Understanding University Enterprise Collaboration for Disaster Resilience in South-East Asia

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Introduction

This paper is based on the initial findings of an ERASMUS+ project, Strengthening University Enterprise Collaboration for Resilient Communities in Asia (SECRA). The project focuses on three Asian countries: the Philippines, Sri Lanka and Thailand. University Enterprise Collaboration (UEC) refers to collaborative initiatives between universities and external stakeholders, exchanging knowledge, resources, and expertise to address challenges and promote mutual benefits. The concept of collaboration between universities and various sectors, including business, non-profit organisations, and government departments, has been widely disseminated (Awasthy et al., 2020; Guimón, 2013; Larsen et al., 2016).

Collaborations create advantages for both universities and enterprises. For example, successful collaborations allow universities to engage in up-to-date problem-based projects, secure funding and use their knowledge and skills in real-life situations (Larsen et al., 2016; Singh and Prakash, 2010; Tantanee et al., 2019). Conversely, enterprises can utilise academic knowledge for their projects, obtain better profits, lower costs, and become knowledge-based enterprises (Ankrah and Al-Tabbaa, 2015). Collaborations also benefit broader society, which profits from innovation and invention (Buys and Bursnall, 2007).

Collaborations between universities and enterprises are considered necessary by educators and policymakers in all partner countries to enhance DRM (Asian Preparedness Partnership, 2021), disaster recovery (Kong, 2013) and risk reduction (Burke Rolfhamre, 2019). Disaster resilience (DR) encompasses the capacity of communities, organisations, and systems to withstand, adapt to, and recover from disasters. It involves various dimensions: mitigation, preparedness, response, recovery, and long-term adaptation (Bullock et al., 2012). DR-UEC integrates the principles of UEC to strengthen DR. Consequently, DR-UEC entails collaborations between university, enterprise and government stakeholders to develop

innovative approaches, solutions, and strategies for disaster mitigation, preparedness, response, and recovery (Kaklauskas et al., 2018; Randil et al., 2018).

Document reviews were conducted in the Philippines, Sri Lanka, and Thailand to explore primary topics related to DR-UEC, including the current context and good practices. The current context of DR-UEC covered UEC models, policies, barriers, and enablers. Good practices showcased successful examples of DR-UECs in the partner countries. The paper aims to synthesise the findings and offer recommendations for implementing successful UECs for DR in the three Asian partner countries. These research findings provide the basis for developing a heuristic framework that guides DR-UECs.

Methodology

Documentary reviews were conducted in each partner country using systematic search strategies in relevant databases. The analytical unit was primary and secondary sources. Primary sources, such as laws, regulations, and strategies, are essential in DR-UEC research as they capture information regarding official policies and legal frameworks in each partner country. The analysis of primary sources allowed the efficacy and implementation of DR-UEC laws, regulations and strategies to be evaluated across the partner countries. Secondary sources, notably academic articles, offer broader perspectives encompassing theoretical frameworks, empirical evidence, case studies, and expert opinions. Secondary sources facilitate critical evaluations by contextualising DR-UECs and permitting evaluations between perspectives and findings. Secondary sources supplement the findings derived from primary sources, thus enriching the DR-UEC discourse.

The research leads in each partner country were briefed on the methodology for the documentary reviews to facilitate a consistent and valid synthesis of findings across all country reviews. Sources were derived from Google Scholar, Scopus and Science Direct. Grey and

indexed literature were sourced from local and national conferences, Academia.edu, government reports, policy papers, research reports, handbooks and manuals through official websites. This allowed crucial contextual information to be identified about DR-UECs in the partner countries to understand specific issues in DR-UECs and where and why further development and evaluation are required.

All searches used a combination of search terms, including:

- "University Enterprise Collaboration", "University-Industry Partnership", "University-Industry Collaboration", "University-Industry Linkage", and "Public Private Partnership"; AND
- "Disaster Risk Management", "Disaster Risk", Disaster Mitigation; AND
- "Partner Country Name"

According to the partner countries, some search terms were slightly modified to reflect their common use terms, e.g., "Academe industry partnership Philippines".

Eligible literature published after 2000 was considered, focusing on literature from the last ten years to ensure up-to-date information. Relevance to the research aims, which included DR-UEC models, policies and initiatives, barriers and enablers, and good practices, was used to assess the eligibility of identified literature. The number of citations received by a literature source was considered an indicator of quality.

Qualitative content analysis was applied to the country reviews to systematically identify and analyse common themes and concepts across the partner countries. Content analysis provides a systematic approach to data analysis, ensuring objectivity and reliability. A concept-centric approach was adopted to synthesise concepts that emerged from the country reviews and determine the point of data saturation, where no new concepts emerged (Webster and Watson, 2002). The concept-centric approach is considered superior to an author-centric

approach as it enables the synthesis of concepts within and between articles (Webster and Watson, 2002).

A comprehensive analysis of the country reports was conducted, identifying broader concepts encompassing shared characteristics and themes across the reports. Matrices were created to synthesise common concepts between articles, and an iterative process involving multiple reviewers was employed to interpret the findings. This approach allowed for a deeper understanding of DR-UECs across all partner countries.

Results

One hundred thirty-nine sources were included across all country reports, including thirty-three grey literature sources, fifty-nine journal articles, twenty-four government documents, six books/chapters, and seventeen websites (See supplementary file).

Current context

The analysis of the current context of DR-UECs across the partner countries yielded findings across four distinct domains: policies, models, barriers, and enablers.

Policies and Incentives

UEC policies in the Philippines focus on education and training in enterprises. Executive Order No. 83 led to collaboration among government agencies such as the Department of Education, Technical Education and Skills Development Authority, Commission on Higher Education, Professional Regulation Commission, and Department of Labour and Employment to develop the Philippine Qualifications Framework (PQF). The PQF aims to improve education and training, develop lifelong learners, and establish industry-aligned training standards and qualifications (Symaco and Bustos, 2021).

In Sri Lanka, the government started supporting UEC in 2005 when the university grants commission granted annual leave for senior university academics to work in enterprises (Wickramasinghe and Malik, 2018). In 2014, the Sri Lankan government introduced a triple tax deduction mechanism for enterprises engaged in research with universities (Wickramasinghe and Malik, 2018). The UGC also provided grant funding for UECs in various areas in 2015 (Wickramasinghe and Malik, 2018), including:

- Innovations and research conducted in pure sciences.
- Research that directly impacts society.
- Post-doctoral researchers for academics.
- National and international training programmes for academic staff.
- Loans with favourable terms and conditions for academic staff to commercialise products derived from research and innovation (R&I).

Thailand has developed comprehensive policies for DR, highlighting several strategies, sub-strategies, and DRM operational guidelines (Department of Disaster Prevention and Mitigation, 2015). The 12th National Economic and Social Development Plan (2017-2021) promotes research and development, intelligent technology, and entrepreneurial skills (Office of the National Economic and Social Development Board, 2017). It also aims to increase connectivity between major production sectors, small and medium enterprises (SMEs), research institutes and the academic sector (Office of the National Economic and Social Development Board, 2017). See Table I.

INSERT TABLE I HERE

DR-UEC Models

The triple helix model (Etzkowitz and Zhou, 2017) highlights interactions between academia, industry, and government to promote economic and social development. However,

the Philippines adopted an extended version of the triple helix - the human capital development model (Hermosura, 2019). This model elucidates interactions between universities, government, and industries for economic and social development and provides practical suggestions for successful collaborations (Hermosura, 2019). The Philippines review also highlighted other frameworks, including the Student Internship Model, the Faculty Immersion Model, the R&I Model, and Research and Extension Model.

The student internship model promotes internships, on-the-job training, and work placements with enterprises to provide opportunities for students to acquire competencies for employment (Navarro, 2018). The faculty immersion model encourages academic researchers to engage with enterprise projects to enhance their knowledge and skills (Abendan, 2017). The R&I model supports universities in facilitating the discovery of new knowledge, integrating theories and skills, and applying relevant knowledge (Sevilleja, 2014). The research and extension model promotes the transfer of knowledge, skills, and technology from academic research to enterprises, fostering industry experience and innovative solutions (Hall et al., 2018).

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In contrast, the Thailand review utilised its UEC model to strengthen competitive production and promote technology-intensive and innovation-driven service sectors via knowledge transfer (Office of the National Economic and Social Development Board, 2017). The UEC model has been implemented through government programs such as talent mobility, collaborative research projects, industrial consultancy, economic innovation, university business incubators, and entrepreneur creation projects (Schiller and Diez, 2007). However, the primary focus of the UEC model was commercial gain rather than addressing DR (Tantanee et al., 2018). See Table II.

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DR-UEC Barriers

The barriers identified encompass several factors that can hinder the development, maintenance or success of a DR-UEC. Material barriers refer to tangible obstacles related to the availability or accessibility of resources, infrastructure, equipment, facilities, or technology. Structural barriers are systemic factors and conditions often ingrained in social, economic, political, or organisational structures. Cultural barriers refer to the challenges arising from differences between cultural norms, values, beliefs, attitudes, and practices between organisations. Relational barriers refer to obstacles that arise in the relationships between stakeholders. Refer to Table III for a breakdown of each barrier and concept identified within each country review.

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DR-UEC Enablers

The country reviews highlighted several enablers of DR-UEC. These enablers, again, encompassed material, structural, cultural or relational concepts, alike the barriers discussed previously. However, enablers oppose barriers in that they facilitate the development,

maintenance, or success of a DR-UEC. Refer to Table IV for a breakdown of each barrier and concept identified within each country report.

INSERT TABLE IV HERE

Good Practices

Good practices in UECs across the partner countries typically encompass activities related to service and training, patenting, collaborative R&I, networking events, industrial collaboration for education, incubators, SME support, and science parks (Moeliodihardjo et al., 2012). The good practices identified across the country reviews provide examples of how stakeholders can engage in UEC for DR (see Table V).

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Discussion

Policies and Incentives

The reviews in each partner country highlighted the need for general UEC policies and initiatives and specific policies for DR-UEC. As the governing agency of universities in the Philippines, CHED issued various UEC policies. In 2014, CHED, DepEd, TESDA, and DOLE jointly released a guideline to address employment concerns during the transition to the new K to 12 programs. Initially, primary education in the Philippines lasted ten years, although there were proposals to extend it by two years (Adarlo and Jackson, 2016). However, these proposals faced criticism due to the increased workload for teachers without clear benefits in equipping students with skills for work and addressing unemployment (Calderon, 2015).

Despite efforts to improve the Philippine education system, these initiatives do not specifically focus on DR. Instead, the additional two years of compulsory education prioritise specialised areas such as sports, arts and design, or technical-vocational subjects (Cabalfin et

al., 2019). Whilst some of these areas may broadly encompass DR, it is unclear how these changes will benefit society for DR education, training, and skill development.

The assistance programs in Executive Order No. 104 include professional development, livelihood development, and welfare assistance. For instance, CHED Memorandum Order (CMO) No.14 introduces the Sectoral Engagement Program (SEP) for teachers affected by the curriculum change. Through SEP, teachers can work full-time or part-time in their chosen enterprise, enjoying a reduced working scheme and financial assistance upon successful application (Cabalfin et al., 2019). Teachers engaged in SEP enhance their skills and knowledge to share with students upon their return to teaching (Brillantes et al., 2018). Enterprises benefit as they no longer need to pay for specific services or professional expertise that other employees can learn from (Brillantes et al., 2018).

CHED issued CMO No. 52 Series to guide R&I and extension programs between universities and potential collaborators. The Series outlines the benefits of UECs for universities and enterprises and the criteria for research grants. It promotes work on sustainable development goals, including DR, climate change, and education. However, strict eligibility criteria restrict grant accessibility based on university status, unliquidated grants/funding, researcher nationality, and experience, which may impede DR-UEC development. Moreover, CMO No. 104 aims to equip students with knowledge and skills through work experience in their chosen field. Students, universities, and collaborating enterprises benefit from such partnerships. Furthermore, CHED established a Memorandum of Understanding (MoU) with the Department of Trade and Industry in October 2020 to develop policies, standards, and guidelines for higher education advancement in the Philippines. However, there are no policies to guide the formation of DR-UECs specifically.

Instead, the emphasis is on transforming the education system to address unemployment and improve student abilities. Furthermore, UEC policies primarily target academic stakeholders, overlooking the potential benefits of DR-UECs for diverse stakeholders. This limitation impedes the progress of DR-UECs. Similarly, Sri Lankan UEC initiatives face implementation challenges, despite government efforts to enable DR-UECs.

Thailand has developed comprehensive policies for DR, highlighting several strategies, sub-strategies, and operational guidelines (Department of Disaster Prevention and Mitigation, 2015). However, there is a lack of specific policies guiding DR-UEC (National Science Technology and Innovation Policy Office, 2012).

The country reviews indicate the need for cohesive DR-UEC policies and initiatives. The Philippines focuses on DR education, Sri Lanka emphasises financial incentives, and Thailand's policies revolve around R&I. However, Thailand lacks programs supporting knowledge application or R&I for DR. Effective policy development and implementation are necessary to enable DR-UECs in all partner countries. As country reviews indicate, DR-UEC requires more funding, implementation, continuity, and long-term strategic planning, especially in DR. Moreover, the adequacy, availability, and DR relevance of partner countries' policies must be reviewed and update to ensure their efficacy for enabling DR-UECs. Policy implementation issues also arise, necessitating effective implementation strategies, particularly in DR.

DR-UEC Models

Efforts to utilise frameworks for DR-UEC are insufficient. UEC models lack depth and understanding of stakeholder dynamics, thus highlighting the need to understand the complex dynamics between stakeholders, including their roles and expected contributions to a DR collaboration. Furthermore, diversity in terms of the type and purpose of UECs needs to be

improved, as most models focus solely on economic development rather than DR. As such, universities and other stakeholders could benefit from a systematic framing of UECs in DR. This will strengthen institutional procedures and practices under the scope of a singular DR-UEC framework.

Material Barriers

Country reviews highlight the need for increased investment, venture capital, and funding to overcome barriers in DR-UECs. In Thailand, a lack of research funding hinders R&I activities, while in the Philippines, the need for early-stage investors and venture capital impedes UEC initiation. Sri Lanka also faces inadequate funding from government strategies. These funding-related barriers impact various aspects of UECs, including research partnerships, curriculum development, student mobility, and technology development, all of which are essential for DR.

Although the Thailand review did not comment, from the country reviews in the Philippines and Sri Lanka, a lack of effective marketing and promotion strategies and limited awareness of DR-UECs in universities and external enterprises were identified as barriers to DR-UECs. The Sri Lankan review highlighted the importance of universities recognising social obligations and collaborating with SMEs to achieve social impact. In some cases, social effects may be better achieved via collaborations with SMEs than larger organisations. For example, universities co-develop scientific, evidence-based programmes, government and business sectors provide resources, and SMEs implement them at the community level. The Philippines review emphasised the need for an effective marketing mechanism and clear collaboration guidelines to engage stakeholders in DR-UECs. Promoting innovation at SMEs through close networks and favourable infrastructure with universities, research institutes, and technology support centres was emphasised in both reviews as crucial for DR-UECs.

Inadequate research facilities hindered DR-UECs in the Philippines and Sri Lanka. While the Thailand review did not mention this as a barrier, it emphasised the need to develop university research facilities to facilitate collaborations for DR. The Sri Lankan review highlighted the necessity of improving university research and development facilities to support research, making universities better equipped for R&I projects in general and in the context of DR. Insufficient research facilities may deter potential partners, including enterprises and governmental agencies, from engaging in collaborative efforts with universities, as the lack of adequate facilities may compromise the quality of university capabilities.

Absorptive capacity refers to identifying, integrating and commercialising external knowledge (Cohen and Levinthal, 1990). While the Philippines and Thailand reviews did not discuss absorptive capacity, the Sri Lanka review highlighted that insufficient absorptive capacity among collaborating enterprises hinders knowledge utilisation in DR-UECs. For instance, despite advanced research activities by Sri Lankan universities to enhance flood-related risk estimation, the lack of absorptive capacity resulted in local authorities not utilising the generated knowledge. Insufficient absorptive capacity limits stakeholders' ability to assimilate and apply knowledge effectively, impeding the translation of research findings into practical applications and hindering evidence-based strategies for DR.

Material Enablers

The Philippines and Thailand reviews emphasised science and technology scholarships, university R&I funding, and financial support for collaborating enterprises as enablers of DR-UEC. In Sri Lanka, funding primarily focuses on establishing start-ups by faculty members and students rather than DR activities. Funding for DR topics is available for strategic and fundamental research across all partner countries but is often integrated with broader themes

such as health, societal, and environmental development. Researchers should align their DR research with the specific themes of funding agencies to facilitate DR-UECs.

All countries report financial grants as enablers of DR-UECs, but clarity regarding their operation is necessary, including eligibility and accessibility criteria. Grants typically involve competition, favouring larger organisations based on their capacity, resources, and investment potential. This may create unfair competition, making it essential for universities to pay attention to SMEs in DR-UECs, especially in community contexts. Involving SMEs permits local knowledge utilisation to address community needs and enhance grassroots-level DR. This approach promotes local solutions, context-specific strategies, and community-driven approaches to DR. Engaging SMEs in DR-UECs fosters inclusivity, diversifies expertise and resources, and promotes a more equitable DR-UEC landscape.

All country reviews highlighted marketing mechanisms to encourage collaboration between potential stakeholders and universities. The Sri Lankan review discussed triple tax deduction mechanisms as incentives for collaborating enterprises. The Philippines review described flexible working arrangements and financial benefits for academic staff to incentivise their engagement with UECs. The Thailand review emphasised the importance of specific policies for promoting UEC without considering their absence as a barrier to UEC. However, there were no documented specific incentives for potential stakeholders to engage with DR-UECs. By offering targeted incentives and benefits tailored to the context of DR initiatives, policymakers can attract a broader range of stakeholders to participate in DR-UECs. This can introduce different perspectives, expertise, and resources contributing to innovative DR-UECs.

Technology transfer refers to utilising available technologies for novel applications via cooperative activities between multiple stakeholders (Lane, 1999). The Sri Lankan review

emphasised technology transfer as an essential enabler in DR-UECs. Similarly, the Thailand review highlighted that knowledge and technology transfers between stakeholders are needed for innovative DR solutions. Therefore, improvements to research facilities at universities in terms of specialised research equipment, IT systems and professional supporting staff are required to facilitate the development and implementation of effective DR-UECs.

The Sri Lankan review emphasised technology transfer as an essential enabler in DR-UECs. Similarly, the Thailand review highlighted the need for knowledge and technology transfers between stakeholders for innovative DR solutions. Improvements to research facilities at universities, including specialised research equipment, IT systems, and professional support staff, are required to facilitate the development and implementation of effective DR-UECs. Although recognising inadequate facilities as a barrier to DR-UECs, the Philippines review did not consider improvements as an enabler.

Structural Barriers

One structural barrier identified in all country reviews is the lack of clear guidelines and ineffective policies governing DR-UECs, resulting in ambiguity and uncertainty for stakeholders. The Philippines and Sri Lanka review drew attention to specific government policies and initiatives, indicating the need for improved guidelines and policies regarding DR-UECs. The Thailand review highlighted unclear policies to support UEC, a lack of contribution to global R&I for DR, and community unpreparedness for disaster impacts as barriers specifically to DR-UEC.

All country reviews highlighted bureaucratic complexities in government and university procedures, hindering collaborative processes. The Philippines review noted bureaucratic regulatory processes, particularly in equipment procurement and fund disbursement. However, it also highlighted good practices in bridging funds to bypass

bureaucracy and enable UECs. While this short-term solution is commendable, a long-term approach is necessary to facilitate DR-UECs. The Sri Lanka review revealed inflexible rules and guidelines for DR-UECs, leading to slow responses to industrial demand.

Meanwhile, the Thailand review emphasised national and local government bureaucratic barriers. These barriers stem from conventional practices, a lack of adaptability, centralisation prioritisation over decentralisation, hierarchical structures, excessive paperwork, underutilisation of technology, and laborious regulations and inspections. Such barriers impede the efficiency required for successful DR-UECs. Therefore, all countries should revise their regulatory procedures to avoid bureaucracy as far as reasonably possible to make DR-UEC processes straightforward and accessible, especially for those unfamiliar with the intricate procedures.

Whilst a lack of human resource development (HRD) was only highlighted in the Thailand review as a barrier to successful DR-UECs, poor HRD results in a lack of knowledge and competencies to effectively execute DR-UECs. This results in the absence of a skilled workforce to undertake DR-UECs, which was also reported as a barrier to DR-UECs in all country reviews. As such, insufficient HRD coupled with the absence of a skilled workforce simultaneously hinders the ability to plan and execute DR-UECs.

The reviews in the Philippines and Sri Lanka highlight the lack of expertise and capacity in handling legal arrangements for intellectual property rights, contract negotiations, and the establishment of MoU and MoA, hindering DR-UEC development. The Thailand review did not identify deficient legal expertise as a barrier to DR-UECs but emphasised the need to transition from informal to formal collaborations for enabling DR-UECs. Regardless, partner countries typically rely on informal contracts for DR-UECs, which often lack specific provisions for intellectual property rights, conflict resolution, and responsibility and output

distribution. The lack of clarity and protection for intellectual property rights and challenges in negotiating fair and mutually beneficial contracts create hesitancy among potential collaborators. Insufficient expertise and capacity in legal arrangements may also cause collaboration delays and conflicts, further impeding DR-UECs.

Output-sharing issues hindered DR-UECs in partner countries. The Thailand review stressed the importance of clarity regarding industry expectations, staff capabilities, resource investment, and equitable sharing of revenue and intellectual property benefits. However, the review noted an inherent disparity due to the prevailing focus on financial outputs for enterprises and social development for non-profit stakeholders. Industries prioritise fast commercial results and short-term outcomes, while universities concentrate on basic research and academic publications, as highlighted in the Philippines and Thailand reviews. This misalignment poses challenges for collaboration, as firms seek immediate returns and clear contributions, while university researchers are motivated to publish their research results quickly.

Moreover, The Sri Lanka review raised concerns about universities' legitimate power to commercialise intellectual property rights (IPR). The University Act of 1978 primarily focuses on teaching and education, with limited provisions for research commercialisation. Consequently, the absence of clear regulations on ownership of inventions from public research and development conducted at universities and research institutes further complicates the matter. Consequently, private sector engagement and investment in DR-UECs may be deterred.

Structural Enablers

All reviews emphasised the importance of investing in human resources to develop the necessary skills to undertake UEC in general and DR contexts. HRD is considered to enable successful UECs (Vea, 2014). Specifically, the Philippines review suggested that universities

must plan and observe how faculty immersion in enterprise enables UECs. Faculty immersion can allow academics to gain more experience in enterprise to situate theory into practice by integrating approaches, theories, and methods from across disciplines (Hall et al., 2018).

The Sri Lankan review found academic staff commonly fostered university-enterprise partnerships through student internships and consultancy. Internship programs create collaborations between enterprises and universities, resulting in shared benefits (Weerasinghe and Jayawardane, 2018). For instance, recruiting trained graduates and postgraduates expands networks within academia and enterprises, facilitating the adoption of new approaches, methods, and techniques. Additionally, academic consultancy offered by university faculty can enhance long-term partnerships by better understanding enterprises' aspirations, objectives, and values. From an enterprise perspective, collaborative research activities foster innovation and the development of product prototypes, which rely on academic input.

The Thailand review also recognises HRD as an enabler of UEC and outlined several educational approaches that could be utilised for HRD, including:

- Undergraduate/postgraduate programs (e.g., M.Sc. in Disaster Analysis, Management and Mitigation by the University of Colombo, postgraduate diplomas and graduate programs for PhD students by the University of Peradeniya).
- Final projects/ dissertations (e.g., Module offered in Disaster Management under the M.Sc. in Project Management by the University of Moratuwa).
- Continued professional development.
- Short DR courses.

While DR education can facilitate DR-UECs, the multidisciplinary nature of DR presents a challenge for universities in preparing students for DR careers through formal curriculum delivery. Therefore, adopting a collaborative approach to curricular revisions is beneficial to ensure students possess both a theoretical understanding and practical skills required to meet entrepreneurial demands in DR (Gotangco et al., 2020). Conversely, entrepreneurs face the challenge of developing business models that effectively integrate DR investment with robust business continuity plans (Lorenzana and Sario, 2016). However, universities can contribute by researching to inform business continuity planning for DR projects.

While the Sri Lanka and Thailand reviews do not address human capital retention, the Philippines review emphasises its significance in DR-UECs. Retaining human capital fosters a culture of expertise and experience within organisations. Enhancing human capital retention cultivates specialised knowledge and skills, creating a valuable pool of expertise for future collaborations. Consequently, human capital retention supports establishing long-term professional relationships and networks, ensuring the continuity of DR-UECs.

The Philippines review highlighted the importance of developing rules, regulations, and policies for UECs to facilitate the establishment and sustainability of successful DR-UECs. Similarly, the Sri Lankan review underscored the role of universities in collaborating with the government and relevant institutions to formulate rules, regulations, and policies for UECs. Therefore, revising existing UEC policies is crucial to promote effective collaborations. However, adopting a cooperative approach among relevant stakeholders can further enhance DR-UECs by considering all stakeholders' interests in the ensuing policies.

The National Policy and Plan of Science, Technology, and Innovation No.1 (2012-2021) in Thailand highlighted the presence of unclear policies, insufficient contribution to global

research and innovation in the context of disaster resilience (DR), and unpreparedness of communities for disaster impacts as barriers specifically affecting DR-UECs. The Thailand review further explained that updated policies accommodating all stakeholders would facilitate DR-UECs. Therefore, it would benefit all countries to assess the adequacy, upgradability, availability, and relevance of their DR-UEC policies to various stakeholders, both in general and specifically for DR-UECs. Moreover, utilising policy instruments to ensure the effective implementation of DR-UEC policies can further promote the establishment and sustainability of successful collaborations (OECD, 2015; OECD., 2019).

In all country reviews, policy-related barriers related to intellectual property rights (IPR) were identified. The reviews proposed innovative strategies to address these issues. The Thailand review emphasised the need for considerations regarding intellectual property to empower collaborations, while the Sri Lankan review underscored the importance of clearly defining and enforcing rules for IPR. The Philippines review highlighted the significance of academia developing IP policies and guidelines, specifically for IP disclosures, contract arrangements, and license agreements. Implementing such measures will enable DR-UECs.

The Philippines has established IP offices (IPO) which are government agencies tasked with implementing IP policies and strengthening IP rights within the country (Cruz et al., 2021). IPOs also play a crucial role in facilitating the transition from proposal to commercialisation by offering specialised expertise (Cruz et al., 2021). Establishing IPOs has proven effective in promoting DR-UECs by addressing ownership concerns, providing updates, and enabling exclusive licenses when substantial investments of time and resources are necessary for technology commercialisation.

All country reviews emphasised the significance of clear and concise agreements in enabling DR-UECs. Such agreements, like MoUs, establish strong bonds between UECs with a high level of commitment (Alagao, 2014). This commitment cultivates trust, cooperation, and accountability, which is crucial for facilitating effective DR-UECs. Moreover, well-defined agreements encompassing elements like intellectual property rights, ownership, revenue sharing, and commercialisation processes help prevent potential conflicts related to commercialisation (Schaeffer et al., 2020). Furthermore, when promptly established, clear and concise agreements ensure commercial success and appropriate returns (Guimón, 2013).

Cultural Barriers

All reviews highlighted the lack of entrepreneurship as a barrier to DR-UECs. In Thailand, it was observed that the absence of university policies encouraging staff involvement in industry activities within collaborative initiatives hindered entrepreneurial drive. The lack of explicit support from higher education institutions and government entities limited the motivation and incentives for academic staff to engage in UECs. Similarly, the Sri Lanka review emphasised that universities' reluctance to collaborate with industry challenged the establishment of DR-UECs.

The Sri Lanka review identified several factors contributing to the lack of entrepreneurial drive among academics, including low confidence, insufficient motivation, a scarcity of entrepreneurial spirit, and a perception that collaborating with industry is beyond the role of academic researchers. Consequently, insufficient entrepreneurial drive among faculty members can impede universities' involvement in collaborating with industries for DR development. Similarly, the Philippines review emphasised that a lack of entrepreneurial drive created barriers to DR-UECs in the country. As discussed by Vea (2014), the limited interest of faculty members in UEC projects can be attributed to the cultural trait of "fear of failure"

prevalent in Filipino society. The cultural perception of avoiding failure fosters a conservative academic environment prioritising traditional research and teaching activities over UEC projects. Faculty members may perceive UECs as high-risk ventures that could divert their attention and resources from their core responsibilities. Consequently, the limited interest of faculty members in UEC projects hampers DR-UECs.

The Philippines and Sri Lanka review also highlighted the lack of interest from external stakeholders in UECs as a barrier. While the Thailand review did not mention this barrier, the Philippines review explained that the high cost associated with UECs discourages potential stakeholders. Additionally, the Sri Lanka review suggested that the excessive rates for academic expertise act as the main deterrent. In Sri Lankan universities, guidelines allocate funds to the university for its resources and facilities, resulting in minimal profit for the researcher. For instance, universities charge 46% of the total university overheads for academic consultancy. Opaque regulations further impede cost transparency (Randil et al., 2018). Consequently, this may diminish enterprise interest in DR-UECs and hinder DR initiatives.

All the country reviews highlighted heavy academic workloads as a substantial barrier to DR-UECs. Specifically, the Thailand review emphasised that DR-UECs are hindered by the constraints arising from the heavy workload of university staff and the inadequate focus on industry needs. In Thailand, the emphasis placed by university administrators on research publications and outputs often results in academic staff being prioritised for research-related responsibilities over other obligations. Similarly, the Philippines review highlighted the importance of balancing research and teaching, as current academic workloads could be more conducive to collaborative activities. In Sri Lanka, the review highlighted that the heavy academic workload faced by academic staff often leaves them with limited time to undertake

industry-related research. This constraint hinders their ability to actively participate in UECs and engage in collaborative projects with industries.

Although neither the Sri Lanka nor Thailand reviews acknowledged the role of diversity in UECs, the Philippines emphasised the lack of diversity in academic staff as a cultural barrier to DR-UECs. In the Philippines, restricting full-time professorial positions to citizens limits the introduction of diverse worldviews in classrooms (Vea, 2014). This restriction hampers the opportunity for students and academic staff to gain exposure to a broader range of perspectives and insights, including those related to DR. The absence of diverse worldviews may restrict the depth and breadth of discussions and hinder the understanding of DR issues. Furthermore, the limitation on foreign professionals in full-time positions may impact the involvement of multinational companies in R&I projects.

The reliance on mother companies for R&I initiatives indicates a potential gap in accessing external expertise and resources locally (Alagao, 2014). Without the active participation of multinational companies in DR projects, there may be missed opportunities for cross-disciplinary collaboration, technology transfer, and the application of international practices in DR. Involving diverse stakeholders and transferring knowledge from experts in relevant fields strengthens the overall understanding of DR and promotes the development of DR-UECs. Therefore, universities should consider strategies to increase diversity among academic staff and expand faculty knowledge and expertise in DR.

Cultural Enablers

Whilst the Sri Lanka review did not consider promoting research culture as an enabler of DR-UECs, both the Philippines and Thailand reviews highlighted that universities should identify viable means for promoting research culture amongst academic staff and enterprises to stem interest in DR-UECs. The Philippines and Thailand reviews suggested various

approaches to promoting research culture. These include providing financial incentives for research, upgrading facilities, and workload adjustments to accommodate research commitments. However, it is essential to note that promoting research culture in the context of DR-UECs requires a multifaceted approach beyond financial incentives and infrastructure improvements. Therefore, adopting a heuristic approach that combines different elements, such as funding, workshops, networking events, and faculty immersions, is necessary to provide opportunities for knowledge sharing, collaboration, and awareness of DR-UECs.

Whilst the Sri Lanka review highlighted heavy academic workloads as a barrier to UEC, they did not consider the re-evaluation of teaching loads for academics as an enabler of DR-UECs. The Philippines review explained that it is crucial to ensure that academics have sufficient time and resources to collaborate alongside their teaching responsibilities. The Thailand review highlighted the importance of balancing the workload of academic staff to strengthen staff capabilities for DR-UECs. Evaluating workloads will allow academics to dedicate time to DR-UECs.

Although the Philippines review did not comment on the role of university missions, objectives, and values, the Sri Lanka and Thailand review highlighted its role in enabling and facilitating DR-UECs. The Thailand review highlighted the importance of a research-focused environment in building a research culture to strengthen staff capabilities for DR-UECs. The Thailand review explained that by prioritising research and providing the necessary resources, support, and incentives, universities can create an environment that encourages DR-UECs.

As noted in the Sri Lanka review, many universities adhere to a traditional educational framework that prioritises large-scale lecture delivery to undergraduate students, particularly in job-oriented programs. While this framework effectively caters to the demand for graduates

by multinational and large organisations, it may not foster a culture of research and innovation or provide collaboration resources. Additionally, the review highlights that academics primarily engage in research activities to enhance their own profiles rather than focusing on collaborative initiatives that address societal challenges like DR. Thus, realigning resource allocation, individual academic objectives, and the broader objectives of government initiatives can facilitate DR-UECs.

Relational Barriers

All country reviews identified divergent objectives and output aspirations as a relational barrier to DR-UEC. The Sri Lanka review highlighted conflicts related to IP rights and ownership as a significant hindrance. Similarly, the Philippines review pointed out that a divergence of objectives and output aspirations among stakeholders often emerged, with enterprises prioritising fast commercial results. Likewise, the Thailand review emphasised the importance of clarity and alignment regarding industry expectations and staff capabilities as a barrier to DR-UECs. Additionally, the review identified the absence of a clear framework for the fair sharing of benefits, including revenue and intellectual property, as a further hindrance to DR-UECs.

The Philippines review highlighted that mistrust between industry and academia affects their engagement in R&D partnerships. Abendan (2017) noted industry concerns about universities stealing proprietary information, while universities are wary of industries poaching their faculty. Similarly, the Sri Lanka review emphasised the presence of mistrust between industries and universities, with enterprises expressing reservations about the university system's technical capabilities and supervisors' skills. Although the Thailand review did not address mistrust between stakeholders, it is worth noting that mistrust impedes sharing of knowledge, expertise, and resources, thereby hindering DR-UECs.

The Sri Lanka review highlighted a need for networking opportunities as a barrier to DR-UECs. The Sri Lanka review explained that there is no extant technique to collaborate with universities to enterprises rather than personal contacts retained by stakeholders. More networking opportunities must be available to allow universities and enterprises to discover and engage in potential DR-UECs. However, The Philippines and Thailand reviews did not acknowledge this relational barrier to DR-UECs.

Ineffective communication between stakeholders was also revealed as a relational barrier to UEC in the Sri Lanka review. Whilst the Philippines and Thailand reviews did not discuss effective communication, it is acknowledged that effective communication is essential for successful DR-UECs. Ineffective communication, on the other hand, can lead to misunderstandings between stakeholders regarding objectives and expectations, resulting in conflict during collaborations. Furthermore, ineffective communication can result in ineffective knowledge transfer, thus impeding DR-UECs.

Relational Enablers

All country reviews highlighted the importance of networking events for developing DR-UECs. Whilst the Thailand review highlighted networking activities as a good practice for DR-UECs, the Philippines and Sri Lanka reviews highlighted specific networking events and activities that can enable DR-UECs. The Philippines review, as discussed by Liew, Shahdan, and Lim (2013) and echoed by Vea (2014), highlights the pivotal role of networking as an enabler for successful DR-UECs. The review emphasises the importance of student internships and faculty immersion to enable academics to connect and network with professionals and practitioners outside of universities. Moreover, the Philippines review promotes their research and extension model to facilitate the transfer of knowledge and skills for DR.

Similarly, the Sri Lanka review, drawing upon the work of Wickramasinghe and Malik (2018), highlighted several mechanisms that facilitate DR-UECs. These mechanisms include academic consultancy to industry, personal networking through conferences and seminars involving industrial personnel, and part-time secondment of academic staff to industry. The review also recommends targeted partnership initiatives, such as integrating DR through corporate social responsibility and fostering grassroots-level networking for disaster management. Networking events can catalyse DR initiatives by generating interest and engagement in the field. Moreover, these events not only facilitate connections and interactions between universities and industry but also have the potential to encourage corporate social responsibility.

The Philippines review did not highlight promotion as an enabler of DR-UEC. However, both the Sri Lanka and Thailand reviews emphasised the importance of effective promotion in fostering the development of DR-UECs. The Sri Lanka review highlighted the role of government policies in promoting UECs, which included initiatives such as granting annual leave for senior academics to work in enterprises, offering tax deductions for collaborations between universities and enterprises, and funding support for UECs. However, these initiatives were not explicitly targeted at DR-UECs, and their effectiveness in promoting DR-UECs remains to be determined. Similarly, the Thailand review described government policy efforts to promote the utilisation of sciences and technologies, R&I, and budget allocation for DR. The review also emphasised using conferences, seminars, site visits, and mass media to promote and raise awareness of DR-UECs among potential stakeholders. Implementing various promotional strategies can enhance engagement with DR-UECs.

The Sri Lanka and Thailand reviews highlighted forming and maintaining collaborative networks as an enabler for DR-UECs. Sri Lanka and Thailand have implemented incubators and science parks as strategic initiatives to foster collaborative networks for DR-UECs. These

platforms assist the formation and maintenance of start-ups by professors, students, researchers, and entrepreneurs, providing them with vital support mechanisms for enterprise growth and development. Moreover, the Thailand review emphasised the importance of establishing comprehensive databases encompassing past, current, and potential stakeholders. Such databases provide a platform for identifying suitable stakeholders, aligning objectives, and fostering DR-UECs based on shared goals and necessary capabilities. However, the Philippines review did not discuss forming and maintaining collaborative networks as enablers of DR-UECs.

Although not mentioned in the Philippines review, the Sri Lanka and Thailand reviews highlighted the fair sharing of costs and benefits as enablers of DR-UECs. Establishing formal agreements that outline the equitable distribution of costs and benefits can contribute to transparency and trust among stakeholders. This promotes a sense of fairness and ensures that all parties involved in DR-UECs are appropriately incentivised and rewarded, enhancing the overall effectiveness and sustainability of DR-UECs.

Good Practices

Although all country reports highlighted several case studies to evidence good practice in DR-UECs, the Philippines report did not explicitly evidence case studies related to DR-UECs. Instead, it presented instances of good practice regarding distributing funds and establishing policies and specialised units for intellectual property regulations. On the other hand, the Sri Lanka and Thailand reviews highlighted several practical case studies in enhancing disaster mitigation and preparedness. That said, none of the partner countries evidenced cases of DR-UECs for disaster response and recovery. As such, DR-UECs should consider disaster mitigation, preparedness, response, and recovery initiatives to achieve DR across the partner countries.

Conclusions

This paper aimed to synthesise primary and secondary literature on DR-UECs in the Philippines, Sri Lanka, and Thailand, thus revealing considerations for improving DR-UECs in these countries. Overall, there is a need for cohesive DR-UEC policies and initiatives across all partner countries. Currently, a lack of awareness and understanding of DR-UECs, resistance to change arising from traditional academic values, and limited resources hinder the implementation and efficacy of existing policies across all partner countries. Therefore, all countries should address these challenges by ensuring policy depth and relevance to DR and providing clear guidelines to promote, guide, and regulate DR-UECs. That said, university procedures and practices should also be adopted to implement policies and enable DR-UECs.

DR-UECs are hindered by challenges in procuring specialist equipment, a lack of a clear funding process, research expertise and appropriate research facilities. As such, detailed explanations of grant/funding scopes, requirements and eligibility criteria should be accessible. Furthermore, researchers should align their DR research with scope of the funding agency to procure funding. Improvements to research facilities at universities in terms of specialised research equipment, IT systems and professional supporting staff can also facilitate the advancement of knowledge relating to DR-UECs. However, gaining knowledge alone is not enough – is it also important to consider the capacity of stakeholders to implement strategies on the back of knowledge acquisition.

Investment in infrastructure enhancement to increase absorptive capacity will enhance knowledge and technology transfer between stakeholders. Universities and enterprises should consider student and faculty immersions, research and extension, student internships, academic consultancy and curriculum development for HRD to increase absorptive capacity and enable DR-UECs. Additionally, universities should consider strategies by which they can increase diversity amongst academic staff to gain a broader range of expertise and world views to enable

DR-UECs. Policymakers should revise marketing and incentive strategies to incentivise stakeholders to conduct DR-UECs. In turn, this will facilitate the engagement of a broader range of stakeholders to formulate innovative solutions to various aspects of DR.

There are steps that universities and other stakeholders can take to facilitate positive stakeholder relationships to mitigate any mistrust and prevent disputes that may arise in a DR-UEC. Formal agreements can be established before the collaboration begins. Further, the development and implementation of IP rights/ownership legislation will ensure the fair sharing of benefits that arise from collaborative DR projects. Furthermore, policymakers should revise regulatory procedures to avoid bureaucracy to simplify DR-UEC processes, especially for those unfamiliar with the procedures involved. Although each partner country highlighted examples of several successful UECs, future research is needed to understand the strength and reach of collaborative networks for DR initiatives in the partner countries.

While successful UEC examples exist, further research is needed to understand the strength and scope of collaborative networks in DR initiatives. Empirical research is necessary to explore the practical application and feasibility of identified barriers and enablers in real-world contexts. Integrating theoretical and practical perspectives can lead to the development of a comprehensive heuristic framework that guides the initiation and sustenance of successful DR-UECs. This framework will encompass theoretical enablers, barriers, good practices, and a practical understanding of initiating and maintaining successful DR-UECs. It can serve as a valuable tool to inform the process of initiating and maintaining successful DR-UECs.

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Table I. Policies and initiatives for UEC in each partner country

Country	Policy	Purpose and summary
Philippines	Philippine Qualifications Framework (PQF)	To benefit various sectors and stakeholders of education and training to develop lifelong learners, provide employers with specific training standards and qualifications aligned to industry standards, and ensure that training and educational institutions adhere to specific standards and are accountable for achieving the same.
	Memorandum of Understanding with the Department of Trade and Industry (DTI) (2020)	Intends to develop policies, standards, and guidelines for advancing higher education in the Philippines. This partnership also signifies the common goal of DTI and Commission on Higher Education (CHED) of advocating quality and performance excellence in tertiary education in the country.
	CMO Number 104 series of 2017	Stipulates the revised procedures for conducting student internship programs. Specifically, the guidelines aim to fully equip students with knowledge and skills by letting them experience their field of work.
	CMO No.14 series of 2016	Allows teachers affected by curriculum change to apply for a Sectoral Engagement Program, whereby teachers can work full-time or part-time in the industry of their expertise. When their applications are successful, teachers can enjoy a reduced working scheme with financial assistance from CHED and enhance their skills and knowledge in their fields.
	CMO No.52 series of 2016	Guides the implementation of research and development (R&D) and extension programs of universities and their venture with their industry partners and describes the benefits universities and Industry partners can enjoy. It encourages work on different sustainable development goals such as food production and security, environment, disaster risk reduction, climate change, energy, terrestrial and marine, resources: economy, biodiversity, and conservation, smart analytics and engineering innovations, health systems and education for STEAM (Science, Technology, Engineering, Arts & Mathematics).
Sri Lanka	In 2015, the most recent initiative presented by UGC granted funding for university enterprise collaborations.	Encourage innovations and research in pure sciences, research that directly impacts society; post-doctoral researchers for academics who just finished their PhDs; national and international training programs for academic staff in the university and the facilitation of loans having favourable terms and conditions for academic staff to commercialise products that advanced through research and development.
	In 2014, the Sri Lankan government introduced enterprises' triple tax deduction mechanism.	To encourage enterprises to engage with UECs resulting in the development of formal units committed to UECs at the Open University of Sri Lanka, the University of Kelaniya and the University of Colombo.
	The Sri Lankan government began to support university enterprise collaboration from 2005	University grants commission (UGC) announced the circular granting annual leave for senior university academics to work officially in any enterprise.

Table I. *continued*

Country	Policy	Purpose and summary
Thailand	12th National Economic and Social Development Plan 2017-2021 (Office of the National Economic and Social Development Board, 2016)	To promote research and development, foster intelligent technology, and develop technopreneurs' skills. It aims to increase connectivity between major production sectors, small and medium enterprises (SMEs), research institutes and the academic sector. Development strategies are encouraged to support collaborative working networks between research institutes, the academic, public and private sectors, and citizens to develop social innovations.

Table V. Continued

Country	Case Studies	Purpose
Sri Lanka	Community and infrastructure resilience through a strategy by the University of Peradeniya, DMC and UNDP.	Development of Macro Seismic Hazard Zonation
	collaboratively with DMC and UNDP	Preparing communities and infrastructure for future natural disasters by proposing suitable locations for disaster evacuation centres determined by using past disaster experiences of the communities
	The University of Peradeniya collaboratively with DMC and UNDP.	Structural stability improvement project of temporary evacuation centres
		A Flagship program commenced by the university of Ruhuna, and the University of Moratuwa, along with the plantation ministry and Dialog Axiata PLC, to upgrade the protected Agriculture sector of the country by introducing climate smart Agriculture program, introducing auto controlling mechanism for environmental and fertigation control systems connected through IoT platform.
		In collaboration with the University of Central Lancashire, the Ministry of Social welfare and Primary Industries (MoSWPI) has initiated a program to develop a platform to facilitate University-Industry partnerships.
Thailand	Chiang Mai University (CMU) also has closely collaborated with the industries.	Promote development in innovative environment and energy; food and health; adult caring; creative Lanna; producing graduates who have morals, quality and skills to be a citizen of the world; conducting research for excellence and innovation; academic services that are beneficial for society; revenue for sustainable development and integrated management.
	Centre of Excellence in Natural Disaster Management	Research centre focused on conducting research in disaster management.
	Research collaboration among four universities of Mahasarakham University (MSU), King Mongut's University of Technology North Bangkok (KMUNT), Nakhon Panom University (NPU), Rajamangala University of Technology Isan Khon Kaen Campus (RMUTi Khon Kaen), the government agency of Internal Security Operations Command (ISOC) and industry of Arthit Machinery Co., Ltd.	Development of Cylindrical Drum Drying Technology with Infrared Radiation in Combination with Hot Air Discharges
		Dan Sai Municipality and aimed to evaluate the city's greenhouse gas emissions
		Implemented the "Fire Forest Protection and Control by Small Drone Aircraft, Checking Fire Hot Spots" project. This project aimed to monitor fire hot spots in Mae Cham District, Chiang Mai Province
	GHG Evaluation and Mitigation Planning for Low Carbon City	

Case Study

Table V. Continued

Thailand	Chiang Mai University's Geoinformatics Regional Space and Technology Center of Northern Thailand, Faculty of Social Sciences, together with the National Defence Technology Institute UEC involving academic, government, private, and local community sectors.	The haze Pollution in Chiang Mai Project aimed to investigate the building resilience of Chiang Mai during the past ten years, between 2007 and 2016. The villagers' and communities' perceptions and coping strategies in the most affected areas are also examined.

Table II. Models for UEC in each partner country

Country	Model	Description
Philippines	Triple Helix Model	Highlights interactions between academia, industry and government to promote economic and social development.
	Triple Helix Model for Human Capital Development	Elucidates the interactions between universities, government, and industries for economic and social development and practical suggestions to encourage successful collaborations.
	Student Internship Model	Promotes student internship programs or on-the-job training (OJT) courses and work with industry partners to provide opportunities for students to acquire and deepen their most relevant competencies for employment.
	Faculty Immersion Model	Encourages researchers and professional practitioners in academia to engage with enterprise projects that will enhance their knowledge and skills in their specialist fields.
	R&D Model	Supports the engagement of university faculties in R&D endeavours to facilitate the discovery of new knowledge, integrate theories and skills across disciplines, apply relevant knowledge, and implement responsive curricula.
	Research and Extension Model	Promotes activities that allow the transfer of knowledge, skills, and technology generated from academic research to the broader community.
Sri Lanka	Triple Helix Model	Highlights interactions between academia, industry and government to promote economic and social development.
Thailand	UEC Model	Emphasises strengthening existing competitive production and service sectors to become more technology-intensive and innovation-driven by transferring knowledge from research or academic institutions.

Table III. Summary of barriers to UEC in the partner countries.

Category	Barrier	Country		
		Philippines	Sri Lanka	Thailand
Material	Lack of investment/venture capital/ funding opportunities.	X	X	X
	Lack of marketing, promotion and awareness of UEC.	X	X	
	Lack of adequate research facilities.	X	X	
	Inadequate absorptive capacity.		X	
	Lack of infrastructure, mechanisms and supporting systems for initiating and maintaining collaborations.	X	X	X
Structural	Lack of clear guidelines and ineffective policies regarding UEC.	X	X	X
	Bureaucracy in government and university procedures (e.g. procurement of equipment, liquidation of funding, contract development).	X	X	X
	Lack of human resource development.			X
	Absence of a skilled workforce to undertake UECs.	X	X	X
	Limited expertise and capacity for legal arrangements (e.g. IP rights, contracts, MoU, MoA).	X	X	
	Output sharing issues (e.g. unfair sharing of IP, patents and publications).	X	X	X
Cultural	Lack of interest in UECs amongst academic staff.	X	X	X
	Lack of established research culture.	X	X	X
	Lack of diversity in academic staff.	X		
	Heavy academic workloads.	X	X	X
	Lack of interest in UECs from businesses/organisations.	X	X	
	Academic researchers charging excessive rates.		X	
Relational	Divergence of objectives between stakeholders, along with competing priorities of academics.	X	X	X
	Divergence in output aspirations.	X	X	X
	Mistrust between universities and enterprises	X	X	
	Lack of networking opportunities.		X	
	Ineffective communication between universities and potential collaborators.		X	

Table IV. Summary of enablers of UEC in the partner countries

Category	Enablers	Country		
		Philippines	Sri Lanka	Thailand
Material	Scholarships, grants and funding	X	X	X
	Sufficient budgets	X		X
	Incentives for stakeholders to engage with UEC	X	X	
	Relevant and functional equipment and research facilities	X	X	X
	Technology transfer	X	X	X
	Infrastructure to facilitate UEC (e.g. centralised admin, IT systems)	X	X	X
Structural	Human capital development	X	X	X
	Faculty immersion	X	X	
	Curricular revisions (e.g. DR courses, industrial internships etc.)	X	X	X
	Relevant training courses (e.g. undergraduate, postgraduate and CPD)	X		X
	Human capital retention	X		
	Appropriate legal frameworks and policies	X	X	X
	Effective framework/policy implementation			X
	Clear and concise contracts (i.e. MoU, MoA)	X	X	X
Cultural	Promotion of research culture among academic staff	X		X
	Re-evaluation of teaching loads for academics (e.g. allocated time for UEC, reduced teaching loads)	X		X
	Clarification of university missions, objectives and values (i.e. research-focus, teaching-focus		X	X
Relational	Networking events	X	X	X
	Promotion of UEC (e.g. conferences, seminars, site visits and mass media)		X	X
	Formation and maintenance of collaborative networks (i.e. a database of previous, current and potential collaborators, interaction channels, i.e. science parks and incubators).		X	X
	Fair sharing of costs and benefits		X	X

Table V. Summary of good practices to UEC in the partner countries.

Country	Case Studies	Purpose	DR Aspect
Philippines	Formation of The UPLB Foundation Inc. (UPLB FI)	Performs services related to project development, implementation, monitoring and evaluation and has signed a memorandum allowing its access to UPLB's facilities and experts. Between 2005 and 2009, UPLBFI administered research funds totalling PhP 700M compared with only PhP 300M for central administration and provided bridging funds for projects whose disbursements were delayed.	Regulatory processes
	The triple helix partnership between the College of Management in the University of the Philippines Visayas, the Province of Capiz and Roxas City (Government), and Pueblo de Panay, Inc. (Industry), a real estate developer.	This arrangement was envisioned to provide continuing, long-term developmental solutions to jumpstart the economic development of Roxas City.	Establishing IPOs and reviewing IP policies
	The establishment of an IP Office (IPO)	The IPO can negotiate and resolve questions of IP ownership and facilitate the process from proposal review to commercialisation of products, which requires specific expertise and capacity for legal arrangements. The IPO also provides seminars and workshops on IP.	Establishing IPOs and reviewing IP policies
Sri Lanka	Disaster Management Centre consultancy and state universities	To consult Universities on the planning of coastal hazard analysis, Tsunami deluge guides and improvement of drought hazard studies.	Disaster Mitigation
	National Building Research Organization, Ministry of Disaster Management and the University of Moratuwa	Consultation projects for national development.	Disaster Mitigation
	Irrigation Department The Irrigation Department launched Climate Resilience Improvement Project (CRIP)Irrigation Department launched Climate Resilience Improvement Project (CRIP) with the collaboration of the Mahaweli Authority, Disaster Management Centre, governmental organisations, the University of Moratuwa and diverse	Improve climate resilience	Disaster Preparedness

***Table V.* Continued**

Country	Case Studies	Purpose	
Sri Lanka	Community and infrastructure resilience through a strategy by the University of Peradeniya, DMC and UNDP.	Development of Macro Seismic Hazard Zonation to communities and infrastructure for future natural disasters by proposing suitable locations for disaster evacuation centres determined by using past disaster experiences of the communities	Disaster mitigation and preparedness
		Structural stability improvement project of temporary evacuation centres	Disaster preparedness and response
	The University of Peradeniya collaboratively with DMC and UNDP.	A Flagship program commenced by the university of Ruhuna, and the University of Moratuwa, along with the plantation ministry and Dialog Axiata PLC, to upgrade the protected Agriculture sector of the country by introducing climate smart Agriculture program, introducing auto controlling mechanism for environmental and fertigation control systems connected through IoT platform.	Disaster preparedness
		In collaboration with the University of Central Lancashire, the Ministry of Social welfare and Primary Industries (MoSWPI) has initiated a program to develop a platform to facilitate University-Industry partnerships.	Disaster Mitigation
Thailand	Chiang Mai University (CMU) also has closely collaborated with the industries.	Promote development in innovative environment and energy; food and health; adult caring; creative Lanna; producing graduates who have morals, quality and skills to be a citizen of the world; conducting research for excellence and innovation; academic services that are beneficial for society; revenue for sustainable development and integrated management.	Disaster Mitigation
	Centre of Excellence in Natural Disaster Management	Research centre focused on conducting research in disaster management.	Disaster Mitigation

nongovernmental organisations.

Dialog Axiata plc and Millennium IT Pvt. ltd., the Mobile Communications Research Laboratory at the University of Moratuwa (UOM)	To develop the Disaster Early Warning Network (DEWN), the first mass alert early warning network in Sri Lanka.	Disaster Mitigation and Preparedness
The University of Moratuwa with the meteorological department	To develop automated rainfall monitoring systems.	Disaster Mitigation
The University of Moratuwa, together with the Wildlife Conservation Society in Sri Lanka	To build an "eleAlert" system to recognise and find elephant violations in elephant guard fences.	Disaster Preparedness

Table V. Continued

	Research collaboration among universities of Mahasarakham Universit, King Mongut's University of Technology North Bangkok, Nakhon Panom Universit, Rajamangala University of Technology Isan Khon Kaen Campus, the government agency of Internal Security Operations Command and industry of Arthit Machinery Co., Ltd.	Development of Cylindrical Drum Drying Technology with Infrared Radiation in Combination with Hot Air Discharges	Disaster Preparedness
	Chiang Mai University's GISTNORTH (Geo – informatics Regional Space and technology Centre of Northern Thailand), Faculty of Social Sciences together with the National Defence Technology Institute	Implemented the "Fire Forest Protection and Control by Small Drone Aircraft, Checking Fire Hot Spots" project. This project aimed to monitor fire hot spots in Mae Cham District, Chiang Mai Province	Disaster Mitigation
	GHG Evaluation and Mitigation Planning for Low Carbon City Case Study	Dan Sai Municipality and aimed to evaluate the city's greenhouse gas emissions	Disaster Mitigation
Thailand	Chiang Mai University's Geoinformatics Regional Space and Technology Centre of Northern Thailand, Faculty of Social Sciences, and the National Defence Technology Institute	The haze Pollution in Chiang Mai Project aimed to investigate the building resilience of Chiang Mai during the past ten years, between 2007 and 2016. The villagers' and communities' perceptions and coping strategies in the most affected areas are also examined.	Disaster preparedness

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