation in the treatment of HIV, nuclear-related management services, food testing, and certification services. All projects were found to be on a smaller scale and not guided by any policy framework.

3.4.3. Elements for effective promotion of PPPs in RI

The views shared by respondents confirm that researchers' recognition through awards, tax holidays, tax relief, and tax waivers are essential elements required to implement PPPs in RI effectively. Furthermore, recognising researchers with non-financial rewards is also an element worth considering as a regulatory measure to incentivise PPPs in RI and intellectual property legislation, as indicated in the following excerpts.

If the government were to devise a deliberate policy to support industries that use research institutions within the country by coming up with some waver, you know—relief in terms of tax [R1].

In addition, some respondents emphasise the need to remove bureaucratic procedures for effectiveness in conducting research and innovation. Others also point out that administrative procedure bureaucracy has predominantly increased inefficiencies in many sectors. Streamlining procedures is a solution to optimising PPPs in RI, as summarised in the following quote.

For anything coming into this country for research purposes, we need to be able to remove all the bureaucracy and taxes. I think it requires you to sit and remove all that I call bottlenecks, whether from the regulatory side or otherwise [R1].

All the respondents stressed that partnerships were the other key element essential for the effective use of PPPs in RI. Accordingly, as reported by respondents, among the elements to be embedded in partnerships are clearly defined engagement models. They should be in consortiums, joint research, contract research, and research networks. This is demonstrated in the quote below from one respondent.

Partnership with both academic and industry experts is cardinal. We have been working closely with other bodies within the SADC region. The SADC members are coming on board to research how various institutions responded to the COVID-19 pandemic and how institutions adapted and fought through the pandemic [R15].

3.4.4. Priority sectors of PPPs in RI

Respondents identified several priority sectors from different professional backgrounds. One important outcome was that PPPs in RI would be helpful in agriculture, food production, energy, climate change and sustainability, and health and sanitation. A Director of Research and Graduate Studies from an academic institution argued:

When discussing striking PPPs, I mentioned that the Directorate had developed priority areas for energy, agriculture, and natural resources. We have priority areas, which are: 1. food and agriculture. 2; energy and natural resources 3. AIDS and sanitation 4. Engineering and technology 5. Environment, climate change and sustainability [R2].

The Deputy Director of Research Coordination at a health research authority argued that introducing PPPs in RI would create platforms where the private sector can develop technologies that would benefit the country. She cited examples from ICTs that would benefit health, agriculture and agro-processing.

PPPs would be viable for the private sector to benefit commercially from the research. The areas should include research in ICT in health to support diagnosis and treatment. Agriculture and agro-processing can also attract PPP investment. The most important thing is to sell the RI to the private sector and how they can benefit from it [R16].

Table 2. Priority sectors for establishing PPP in RI.

8NDP Strategic Development area	Sectors and subsectors	Priority
Strategic Development Area 3: Environmental Sustainability	Energy, e.g. renewable energy (solar power, hydro and biogas etc.). Environment, e.g. climate change (developing early warning systems for floods, droughts, etc.). Waste Management, e.g. sanitation and recycling.	1
Strategic Development Area 2: Human and Social Development	Education, e.g. training partnerships and knowledge sharing Information Technology, e.g. Cloud technology, Artificial intelligence, etc. Healthcare, e.g. vaccines, R&D, diagnosis, etc.	2
Strategic Development Area 1: Economic Transformation and Job Creation	Manufacturing and value addition, e.g. organic fertiliser manufacturing, food production, etc. Agriculture, e.g. smart agriculture systems/agro-processing. Financial, e.g. FinTech innovation Mining, e.g. exploration and mining with the latest technology	3

A Deputy CEO at a health research centre explained that his organisation had developed an ICT innovation through donor funding. He argued that such innovations would work well under PPP in RI arrangements, particularly in rolling out the innovation to the public.

So, we took it upon ourselves to develop an ICT system...we built software in-house, designed the hardware in-house and got it manufactured in China, and just like that, we deployed it in our labs [R1].

The Deputy CEO added that his organisation had developed another ICT innovation called 'SMARTNET for health monitoring. He contended that this innovation had helped in health management and would be scaled up if resources could be made available through funding platforms like PPPs in RI.

The identified priority sectors for promoting PPPs in RI identified by experts are based on the appetite for attracting private sector financing in RI that can lead to commercially viable ventures in four Strategic Development Areas identified in Zambia's Eight National Development Plan of 2022 to 2026 anchored on economic transformation and job creation; human and social development; environmental sustainability; and good governance environment pillars as are summarised [Table 2](#).

3.4.5. Expected outcomes of implementing PPP in RI

Respondents identified several outcomes from different professional backgrounds. One important outcome was that PPPs would lead to the generation and sharing of knowledge, leading to 'implementation science' and enabling the government to make decisions based on factual information. Such decisions provide better opportunities to achieve the desired results. A Deputy CEO from a health research institution argued:

That is the essence of what we call 'implementation science, and that is what we do. Through our work with the prison service, we noticed that most juveniles sometimes go to prison for minor offences. Moreover, they go to prison healthy but come out infected with Tuberculosis or HIV. So, that research informed the Ministry of Social Development to figure out how to have other forms of punishment or go to Restorative Justice Centres [R1].

Consistent with the above account, a director of research from a public university argued that PPPs in RI create synergies that enable partners to achieve more together than when each works separately. These collaborations also ensure that the other partner compensates for the weaknesses of one partner.

We can partner; for example, where public university A needs improvement, they can contact public university B. It does not only have to be university to university, but it can be the university to industry to ensure more collaborative work to build one another. [R2]

A research director from a different public university supported this position and stated that such collaborations would help stimulate joint academic activities between universities. He said his university had already started collaborating with other universities and industries for joint research, staff exchange and joint student supervision.

Our role as a Directorate is to facilitate national and international partnerships in research and innovation. The kind of partnerships we facilitate involve joint research and contract research. We also facilitate academic staff mobility from our university to other regional universities or within the industry. [R5].

3.4.6. Challenges envisaged in implementing PPPs in RI

One of the main challenges of using PPPs in RI is the need for more government support, primarily through funding. A Deputy CEO from a research institution reflected on how Zambia, like many other African countries, failed to prioritise RI. He gave the example of the COVID-19 pandemic, where foreign countries developed all vaccines used in the country. The government did not see the need to invest in vaccine technology.

As I said, it is a common Zambian problem. I have had the privilege of doing this kind of work in 34 African countries, which is the same problem [...]. Many African countries do not prioritise research and innovation. I hope that with the experience we went through with COVID-19, all of us African people can realise that research is key [R1].

A research director at a research institution argued that collaborations such as PPPs come with the challenge that the funder sets the agenda and carries the voice. This creates the problem of pursuing goals that may need to be more congruent with the needs of other stakeholders in the partnership.

The private sector throws much money into its own research, for its own purposes, for commercial gain, and you cannot fault it because that is what it exists for. So, if you are looking for some innovation, yes, they will innovate, but they will be limited to those things that will give them quick wins rather than something that will take a very long research time. [R3].

A Deputy Vice Chancellor of a private university reiterated that the early phase of the research, commonly known as basic research, is not attractive for funding from the industry. Therefore, this component needs government support until the research prototypes are ready. At the prototype stage, it is easy to invite the industry for funding and create PPPs in RI, as demonstrated in the quote below:

However, because basic research is costly and does not give immediate promise, you find that in situations of mega resources, not so many people dive into that area. We tend to go for research rolling out known products so that people can immediately benefit [R8].

3.4.7. Consolidated elements for promoting PPP in RI

Based on the key findings, the elements for promoting PPPs in RI must be consolidated, as demonstrated in Figure 1.

The elements are based on an iterative process of examining elements that, when arranged together, lead to effective identification and implementation of PPP in RI. The proposed elements are designed to enhance flexibility and open avenues for brainstorming possible PPPs in RI. The step is to identify the best practices that can drive collaborations leading to PPP in RI. This ensures that the PPPs in RI are anchored on a solid business case. Secondly, effective elements focus on the success factors that can lead to successful PPP in RI when leveraged by players. Furthermore, the envisaged challenges for promoting PPP in RI are highlighted, including the barriers and risk factors that should be critically analysed as part of the mechanisms to promote PPP in RI.

Promoting PPP in RI will also require effective engagement platforms for stakeholders, such as websites, direct engagements, formal meetings, conferences, investment expos and fairs, social media (e.g. Facebook, Twitter now X, LinkedIn, Instagram, etc.), and academic platforms (Web of Science, Researchgate, Academia, Scopus, Google Scholar).

Furthermore, from the respondents' perspective, the identified priority sectors for establishing PPPs in RI are based on the appetite to attract private sector financing in research and innovation that can lead to commercially viable ventures. A combination of elements or mechanisms, when effectively leveraged, should promote PPP in RI, leading to outcomes such as the opportunity to share knowledge, access to resources for technology development, research commercialisation of RI to the market, the opportunity to draw on synergies and creating databases and clusters of professionals in different fields for industry, researchers and innovators to interact. Ultimately, PPP in RI should contribute to accelerating socio-economic development through high-impact research and commercialisation.

4. Discussion and conclusions

The research sought to establish the key elements (i.e. enablers, which include best practices of PPPs in RI, elements for effective implementation of PPP in RI, platforms for engagement, priority sectors for PPPs

in RI) for promoting PPPs in RI as a mechanism for funding high-impact research. Furthermore, the research explored the main challenges (barriers) to promoting PPP in RI from a developing country perspective.

4.1. Best practices

Figure 1 indicates that the best practices in promoting PPP in RI include the addition of a clause in PPP in the regulatory framework to cater for RI, research institutions to solve industry problems, seed funding, and international collaboration with local and international authors. Furthermore, elements for effectively promoting PPP in RI suggest developing intellectual property policies that will protect innovation. Notably, the key elements provide for commercialisation prototypes that the industry can easily fund because of prospects and guaranteed returns associated with commercialisation. One of the incentive-based practices is the clear outlining of profit-sharing schemes because of the motivational and assurance tag they carry. The findings corroborate the literature emphasising the role of universities and research institutions in designing and applying PPPs in the RI to solve industry challenges (Koschatzky, 2017). Furthermore, collaboration in RI is driven by factors such as the availability of seed funding and access to equipment, and political factors such as national, regional, and global political interests also play an essential part in access to expertise (Choi et al., 2020).

4.2. Elements for effective implementation of PPP in RI

Furthermore, elements for effective implementation of PPP in RI include success factors and incentives. For example, providing tax relief on imported equipment and reagents, utilising location advantage for PPP in RI, a supportive regulatory framework and public institutions for implementing PPPs in RI and linking SMEs with scientific research. The findings are consistent with prior research on implementing PPPs in RI. For example, Liu et al. (2021) suggest that at the institutional level, proximate research goals of both partners, cognitive closeness, geographical proximity, and academic ties between institutions are key factors driving collaborations in RI as some of the effective elements. Recognising researchers with non-financial rewards is also worth considering (Carbonara & Pellegrino, 2020; Koschatzky, 2017; OECD, 2016), providing tax incentives and intellectual property legislation.

4.3. Priority sectors

Figure 1 presents the summary of key elements, which contains a section for implementing PPPs in RI whose results suggest that priority sectors for PPP in RI include renewable energy, climate change,

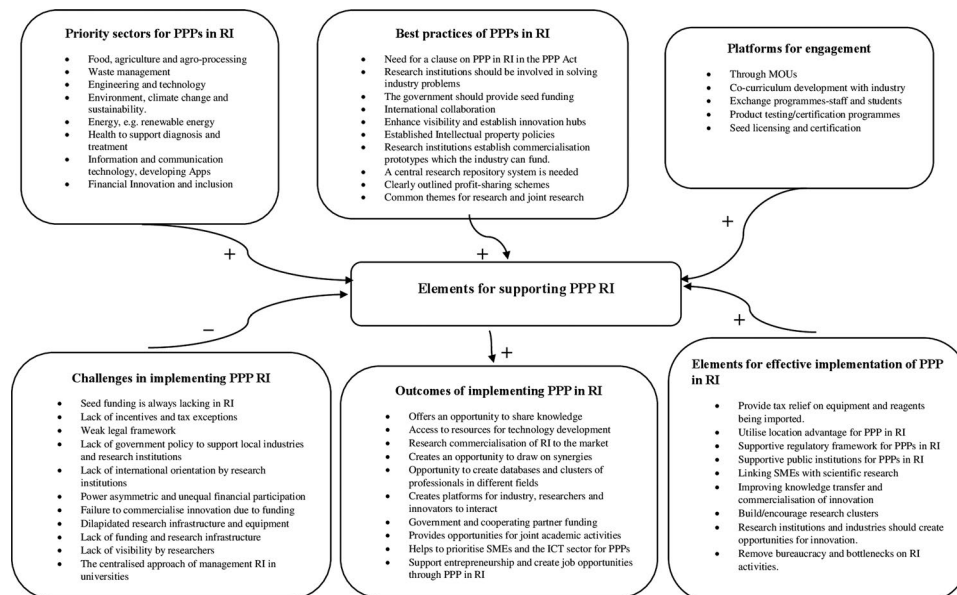


Figure 1. Elements for supporting the implementation of PPP in RI.

agriculture, information technology, health and financial technology. This is because demand for such services is high, making it attractive for the private sector to express willingness to invest in those sectors. The identified priority sectors have presented supply or availability challenges, naturally creating demand that would easily attract private investment. This is consistent with literature that suggests technology development, solid waste management, and climate change are priority sectors for implementing PPP in RI (Carbonara & Pellegrino, 2020; Trotsenko & Slukin, 2020; Water Sanitation for the Urban Poor, 2017). PPP in RI is envisaged to produce positive outcomes. For example, Trotsenko and Slukin (2020) argue that the main objective of PPP in RI collaboration is to leverage resources and complementary technical capacity for strategic research that a single organisation could not attain.

4.4. Platforms for engagement

Additionally, Figure 1 outlines platforms through which RI collaborations would be effective. The research reveals that using the website and direct engagements through meetings, investment expos, and conferences can facilitate collaborations, leading to PPPs in RI. However, contrary to the findings, for example, in Europe, doctoral training schemes and exchanges, SMEs' interactions with universities and joint publications are the leading platforms for engagement for collaboration in RI (OECD, 2016). Furthermore, Choi et al. (2020) argue that platforms for engagement involve joint research publications in journals as a key avenue. Similarly, Ribeiro et al. (2018) add that most scholars engaging in RI use journal publications and academic platforms to find research partnerships beyond their institutions and countries.

4.5. Challenges envisaged in implementing PPP in RI

Challenges envisaged in promoting PPP in RI, as presented in Figure 1, include more government funding for early-stage research, weak regulatory framework, lack of incentives to investors, researchers and research institutions, and lack of funding and modern research infrastructure, among others. Oyelaran-Oyeyinka et al. (2018) argue that contextual factors such as a weak regulatory, financial and institutional framework fail to support private sector involvement. Furthermore, Vallejo et al. (2020) reiterated that an underdeveloped institutional setting, lack of incentives, and access to sustainable funding are challenges to implementing PPPs in RI, particularly in low- and middle-income countries. Castelblanco et al. (2023), on the other hand, reiterate the concessions period as a key factor in managing risks in PPP; the argument is that the longer the PPP concessions, the higher the impact on project risk and revenue and operations.

4.6. Envisaged outcomes of implementing PPP in RI

Finally, the expected outcomes are the desired results suggested by respondents if the PPP in RI are implemented. These include opportunities for knowledge sharing between government, industry, and academia, access to resources for technology development, research commercialisation of RI to the market, and an opportunity to draw on synergies and create databases and clusters of professionals in different fields. Vallejo et al. (2020) argue that PPP in RI is an instrument that can be used to leverage the experience and funds of the private sector for RI, thereby creating jobs, upgrading skills, improving delivery, and increasing the quality of performance. Most studies show that most benefits of PPP in RI are skewed toward the public sector (Carbonara & Pellegrino, 2020; Vallejo et al., 2020). However, the private sector also enjoys significant benefits from collaboration with public sector research institutions, such as low market risks, access to local genetic material, and trial of new technology with greater protection of intellectual property rights (Trotsenko & Slukin, 2020).

5. Conclusions

The study was conducted to establish the key elements (best practices of PPPs in RI, Elements for effective implementation of PPP in RI, platforms for engagement, priority sectors for PPPs in RI) for promoting PPPs in RI as a mechanism for funding high-impact research. Furthermore, the research explored the

main challenges to promoting PPP in RI from a developing country perspective. The research revealed that MOUs underpin most research collaborations. Furthermore, several best practices were outlined, including the need for a clause on PPP in RI in the PPP Act, proactive solving of industry problems by research institutions, seed funding, the need for partnerships for commercialisation and many others. In terms of elements for effectively promoting PPP in RI, the results show that utilising location advantage (proximity) for collaboration can promote PPP in RI, government allocating a percentage to funding RI and providing incentives such as tax waivers on research equipment.

Moreover, some elements for effective implementation of PPP in RI include the need for a clearly defined model of engagement between government and research institutions. Furthermore, there is a need for PPP RI to support entrepreneurship, SMEs, and innovation in creating job opportunities. Additionally, priority areas for possible PPP in RI highlighted include food and agriculture, energy and natural resources, waste and sanitation, which are basically identified as major problems affecting Africa. Others include engineering and technology, environment, climate change and sustainability. Additionally, the findings from the analysis also revealed perceived challenges in implementing PPP in RI, such as lack of funding for early-stage research, failure to commercialise innovation due to funding challenges, and dilapidated research infrastructure and equipment. Regarding platforms for collaborations in RI, most respondents indicated that they use websites and direct engagements through meetings and conferences. Also, the research findings show that PPP in RI can provide outcomes such as knowledge sharing knowledge, access to resources for technology development, synergies and joint academic activities.

The study concluded that opportunities exist in PPP in RI and that challenges and hurdles can be overcome having been identified with possible solutions available. It is the first time that the key elements (best practices of PPPs in RI, Elements for effective implementation of PPP in RI, nature of collaboration to support PPP in RI, priority sectors for PPPs in RI) for promoting PPPs in RI in a developing country context such as Zambia. Therefore, the study could benefit many other countries that need to craft frameworks and policies for promoting PPP in RI. This significantly contributes to the body of knowledge within Zambia's borders and beyond.

6. Policy recommendations

Promoting PPP in RI should be anchored on key elements identified in the study. Based on the research findings, the following recommendations are proposed.

The study recommends that the National Science and Technology Council of Zambia and science granting councils in the region should organise annual symposia on PPP in RI to enhance awareness of PPP in RI with industry and research institutions. Furthermore, there is a need for government seed funding to support the early phases of the research, which may not be attractive to the private sector. In addition, the public and private sector players must leverage key elements, such as utilising geographical and social proximity, to promote PPP in RI. The public and private sectors should promote PPP in RI in the priority sectors with existing or potential demand for products and services. Finally, the government should provide tax incentives and exemptions for research equipment used in PPP for RI. These recommendations may not be limited to Zambia; they could be highly applicable to similar developing countries that have the same economic and political landscape opportunities and challenges, especially in Africa. Many countries in Sub-Sahara Africa share similar landscapes when funding high-impact research.

Authors' contributions

Shem Sikombe- (Conceptualisation, problematisation, drafting, final approval of the version to be published); Franco Muleya (Literature review, data collection, drafting); Joseph Phiri (Methods, data analysis and revisions); Sambo Zulu (Interpretation and discussion); Peter L. Simasiku (Literature review and data collection) and Mercy Situtu (Literature review and data collection). Authors agree to be accountable for all the aspects of this work.

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Data availability statement

The full report for the study, conducted to develop a framework for promoting PPP in research and innovation in Zambia, contains all the data used in writing the article. Furthermore, we developed a policy brief from the full report for dissemination to government institutions and other stakeholders. The corresponding author (Shem Sikombe) agrees to make data and materials supporting the results or analyses presented in their paper available upon reasonable request and clearance from the National Science and Technology Council (NSTC) funders in Zambia.

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