



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

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

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

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

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

56 **Methodology**

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

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

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3 71 indexed literature were sourced from local and national conferences, Academia.edu,
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5 72 government reports, policy papers, research reports, handbooks and manuals through official
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7 73 websites. This allowed crucial contextual information to be identified about DR-UECs in the
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9 74 partner countries to understand specific issues in DR-UECs and where and why further
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11 75 development and evaluation are required.
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15 76 All searches used a combination of search terms, including:

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18 77 ○ "University Enterprise Collaboration", "University-Industry Partnership",
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20 78 "University-Industry Collaboration", "University-Industry Linkage", and "Public
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22 79 Private Partnership"; AND
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24 80 ○ "Disaster Risk Management", "Disaster Risk", Disaster Mitigation; AND
- 25
26 81 ○ "Partner Country Name"
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30 82 According to the partner countries, some search terms were slightly modified to reflect
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32 83 their common use terms, e.g., "Academe industry partnership Philippines".
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36 84 Eligible literature published after 2000 was considered, focusing on literature from the
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38 85 last ten years to ensure up-to-date information. Relevance to the research aims, which included
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40 86 DR-UEC models, policies and initiatives, barriers and enablers, and good practices, was used
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42 87 to assess the eligibility of identified literature. The number of citations received by a literature
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44 88 source was considered an indicator of quality.
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48 89 Qualitative content analysis was applied to the country reviews to systematically
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50 90 identify and analyse common themes and concepts across the partner countries. Content
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52 91 analysis provides a systematic approach to data analysis, ensuring objectivity and reliability. A
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54 92 concept-centric approach was adopted to synthesise concepts that emerged from the country
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56 93 reviews and determine the point of data saturation, where no new concepts emerged (Webster
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58 94 and Watson, 2002). The concept-centric approach is considered superior to an author-centric
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95 approach as it enables the synthesis of concepts within and between articles (Webster and
96 Watson, 2002).

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

102 **Results**

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

106 **Current context**

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

109 ***Policies and Incentives***

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

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3 117 In Sri Lanka, the government started supporting UEC in 2005 when the university grants
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6 118 commission granted annual leave for senior university academics to work in enterprises
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8 119 (Wickramasinghe and Malik, 2018). In 2014, the Sri Lankan government introduced a triple
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10 120 tax deduction mechanism for enterprises engaged in research with universities
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12 121 (Wickramasinghe and Malik, 2018). The UGC also provided grant funding for UECs in various
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14 122 areas in 2015 (Wickramasinghe and Malik, 2018), including:

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18 123 ○ Innovations and research conducted in pure sciences.
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20 124 ○ Research that directly impacts society.
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22 125 ○ Post-doctoral researchers for academics.
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24 126 ○ National and international training programmes for academic staff.
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27 127 ○ Loans with favourable terms and conditions for academic staff to commercialise
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29 128 products derived from research and innovation (R&I).

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32 129 Thailand has developed comprehensive policies for DR, highlighting several strategies,
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34 130 sub-strategies, and DRM operational guidelines (Department of Disaster Prevention and
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36 131 Mitigation, 2015). The 12th National Economic and Social Development Plan (2017-2021)
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38 132 promotes research and development, intelligent technology, and entrepreneurial skills (Office
39
40 133 of the National Economic and Social Development Board, 2017). It also aims to increase
41
42 134 connectivity between major production sectors, small and medium enterprises (SMEs),
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44 135 research institutes and the academic sector (Office of the National Economic and Social
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46 136 Development Board, 2017). See Table I.

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51 137 **INSERT TABLE I HERE**

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54 138 ***DR-UEC Models***

55
56 139 The triple helix model (Etzkowitz and Zhou, 2017) highlights interactions between
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58 140 academia, industry, and government to promote economic and social development. However,
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1
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3 141 the Philippines adopted an extended version of the triple helix - the human capital development
4
5 142 model (Hermosura, 2019). This model elucidates interactions between universities,
6
7 143 government, and industries for economic and social development and provides practical
8
9 144 suggestions for successful collaborations (Hermosura, 2019). The Philippines review also
10
11 145 highlighted other frameworks, including the Student Internship Model, the Faculty Immersion
12
13 146 Model, the R&I Model, and Research and Extension Model.
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17 147 The student internship model promotes internships, on-the-job training, and work
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19 148 placements with enterprises to provide opportunities for students to acquire competencies for
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21 149 employment (Navarro, 2018). The faculty immersion model encourages academic researchers
22
23 150 to engage with enterprise projects to enhance their knowledge and skills (Abendan, 2017). The
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25 151 R&I model supports universities in facilitating the discovery of new knowledge, integrating
26
27 152 theories and skills, and applying relevant knowledge (Sevilleja, 2014). The research and
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29 153 extension model promotes the transfer of knowledge, skills, and technology from academic
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31 154 research to enterprises, fostering industry experience and innovative solutions (Hall et al.,
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33 155 2018).
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39 156 The student internship model promotes internships, on-the-job training, and work
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41 157 placements with enterprises for students to acquire competencies (Navarro, 2018). The faculty
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43 158 immersion model encourages researchers to engage with enterprise projects to enhance their
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45 159 knowledge and skills (Abendan, 2017). The R&I model supports universities in facilitating the
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47 160 discovery of new knowledge, integrating theories and skills, and applying relevant knowledge
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49 161 (Sevilleja, 2014). The research and extension model promotes the transfer of knowledge, skills,
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51 162 and technology from academic research to enterprises, fostering industry experience and
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53 163 innovative solutions (Hall et al., 2018).
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3 164 In contrast, the Thailand review utilised its UEC model to strengthen competitive
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6 165 production and promote technology-intensive and innovation-driven service sectors via
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8 166 knowledge transfer (Office of the National Economic and Social Development Board, 2017).
9
10 167 The UEC model has been implemented through government programs such as talent mobility,
11
12 168 collaborative research projects, industrial consultancy, economic innovation, university
13
14 169 business incubators, and entrepreneur creation projects (Schiller and Diez, 2007). However,
15
16 170 the primary focus of the UEC model was commercial gain rather than addressing DR (Tantane
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18 171 et al., 2018). See Table II.

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22 172 **INSERT TABLE II HERE**

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25 173 ***DR-UEC Barriers***

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27 174 The barriers identified encompass several factors that can hinder the development,
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29 175 maintenance or success of a DR-UEC. Material barriers refer to tangible obstacles related to
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31 176 the availability or accessibility of resources, infrastructure, equipment, facilities, or technology.
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33 177 Structural barriers are systemic factors and conditions often ingrained in social, economic,
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35 178 political, or organisational structures. Cultural barriers refer to the challenges arising from
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37 179 differences between cultural norms, values, beliefs, attitudes, and practices between
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39 180 organisations. Relational barriers refer to obstacles that arise in the relationships between
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41 181 stakeholders. Refer to Table III for a breakdown of each barrier and concept identified within
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43 182 each country review.

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49 183 **INSERT TABLE III HERE**

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52 184 ***DR-UEC Enablers***

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54 185 The country reviews highlighted several enablers of DR-UEC. These enablers, again,
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56 186 encompassed material, structural, cultural or relational concepts, alike the barriers discussed
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58 187 previously. However, enablers oppose barriers in that they facilitate the development,
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188 maintenance, or success of a DR-UEC. Refer to Table IV for a breakdown of each barrier and
189 concept identified within each country report.

190 **INSERT TABLE IV HERE**

191 **Good Practices**

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

197 **INSERT TABLE V HERE**

198 **Discussion**

199 ***Policies and Incentives***

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

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

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

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

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

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3 234 Instead, the emphasis is on transforming the education system to address unemployment
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5 235 and improve student abilities. Furthermore, UEC policies primarily target academic
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7 236 stakeholders, overlooking the potential benefits of DR-UECs for diverse stakeholders. This
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10 237 limitation impedes the progress of DR-UECs. Similarly, Sri Lankan UEC initiatives face
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12 238 implementation challenges, despite government efforts to enable DR-UECs.
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15 239 Thailand has developed comprehensive policies for DR, highlighting several strategies,
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17 240 sub-strategies, and operational guidelines (Department of Disaster Prevention and Mitigation,
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19 241 2015). However, there is a lack of specific policies guiding DR-UEC (National Science
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21 242 Technology and Innovation Policy Office, 2012).
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25 243 The country reviews indicate the need for cohesive DR-UEC policies and initiatives. The
26
27 244 Philippines focuses on DR education, Sri Lanka emphasises financial incentives, and
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29 245 Thailand's policies revolve around R&I. However, Thailand lacks programs supporting
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31 246 knowledge application or R&I for DR. Effective policy development and implementation are
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33 247 necessary to enable DR-UECs in all partner countries. As country reviews indicate, DR-UEC
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35 248 requires more funding, implementation, continuity, and long-term strategic planning,
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37 249 especially in DR. Moreover, the adequacy, availability, and DR relevance of partner countries'
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39 250 policies must be reviewed and updated to ensure their efficacy for enabling DR-UECs. Policy
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41 251 implementation issues also arise, necessitating effective implementation strategies, particularly
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43 252 in DR.
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49 253 ***DR-UEC Models***

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51 254 Efforts to utilise frameworks for DR-UEC are insufficient. UEC models lack depth and
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53 255 understanding of stakeholder dynamics, thus highlighting the need to understand the complex
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55 256 dynamics between stakeholders, including their roles and expected contributions to a DR
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57 257 collaboration. Furthermore, diversity in terms of the type and purpose of UECs needs to be
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3 258 improved, as most models focus solely on economic development rather than DR. As such,
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6 259 universities and other stakeholders could benefit from a systematic framing of UECs in DR.
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8 260 This will strengthen institutional procedures and practices under the scope of a singular DR-
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10 261 UEC framework.

13 262 Material Barriers

15 263 Country reviews highlight the need for increased investment, venture capital, and
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17 264 funding to overcome barriers in DR-UECs. In Thailand, a lack of research funding hinders R&I
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19 265 activities, while in the Philippines, the need for early-stage investors and venture capital
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21 266 impedes UEC initiation. Sri Lanka also faces inadequate funding from government strategies.
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23 267 These funding-related barriers impact various aspects of UECs, including research
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25 268 partnerships, curriculum development, student mobility, and technology development, all of
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27 269 which are essential for DR.

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33 270 Although the Thailand review did not comment, from the country reviews in the
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35 271 Philippines and Sri Lanka, a lack of effective marketing and promotion strategies and limited
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37 272 awareness of DR-UECs in universities and external enterprises were identified as barriers to
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39 273 DR-UECs. The Sri Lankan review highlighted the importance of universities recognising social
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41 274 obligations and collaborating with SMEs to achieve social impact. In some cases, social effects
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43 275 may be better achieved via collaborations with SMEs than larger organisations. For example,
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45 276 universities co-develop scientific, evidence-based programmes, government and business
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47 277 sectors provide resources, and SMEs implement them at the community level. The Philippines
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49 278 review emphasised the need for an effective marketing mechanism and clear collaboration
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51 279 guidelines to engage stakeholders in DR-UECs. Promoting innovation at SMEs through close
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53 280 networks and favourable infrastructure with universities, research institutes, and technology
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55 281 support centres was emphasised in both reviews as crucial for DR-UECs.
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3 282 Inadequate research facilities hindered DR-UECs in the Philippines and Sri Lanka.
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6 283 While the Thailand review did not mention this as a barrier, it emphasised the need to develop
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8 284 university research facilities to facilitate collaborations for DR. The Sri Lankan review
9
10 285 highlighted the necessity of improving university research and development facilities to
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12 286 support research, making universities better equipped for R&I projects in general and in the
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14 287 context of DR. Insufficient research facilities may deter potential partners, including
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16 288 enterprises and governmental agencies, from engaging in collaborative efforts with
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18 289 universities, as the lack of adequate facilities may compromise the quality of university
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20 290 capabilities.
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25 291 Absorptive capacity refers to identifying, integrating and commercialising external
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27 292 knowledge (Cohen and Levinthal, 1990). While the Philippines and Thailand reviews did not
28
29 293 discuss absorptive capacity, the Sri Lanka review highlighted that insufficient absorptive
30
31 294 capacity among collaborating enterprises hinders knowledge utilisation in DR-UECs. For
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33 295 instance, despite advanced research activities by Sri Lankan universities to enhance flood-
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35 296 related risk estimation, the lack of absorptive capacity resulted in local authorities not utilising
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37 297 the generated knowledge. Insufficient absorptive capacity limits stakeholders' ability to
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39 298 assimilate and apply knowledge effectively, impeding the translation of research findings into
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41 299 practical applications and hindering evidence-based strategies for DR.
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48 300 Material Enablers

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50 301 The Philippines and Thailand reviews emphasised science and technology scholarships,
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52 302 university R&I funding, and financial support for collaborating enterprises as enablers of DR-
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54 303 UEC. In Sri Lanka, funding primarily focuses on establishing start-ups by faculty members and
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56 304 students rather than DR activities. Funding for DR topics is available for strategic and
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58 305 fundamental research across all partner countries but is often integrated with broader themes
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3 306 such as health, societal, and environmental development. Researchers should align their DR
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6 307 research with the specific themes of funding agencies to facilitate DR-UECs.
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9 308 All countries report financial grants as enablers of DR-UECs, but clarity regarding their
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11 309 operation is necessary, including eligibility and accessibility criteria. Grants typically involve
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14 310 competition, favouring larger organisations based on their capacity, resources, and investment
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16 311 potential. This may create unfair competition, making it essential for universities to pay
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18 312 attention to SMEs in DR-UECs, especially in community contexts. Involving SMEs permits
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21 313 local knowledge utilisation to address community needs and enhance grassroots-level DR. This
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23 314 approach promotes local solutions, context-specific strategies, and community-driven
24
25 315 approaches to DR. Engaging SMEs in DR-UECs fosters inclusivity, diversifies expertise and
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27 316 resources, and promotes a more equitable DR-UEC landscape.
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31 317 All country reviews highlighted marketing mechanisms to encourage collaboration
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33 318 between potential stakeholders and universities. The Sri Lankan review discussed triple tax
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35 319 deduction mechanisms as incentives for collaborating enterprises. The Philippines review
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37 320 described flexible working arrangements and financial benefits for academic staff to incentivise
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39 321 their engagement with UECs. The Thailand review emphasised the importance of specific
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41 322 policies for promoting UEC without considering their absence as a barrier to UEC. However,
42
43 323 there were no documented specific incentives for potential stakeholders to engage with DR-
44
45 324 UECs. By offering targeted incentives and benefits tailored to the context of DR initiatives,
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47 325 policymakers can attract a broader range of stakeholders to participate in DR-UECs. This can
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49 326 introduce different perspectives, expertise, and resources contributing to innovative DR-UECs.
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56 327 Technology transfer refers to utilising available technologies for novel applications via
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58 328 cooperative activities between multiple stakeholders (Lane, 1999). The Sri Lankan review
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329 emphasised technology transfer as an essential enabler in DR-UECs. Similarly, the Thailand
330 review highlighted that knowledge and technology transfers between stakeholders are needed
331 for innovative DR solutions. Therefore, improvements to research facilities at universities in
332 terms of specialised research equipment, IT systems and professional supporting staff are
333 required to facilitate the development and implementation of effective DR-UECs.

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

341 ***Structural Barriers***

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

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

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3 353 bureaucracy and enable UECs. While this short-term solution is commendable, a long-term
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5 354 approach is necessary to facilitate DR-UECs. The Sri Lanka review revealed inflexible rules
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8 355 and guidelines for DR-UECs, leading to slow responses to industrial demand.
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11 356 Meanwhile, the Thailand review emphasised national and local government
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14 357 bureaucratic barriers. These barriers stem from conventional practices, a lack of adaptability,
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16 358 centralisation prioritisation over decentralisation, hierarchical structures, excessive paperwork,
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18 359 underutilisation of technology, and laborious regulations and inspections. Such barriers impede
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21 360 the efficiency required for successful DR-UECs. Therefore, all countries should revise their
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23 361 regulatory procedures to avoid bureaucracy as far as reasonably possible to make DR-UEC
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25 362 processes straightforward and accessible, especially for those unfamiliar with the intricate
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28 363 procedures.
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31 364 Whilst a lack of human resource development (HRD) was only highlighted in the
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34 365 Thailand review as a barrier to successful DR-UECs, poor HRD results in a lack of knowledge
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36 366 and competencies to effectively execute DR-UECs. This results in the absence of a skilled
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38 367 workforce to undertake DR-UECs, which was also reported as a barrier to DR-UECs in all
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41 368 country reviews. As such, insufficient HRD coupled with the absence of a skilled workforce
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43 369 simultaneously hinders the ability to plan and execute DR-UECs.
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46 370 The reviews in the Philippines and Sri Lanka highlight the lack of expertise and
47
48 371 capacity in handling legal arrangements for intellectual property rights, contract negotiations,
49
50 372 and the establishment of MoU and MoA, hindering DR-UEC development. The Thailand
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52 373 review did not identify deficient legal expertise as a barrier to DR-UECs but emphasised the
53
54 374 need to transition from informal to formal collaborations for enabling DR-UECs. Regardless,
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56 375 partner countries typically rely on informal contracts for DR-UECs, which often lack specific
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58 376 provisions for intellectual property rights, conflict resolution, and responsibility and output
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3 377 distribution. The lack of clarity and protection for intellectual property rights and challenges in
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5 378 negotiating fair and mutually beneficial contracts create hesitancy among potential
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7 379 collaborators. Insufficient expertise and capacity in legal arrangements may also cause
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9 380 collaboration delays and conflicts, further impeding DR-UECs.
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14 381 Output-sharing issues hindered DR-UECs in partner countries. The Thailand review
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16 382 stressed the importance of clarity regarding industry expectations, staff capabilities, resource
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18 383 investment, and equitable sharing of revenue and intellectual property benefits. However, the
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20 384 review noted an inherent disparity due to the prevailing focus on financial outputs for
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22 385 enterprises and social development for non-profit stakeholders. Industries prioritise fast
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24 386 commercial results and short-term outcomes, while universities concentrate on basic research
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26 387 and academic publications, as highlighted in the Philippines and Thailand reviews. This
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28 388 misalignment poses challenges for collaboration, as firms seek immediate returns and clear
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30 389 contributions, while university researchers are motivated to publish their research results
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32 390 quickly.
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38 391 Moreover, The Sri Lanka review raised concerns about universities' legitimate power
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40 392 to commercialise intellectual property rights (IPR). The University Act of 1978 primarily
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42 393 focuses on teaching and education, with limited provisions for research commercialisation.
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44 394 Consequently, the absence of clear regulations on ownership of inventions from public research
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46 395 and development conducted at universities and research institutes further complicates the
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48 396 matter. Consequently, private sector engagement and investment in DR-UECs may be deterred.
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52 397 ***Structural Enablers***

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55 398 All reviews emphasised the importance of investing in human resources to develop the
56
57 399 necessary skills to undertake UEC in general and DR contexts. HRD is considered to enable
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59 400 successful UECs (Vea, 2014). Specifically, the Philippines review suggested that universities
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3 401 must plan and observe how faculty immersion in enterprise enables UECs. Faculty immersion
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5 402 can allow academics to gain more experience in enterprise to situate theory into practice by
6
7 403 integrating approaches, theories, and methods from across disciplines (Hall et al., 2018).
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11 404 The Sri Lankan review found academic staff commonly fostered university-enterprise
12
13 405 partnerships through student internships and consultancy. Internship programs create
14
15 406 collaborations between enterprises and universities, resulting in shared benefits (Weerasinghe
16
17 407 and Jayawardane, 2018). For instance, recruiting trained graduates and postgraduates expands
18
19 408 networks within academia and enterprises, facilitating the adoption of new approaches,
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21 409 methods, and techniques. Additionally, academic consultancy offered by university faculty
22
23 410 can enhance long-term partnerships by better understanding enterprises' aspirations,
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25 411 objectives, and values. From an enterprise perspective, collaborative research activities foster
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27 412 innovation and the development of product prototypes, which rely on academic input.
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34 413 The Thailand review also recognises HRD as an enabler of UEC and outlined several
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36 414 educational approaches that could be utilised for HRD, including:
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- 40 415 ○ Undergraduate/postgraduate programs (e.g., M.Sc. in Disaster Analysis,
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42 416 Management and Mitigation by the University of Colombo, postgraduate
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44 417 diplomas and graduate programs for PhD students by the University of
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46 418 Peradeniya).
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48 419 ○ Final projects/ dissertations (e.g., Module offered in Disaster Management under
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50 420 the M.Sc. in Project Management by the University of Moratuwa).
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52 421 ○ Continued professional development.
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54 422 ○ Short DR courses.
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3 423 While DR education can facilitate DR-UECs, the multidisciplinary nature of DR presents a
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5 424 challenge for universities in preparing students for DR careers through formal curriculum
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7 425 delivery. Therefore, adopting a collaborative approach to curricular revisions is beneficial to
8
9 426 ensure students possess both a theoretical understanding and practical skills required to meet
10
11 427 entrepreneurial demands in DR (Gotangco et al., 2020). Conversely, entrepreneurs face the
12
13 428 challenge of developing business models that effectively integrate DR investment with robust
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15 429 business continuity plans (Lorenzana and Sario, 2016). However, universities can contribute
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17 430 by researching to inform business continuity planning for DR projects.
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23 431 While the Sri Lanka and Thailand reviews do not address human capital retention, the
24
25 432 Philippines review emphasises its significance in DR-UECs. Retaining human capital fosters
26
27 433 a culture of expertise and experience within organisations. Enhancing human capital retention
28
29 434 cultivates specialised knowledge and skills, creating a valuable pool of expertise for future
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31 435 collaborations. Consequently, human capital retention supports establishing long-term
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33 436 professional relationships and networks, ensuring the continuity of DR-UECs.
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39 437 The Philippines review highlighted the importance of developing rules, regulations, and
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41 438 policies for UECs to facilitate the establishment and sustainability of successful DR-UECs.
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43 439 Similarly, the Sri Lankan review underscored the role of universities in collaborating with the
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45 440 government and relevant institutions to formulate rules, regulations, and policies for UECs.
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47 441 Therefore, revising existing UEC policies is crucial to promote effective collaborations.
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49 442 However, adopting a cooperative approach among relevant stakeholders can further enhance
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51 443 DR-UECs by considering all stakeholders' interests in the ensuing policies.
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56 444 The National Policy and Plan of Science, Technology, and Innovation No.1 (2012-2021)
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58 445 in Thailand highlighted the presence of unclear policies, insufficient contribution to global
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3 446 research and innovation in the context of disaster resilience (DR), and unpreparedness of
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6 447 communities for disaster impacts as barriers specifically affecting DR-UECs. The Thailand
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8 448 review further explained that updated policies accommodating all stakeholders would
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10 449 facilitate DR-UECs. Therefore, it would benefit all countries to assess the adequacy,
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12 450 upgradability, availability, and relevance of their DR-UEC policies to various stakeholders,
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14 451 both in general and specifically for DR-UECs. Moreover, utilising policy instruments to
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16 452 ensure the effective implementation of DR-UEC policies can further promote the
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18 453 establishment and sustainability of successful collaborations (OECD, 2015; OECD., 2019).
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23 454 In all country reviews, policy-related barriers related to intellectual property rights (IPR)
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25 455 were identified. The reviews proposed innovative strategies to address these issues. The
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27 456 Thailand review emphasised the need for considerations regarding intellectual property to
28
29 457 empower collaborations, while the Sri Lankan review underscored the importance of clearly
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31 458 defining and enforcing rules for IPR. The Philippines review highlighted the significance of
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33 459 academia developing IP policies and guidelines, specifically for IP disclosures, contract
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35 460 arrangements, and license agreements. Implementing such measures will enable DR-UECs.
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41 461 The Philippines has established IP offices (IPO) which are government agencies tasked
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43 462 with implementing IP policies and strengthening IP rights within the country (Cruz et al.,
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45 463 2021). IPOs also play a crucial role in facilitating the transition from proposal to
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47 464 commercialisation by offering specialised expertise (Cruz et al., 2021). Establishing IPOs has
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49 465 proven effective in promoting DR-UECs by addressing ownership concerns, providing
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51 466 updates, and enabling exclusive licenses when substantial investments of time and resources
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53 467 are necessary for technology commercialisation.
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3 468 All country reviews emphasised the significance of clear and concise agreements in
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5 469 enabling DR-UECs. Such agreements, like MoUs, establish strong bonds between UECs with
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7
8 470 a high level of commitment (Alagao, 2014). This commitment cultivates trust, cooperation,
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10 471 and accountability, which is crucial for facilitating effective DR-UECs. Moreover, well-
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12 472 defined agreements encompassing elements like intellectual property rights, ownership,
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14 473 revenue sharing, and commercialisation processes help prevent potential conflicts related to
15
16 474 commercialisation (Schaeffer et al., 2020). Furthermore, when promptly established, clear
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18
19 475 and concise agreements ensure commercial success and appropriate returns (Guimón, 2013).
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23 476 ***Cultural Barriers***

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25 477 All reviews highlighted the lack of entrepreneurship as a barrier to DR-UECs. In
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27
28 478 Thailand, it was observed that the absence of university policies encouraging staff involvement
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30 479 in industry activities within collaborative initiatives hindered entrepreneurial drive. The lack
31
32 480 of explicit support from higher education institutions and government entities limited the
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34 481 motivation and incentives for academic staff to engage in UECs. Similarly, the Sri Lanka
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36 482 review emphasised that universities' reluctance to collaborate with industry challenged the
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39 483 establishment of DR-UECs.
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43 484 The Sri Lanka review identified several factors contributing to the lack of
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45 485 entrepreneurial drive among academics, including low confidence, insufficient motivation, a
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47 486 scarcity of entrepreneurial spirit, and a perception that collaborating with industry is beyond
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49
50 487 the role of academic researchers. Consequently, insufficient entrepreneurial drive among
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52 488 faculty members can impede universities' involvement in collaborating with industries for DR
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54 489 development. Similarly, the Philippines review emphasised that a lack of entrepreneurial drive
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56 490 created barriers to DR-UECs in the country. As discussed by Vea (2014), the limited interest
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59 491 of faculty members in UEC projects can be attributed to the cultural trait of "fear of failure"
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3 492 prevalent in Filipino society. The cultural perception of avoiding failure fosters a conservative
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6 493 academic environment prioritising traditional research and teaching activities over UEC
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8 494 projects. Faculty members may perceive UECs as high-risk ventures that could divert their
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10 495 attention and resources from their core responsibilities. Consequently, the limited interest of
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12 496 faculty members in UEC projects hampers DR-UECs.

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16 497 The Philippines and Sri Lanka review also highlighted the lack of interest from external
17
18 498 stakeholders in UECs as a barrier. While the Thailand review did not mention this barrier, the
19
20 499 Philippines review explained that the high cost associated with UECs discourages potential
21
22 500 stakeholders. Additionally, the Sri Lanka review suggested that the excessive rates for
23
24 501 academic expertise act as the main deterrent. In Sri Lankan universities, guidelines allocate
25
26 502 funds to the university for its resources and facilities, resulting in minimal profit for the
27
28 503 researcher. For instance, universities charge 46% of the total university overheads for academic
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30 504 consultancy. Opaque regulations further impede cost transparency (Randil et al., 2018).
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32 505 Consequently, this may diminish enterprise interest in DR-UECs and hinder DR initiatives.
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37 506 All the country reviews highlighted heavy academic workloads as a substantial barrier
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39 507 to DR-UECs. Specifically, the Thailand review emphasised that DR-UECs are hindered by the
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41 508 constraints arising from the heavy workload of university staff and the inadequate focus on
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43 509 industry needs. In Thailand, the emphasis placed by university administrators on research
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45 510 publications and outputs often results in academic staff being prioritised for research-related
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47 511 responsibilities over other obligations. Similarly, the Philippines review highlighted the
48
49 512 importance of balancing research and teaching, as current academic workloads could be more
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51 513 conducive to collaborative activities. In Sri Lanka, the review highlighted that the heavy
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53 514 academic workload faced by academic staff often leaves them with limited time to undertake
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3 515 industry-related research. This constraint hinders their ability to actively participate in UECs
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6 516 and engage in collaborative projects with industries.
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9 517 Although neither the Sri Lanka nor Thailand reviews acknowledged the role of diversity
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11 518 in UECs, the Philippines emphasised the lack of diversity in academic staff as a cultural barrier
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13 519 to DR-UECs. In the Philippines, restricting full-time professorial positions to citizens limits
14
15 520 the introduction of diverse worldviews in classrooms (Vea, 2014). This restriction hampers the
16
17 521 opportunity for students and academic staff to gain exposure to a broader range of perspectives
18
19 522 and insights, including those related to DR. The absence of diverse worldviews may restrict
20
21 523 the depth and breadth of discussions and hinder the understanding of DR issues. Furthermore,
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23 524 the limitation on foreign professionals in full-time positions may impact the involvement of
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25 525 multinational companies in R&I projects.
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31 526 The reliance on mother companies for R&I initiatives indicates a potential gap in
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33 527 accessing external expertise and resources locally (Alagao, 2014). Without the active
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35 528 participation of multinational companies in DR projects, there may be missed opportunities for
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37 529 cross-disciplinary collaboration, technology transfer, and the application of international
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39 530 practices in DR. Involving diverse stakeholders and transferring knowledge from experts in
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41 531 relevant fields strengthens the overall understanding of DR and promotes the development of
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43 532 DR-UECs. Therefore, universities should consider strategies to increase diversity among
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45 533 academic staff and expand faculty knowledge and expertise in DR.
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50 534 ***Cultural Enablers***

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53 535 Whilst the Sri Lanka review did not consider promoting research culture as an enabler
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55 536 of DR-UECs, both the Philippines and Thailand reviews highlighted that universities should
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57 537 identify viable means for promoting research culture amongst academic staff and enterprises
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59 538 to stem interest in DR-UECs. The Philippines and Thailand reviews suggested various
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3 539 approaches to promoting research culture. These include providing financial incentives for
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5 540 research, upgrading facilities, and workload adjustments to accommodate research
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7 541 commitments. However, it is essential to note that promoting research culture in the context of
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9 542 DR-UECs requires a multifaceted approach beyond financial incentives and infrastructure
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11 543 improvements. Therefore, adopting a heuristic approach that combines different elements, such
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13 544 as funding, workshops, networking events, and faculty immersions, is necessary to provide
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15 545 opportunities for knowledge sharing, collaboration, and awareness of DR-UECs.
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21 546 Whilst the Sri Lanka review highlighted heavy academic workloads as a barrier to UEC,
22
23 547 they did not consider the re-evaluation of teaching loads for academics as an enabler of DR-
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25 548 UECs. The Philippines review explained that it is crucial to ensure that academics have
26
27 549 sufficient time and resources to collaborate alongside their teaching responsibilities. The
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29 550 Thailand review highlighted the importance of balancing the workload of academic staff to
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31 551 strengthen staff capabilities for DR-UECs. Evaluating workloads will allow academics to
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33 552 dedicate time to DR-UECs.
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39 553 Although the Philippines review did not comment on the role of university missions,
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41 554 objectives, and values, the Sri Lanka and Thailand review highlighted its role in enabling and
42
43 555 facilitating DR-UECs. The Thailand review highlighted the importance of a research-focused
44
45 556 environment in building a research culture to strengthen staff capabilities for DR-UECs. The
46
47 557 Thailand review explained that by prioritising research and providing the necessary resources,
48
49 558 support, and incentives, universities can create an environment that encourages DR-UECs.
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54 559 As noted in the Sri Lanka review, many universities adhere to a traditional educational
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56 560 framework that prioritises large-scale lecture delivery to undergraduate students, particularly
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58 561 in job-oriented programs. While this framework effectively caters to the demand for graduates
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1
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3 562 by multinational and large organisations, it may not foster a culture of research and innovation
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5 563 or provide collaboration resources. Additionally, the review highlights that academics
6
7 564 primarily engage in research activities to enhance their own profiles rather than focusing on
8
9 565 collaborative initiatives that address societal challenges like DR. Thus, realigning resource
10
11 566 allocation, individual academic objectives, and the broader objectives of government initiatives
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13
14 567 can facilitate DR-UECs.

18 568 ***Relational Barriers***

21 569 All country reviews identified divergent objectives and output aspirations as a relational
22
23 570 barrier to DR-UEC. The Sri Lanka review highlighted conflicts related to IP rights and
24
25 571 ownership as a significant hindrance. Similarly, the Philippines review pointed out that a
26
27 572 divergence of objectives and output aspirations among stakeholders often emerged, with
28
29 573 enterprises prioritising fast commercial results. Likewise, the Thailand review emphasised the
30
31 574 importance of clarity and alignment regarding industry expectations and staff capabilities as a
32
33 575 barrier to DR-UECs. Additionally, the review identified the absence of a clear framework for
34
35 576 the fair sharing of benefits, including revenue and intellectual property, as a further hindrance
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37 577 to DR-UECs.

42 578 The Philippines review highlighted that mistrust between industry and academia affects
43
44 579 their engagement in R&D partnerships. Abendan (2017) noted industry concerns about
45
46 580 universities stealing proprietary information, while universities are wary of industries poaching
47
48 581 their faculty. Similarly, the Sri Lanka review emphasised the presence of mistrust between
49
50 582 industries and universities, with enterprises expressing reservations about the university
51
52 583 system's technical capabilities and supervisors' skills. Although the Thailand review did not
53
54 584 address mistrust between stakeholders, it is worth noting that mistrust impedes sharing of
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56 585 knowledge, expertise, and resources, thereby hindering DR-UECs.

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3 586 The Sri Lanka review highlighted a need for networking opportunities as a barrier to
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6 587 DR-UECs. The Sri Lanka review explained that there is no extant technique to collaborate with
7
8 588 universities to enterprises rather than personal contacts retained by stakeholders. More
9
10 589 networking opportunities must be available to allow universities and enterprises to discover
11
12 590 and engage in potential DR-UECs. However, The Philippines and Thailand reviews did not
13
14
15 591 acknowledge this relational barrier to DR-UECs.

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18 592 Ineffective communication between stakeholders was also revealed as a relational barrier
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21 593 to UEC in the Sri Lanka review. Whilst the Philippines and Thailand reviews did not discuss
22
23 594 effective communication, it is acknowledged that effective communication is essential for
24
25 595 successful DR-UECs. Ineffective communication, on the other hand, can lead to
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27
28 596 misunderstandings between stakeholders regarding objectives and expectations, resulting in
29
30 597 conflict during collaborations. Furthermore, ineffective communication can result in
31
32 598 ineffective knowledge transfer, thus impeding DR-UECs.

35 599 ***Relational Enablers***

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38 600 All country reviews highlighted the importance of networking events for developing
39
40 601 DR-UECs. Whilst the Thailand review highlighted networking activities as a good practice for
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42 602 DR-UECs, the Philippines and Sri Lanka reviews highlighted specific networking events and
43
44 603 activities that can enable DR-UECs. The Philippines review, as discussed by Liew, Shahdan,
45
46 604 and Lim (2013) and echoed by Vea (2014), highlights the pivotal role of networking as an
47
48 605 enabler for successful DR-UECs. The review emphasises the importance of student internships
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51 606 and faculty immersion to enable academics to connect and network with professionals and
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54 607 practitioners outside of universities. Moreover, the Philippines review promotes their research
55
56 608 and extension model to facilitate the transfer of knowledge and skills for DR.

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3 609 Similarly, the Sri Lanka review, drawing upon the work of Wickramasinghe and Malik
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5
6 610 (2018), highlighted several mechanisms that facilitate DR-UECs. These mechanisms include
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8 611 academic consultancy to industry, personal networking through conferences and seminars
9
10 612 involving industrial personnel, and part-time secondment of academic staff to industry. The
11
12 613 review also recommends targeted partnership initiatives, such as integrating DR through
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14 614 corporate social responsibility and fostering grassroots-level networking for disaster
15
16 615 management. Networking events can catalyse DR initiatives by generating interest and
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18 616 engagement in the field. Moreover, these events not only facilitate connections and interactions
19
20 617 between universities and industry but also have the potential to encourage corporate social
21
22 618 responsibility.
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26
27 619 The Philippines review did not highlight promotion as an enabler of DR-UEC. However,
28
29 620 both the Sri Lanka and Thailand reviews emphasised the importance of effective promotion in
30
31 621 fostering the development of DR-UECs. The Sri Lanka review highlighted the role of
32
33 622 government policies in promoting UECs, which included initiatives such as granting annual
34
35 623 leave for senior academics to work in enterprises, offering tax deductions for collaborations
36
37 624 between universities and enterprises, and funding support for UECs. However, these initiatives
38
39 625 were not explicitly targeted at DR-UECs, and their effectiveness in promoting DR-UECs
40
41 626 remains to be determined. Similarly, the Thailand review described government policy efforts
42
43 627 to promote the utilisation of sciences and technologies, R&I, and budget allocation for DR.
44
45 628 The review also emphasised using conferences, seminars, site visits, and mass media to
46
47 629 promote and raise awareness of DR-UECs among potential stakeholders. Implementing
48
49 630 various promotional strategies can enhance engagement with DR-UECs.
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55 631 The Sri Lanka and Thailand reviews highlighted forming and maintaining collaborative
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57 632 networks as an enabler for DR-UECs. Sri Lanka and Thailand have implemented incubators
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59 633 and science parks as strategic initiatives to foster collaborative networks for DR-UECs. These
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3 634 platforms assist the formation and maintenance of start-ups by professors, students,
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5 635 researchers, and entrepreneurs, providing them with vital support mechanisms for enterprise
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7 636 growth and development. Moreover, the Thailand review emphasised the importance of
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9 637 establishing comprehensive databases encompassing past, current, and potential stakeholders.
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11 638 Such databases provide a platform for identifying suitable stakeholders, aligning objectives,
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13 639 and fostering DR-UECs based on shared goals and necessary capabilities. However, the
14
15 640 Philippines review did not discuss forming and maintaining collaborative networks as enablers
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17 641 of DR-UECs.
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22 642 Although not mentioned in the Philippines review, the Sri Lanka and Thailand reviews
23
24 643 highlighted the fair sharing of costs and benefits as enablers of DR-UECs. Establishing formal
25
26 644 agreements that outline the equitable distribution of costs and benefits can contribute to
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28 645 transparency and trust among stakeholders. This promotes a sense of fairness and ensures that
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30 646 all parties involved in DR-UECs are appropriately incentivised and rewarded, enhancing the
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32 647 overall effectiveness and sustainability of DR-UECs.
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36 648 ***Good Practices***

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40 649 Although all country reports highlighted several case studies to evidence good practice
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42 650 in DR-UECs, the Philippines report did not explicitly evidence case studies related to DR-
43
44 651 UECs. Instead, it presented instances of good practice regarding distributing funds and
45
46 652 establishing policies and specialised units for intellectual property regulations. On the other
47
48 653 hand, the Sri Lanka and Thailand reviews highlighted several practical case studies in
49
50 654 enhancing disaster mitigation and preparedness. That said, none of the partner countries
51
52 655 evidenced cases of DR-UECs for disaster response and recovery. As such, DR-UECs should
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54 656 consider disaster mitigation, preparedness, response, and recovery initiatives to achieve DR
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56 657 across the partner countries.
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658 **Conclusions**

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

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

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

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3 683 DR-UECs. Policymakers should revise marketing and incentive strategies to incentivise
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5 684 stakeholders to conduct DR-UECs. In turn, this will facilitate the engagement of a broader
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7 685 range of stakeholders to formulate innovative solutions to various aspects of DR.
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11 686 There are steps that universities and other stakeholders can take to facilitate positive
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13 687 stakeholder relationships to mitigate any mistrust and prevent disputes that may arise in a DR-
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15 688 UEC. Formal agreements can be established before the collaboration begins. Further, the
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17 689 development and implementation of IP rights/ownership legislation will ensure the fair sharing
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19 690 of benefits that arise from collaborative DR projects. Furthermore, policymakers should revise
20
21 691 regulatory procedures to avoid bureaucracy to simplify DR-UEC processes, especially for
22
23 692 those unfamiliar with the procedures involved. Although each partner country highlighted
24
25 693 examples of several successful UECs, future research is needed to understand the strength and
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27 694 reach of collaborative networks for DR initiatives in the partner countries.
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32 695 While successful UEC examples exist, further research is needed to understand the
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34 696 strength and scope of collaborative networks in DR initiatives. Empirical research is necessary
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36 697 to explore the practical application and feasibility of identified barriers and enablers in real-
37
38 698 world contexts. Integrating theoretical and practical perspectives can lead to the development
39
40 699 of a comprehensive heuristic framework that guides the initiation and sustenance of successful
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42 700 DR-UECs. This framework will encompass theoretical enablers, barriers, good practices, and
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44 701 a practical understanding of initiating and maintaining successful DR-UECs. It can serve as a
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46 702 valuable tool to inform the process of initiating and maintaining successful DR-UECs.
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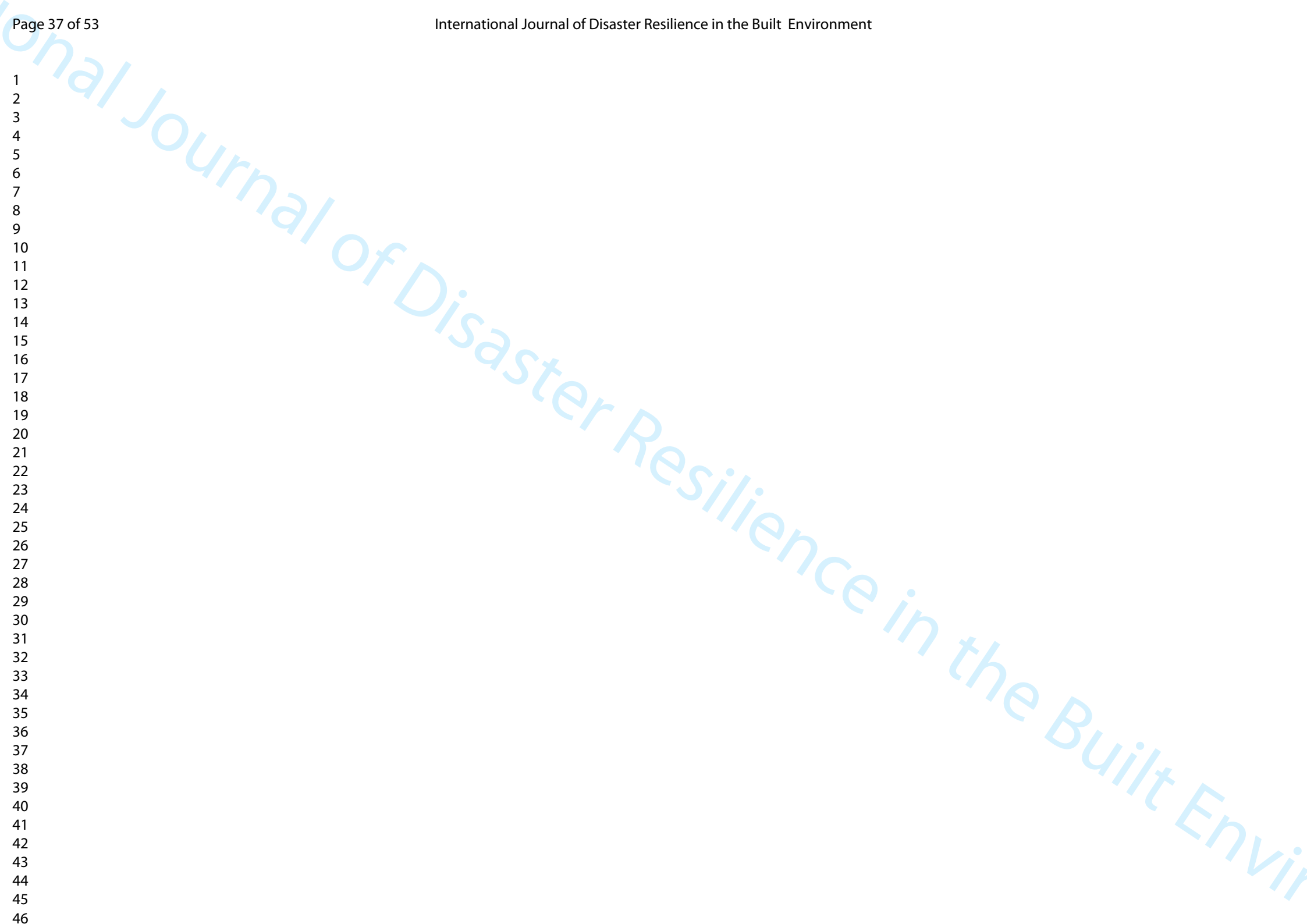
Table I. Policies and initiatives for UEC in each partner country

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. The Sri Lankan government began to support university enterprise collaboration from 2005	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. 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.

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International Journal of Disaster Resilience in the Built Environment

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 Mongkut'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	

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15 16 17 18 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	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.
19 20 21 22	UEC involving academic, government, private, and local community sectors.	

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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
Cultural	Clear and concise contracts (i.e. MoU, MoA)	X	X	X
	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 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 nongovernmental organisations.

Country	Case Studies	Purpose	
	Community Dialogue for Infrastructure Resilience through a Strategy by the University of Moratuwa (UOM) and UNDP.	Develop the development of Mac Disaster Early Warning Network (DEWN) in the first 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
	The University of Moratuwa with the meteorological department	Feasibility improvement project of temporary evacuation centres	Disaster preparedness and Response
Sri Lanka	The University of Moratuwa, together with the Wildlife Conservation Society in Sri Lanka	A Flagship program commenced by the university of Ruhuna, and the University of Moratuwa, along with the plantation ministry and Dialog Axiata PLC to build an "eleAlert" system to recognise and find elephant violations in elephant guard fences.	Disaster preparedness
	The University of Peradeniya collaboratively with DMC and UNDP.	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

Table V. Continued

	Research collaboration among universities of Mahasarakham Universit, King Mongkut'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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