Applying Information Technology for Cross Border Disaster Risk Reduction Through Public Private Partnership Amidst COVID-19

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Abstract. The crisis of humankind, the COVID-19 pandemic, brought the threats but the opportunities toward collaboration on disaster risk reduction (DRR) through public private partnership (PPP) over sustainable development goals (SDGs) at global landscape. Under the direct impact to the social-cultural, political and economic interests, we are in time for change. In the past decade, the concept of PPP has been widely applied to facilitate supply chain resilience after the 2011 the Great East Japan Earthquakes and Tsunami on business continuity planning (BCP). The highlight in 2019 is to implement PPP on climate extremes capacity building programme "Plant Back Better (PBB)" initiatives for Livelihood Continuity Planning (LCP) through the smart technology and climate-smart agriculture across the border for international collaborations. How to look out each other in distance will be the future challenge amidst COVID-19. Consolidating 10 years of implementation findings, this paper developed a cross-border PPP approach on utilizing smart technology for better governance on emergency preparedness and building a stronger partnership engagement on real-time basis. On the digital transformation era, this paper illustrated how we came across the barrier of language, cultural difference and border-control to deliver the DRR mission through PPP amidst the COVID-19 crisis on a common operational picture for emergency preparedness, response and recovery.

Keywords: Emergency preparedness · DRR · PPP · BCP · SDGs · COVID-19

1 Background Development of Public Private Partnership for Collaboration

1.1 A Milestone for Promoting the Public Private Partnership for Emergency Preparedness

Asia-Pacific Economic Cooperation (APEC) [1] region suffered from 70% of global natural disasters over USD100 billion in related losses annually [2]. Since the 2011

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Great East Japan Earthquakes and Tsunami [3], global value chains (GVCs) [4] and supply chain resilience continued to be discussed from a variety of dimensions. APEC took note of a string of costly earthquakes and extreme weather and called for projects on sustainable growth in the world's most natural disaster-affected region to improving business resilience from 2011. The networking engaged APEC collaboration on cross-cutting issues and kick-off a series of project on Business Continuity Planning (BCP) [5] (SMEWG [6], EPWG [7]), Digital Resilience in 2013 (SMEWG, EPWG), 2015 Critical Infrastructure Resilience and Safety [8] (CTWG [9], EPWG), the 7 Principles for Supply Chain Resilience in 2017 (TPTWG [10], EPWG), and Financial Risk Financing (FMP [11]-DRFI [12], EPWG) across boundary.

Meanwhile, through public and private partnership (PPP) [13], APEC invested in promoting BCP for disaster resilience and delivered train-the-trainer workshops on the project output "Guidebook on SME Business Continuity Planning in APEC" [14] based on ISO22301 [15] but SMEs/MSMEs [16] user friendly. The guidebook illustrated 10 easy steps for SMEs/MSMEs on implementing BCP available online in 7 languages, English, Chinese, Spanish, Japanese, Thai, Indonesian and Vietnamese covering 40% of the world population [17]. With the fruitful outcomes and deliverables, APEC Emergency Preparedness Capacity Building Center (EPCC) [18] host "APEC Summit on Resilience" in Nagoya, Japan at Nagoya Institute of Technology (NiTech) [19] to brainstorming the next step for DRR in April 2017.

1.2 Information-Based Preparedness and Scenarios

The concept of information-based preparedness and scenarios for cross-border PPP has been addressed as the concluding summary of APEC Summit on Resilience. It explored the idea of "Operational Framework for Regional Collaboration on Resilience" for strengthening global supply chains through PPP as shown in Fig. 1 [20]. Connecting the "business" to a "Business Continuity Management (BCM)-based supply chain", is aimed at keeping the deadline of shipment on time through cross-border join virtual operation, exercises and drills. It is anticipated to synergise work on regional BCP/BCM efforts for multi-sectorial collaborations at regional level.

In this context, developing information-based preparedness and scenario tools became top priority to ensure stakeholders are on the same page for emergency preparedness. Agreed upon on Geo-spatial distribution maps of lifeline systems, event scenarios, and critical infrastructure resilience in a Wi-Fi readiness environment can help to implement active PPP involvement and voluntary efforts, we pictured a framework for conducting the train the trainer workshop in real-time or near real-time basis for building a keen PPP at the regional level. Streamlining the interdisciplinary countermeasures and cross-cutting issues, the real-time situation assessment for scenario simulation or emergency response/preparedness can take advantage of cloud computing/technology for information exchange and sharing in a timely manner.

Under the Coronavirus Disease 2019 (COVID-19) Pandemic impact [21] in 2020, the tangible and intangible productions and services are interrupted due to lockdown, border control and quarantine in a great deal. The cross-border PPP approach for disaster risk reduction (DRR) on virtual operations and drills turnout to be a no-touch solution for delivering emergency preparedness and response. To further support cross-border

cascading disasters interactive with COVID-19, the long-term objectives are set to deliver a board spectrum activities from policy making to capacity build at the regional level through smart technology. Thus, engaging regional institutes to deliver the virtual single operational picture for emergency response and preparedness on supply chain resilience is the ultimate goal for promoting BCP amidst COVID-19 spreading.

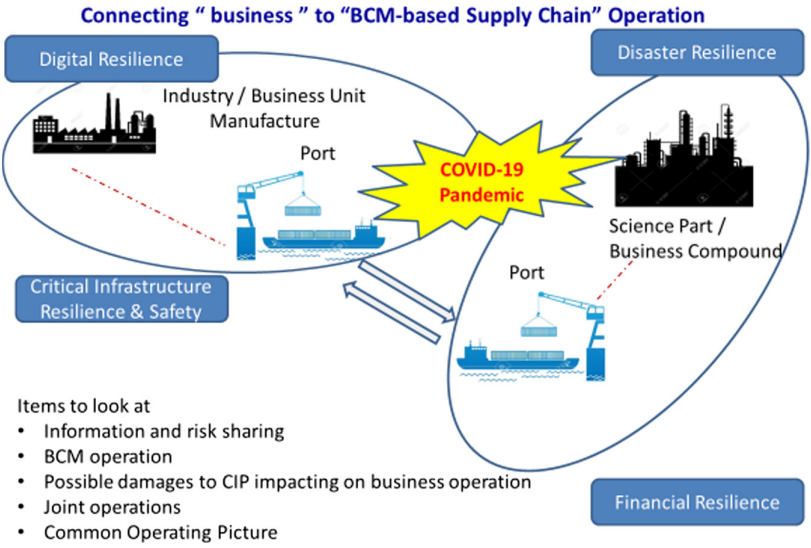

Fig. 1. Operational framework for regional collaboration on resilience, Source: APEC EPCC

2 Cross-Border PPP Approach for New Normal on Climate Extremes

2.1 Plant Back Better for Food Security

The 2019 United Nations' report on Sustainable Development Goals (SDGs) [22] revealed the impact on the climate related disasters. From 1998 to 2017, seventy-seven percent of the estimated direct economic losses (US$3 trillion) are from disasters. It is about a 1.5 time rise compared to the one from 1978 to 1997. Estimated 1.3 million death toll for climate related and geophysical disasters. How to provide the rapid growing global population with economic access to sufficient, safe, nutritious and quality food as well as better livelihoods of millions of rural people, mainly small farmers, particularly women on the vegetable plantation? APEC recognized the urgent need of resilient infrastructure, early warning systems, emergency-actionable plans and countermeasures for better preparedness and recovery to tackle the constant threat of extreme events, earthquakes, floods and natural disasters. Thus, APEC called for climate adaptation countermeasures. In 2019, EPCC demonstrated the Plant Back Better (PBB) initiative [23] as one of the cross border PPP model to function as the countermeasure of food security

over climate extremes to boost microeconomic momentum. The PBB project mainly focused on promoting capacity building by adopting smarter and disaster-resistant plantation of flowers and vegetables in the rural area on local knowledge over the local social network.

2.2 APEC PBB on Cross-Border PPP Approach

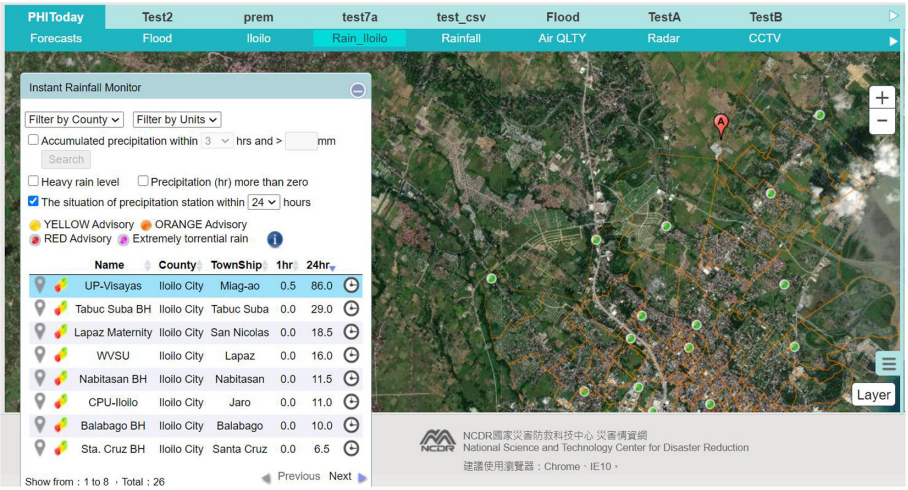

Fig. 2. Hazard sensor network, Source: NCDR

To further engaging key stakeholders as a whole society for implementing PBB and map out a pathway of sustainable and resilient developments, the Iloilo City Government has installed 26 multi-hazard sensor network in partnership with Taiwan's National Science and Technology Center for Disaster Reduction (NCDR) [24] (Fig. 2). APEC EPCC for delivering regional capacity building engaged a cross-border PPP project over Taiwan New South-bound Policy [25] and the Iloilo City Government in the Philippines to constantly look out its APEC PBB project [26] and monitored the situations of natural disasters the situation of natural disasters and climate extremes in the long run.

2.3 Cross-Border PPP Approach on Climate Smart Agriculture for Food Security in Barren Land Amidst COVID-19

PBB project targeted on vegetables and flowers plantation on quick harvests, cash crops and nutrition. To link with the food security priority to support the daily SMEs and MSMEs' activities for a living, PBB initiative incorporates the implementation of the best practices and toolkits [27] for sharing local knowledge and utilising regional resources to facilitate Livelihood Continuity Plan (LCP) before or after disasters and climate extremes since 2018.

In 2020, amidst COVID-19, World Bank indicated that COVID-19 has slowed economic growth, increased unemployment, and raised poverty and hunger. The global output is estimated to shrink by 5.2% in 2020 [28], with a downside estimate of about 8% contraction should the lockdowns continue into the second half of the year. International Labour Organization highlighted the decline in world gross product could lead to an additional 25 million people unemployed worldwide. Hunger will increase, with the number of people facing acute food insecurity doubling to about 265 million by the end of 2020 [29]. These deprivations are likely to hit children, women, and the elderly, as well as least developed countries (LDCs) [30] and other vulnerable developing countries, harder.

How to provide the rapid growing global population with economic access to sufficient, safe, nutritious and quality food as well as better livelihoods of millions of rural people, mainly small farmers, particularly women on the vegetable plantation while COVID-19 spreading? The PBB pilot community in Iloilo City shown its resilience while COVID-19 spreading for border control, lockdown and quarantine. On its continuous harvests (Fig. 3) received from PBB Facebook, PBB pilot community upgraded its role on sharing its harvests. From receiving assistance to delivering assistance, a self-sufficient climate smart agriculture community functioned in the critical moment amidst COVIDE-19 as a food provider outreaching the helping hands to the people in need and sustain the LDCs' activity, circular economy [31] as well as SMEs/MSMEs activities in the Philippines while lockdown for COVID-19.

Fig. 3. APEC plant back better initiative, Source: NCDR & APEC EPCC

To echo United Nations' Food program [32], PBB community continued to share nutritious food, love, healthy life style and hope amidst COVID-19 pandemic spreading.

PBB as a living project helps the most vulnerable people to strengthen their capacities to absorb, adapt, and transform in the face of shocks and long-term stressors amidst COVID-19 lockdown.

3 Capacity Building Through PPP Amidst COVID-19

3.1 New Globalisation for PPP - 2020 International Training Workshop

Youth can play an important role in disaster preparedness and response. To further build up the youth capacity at the regional level to deploy the multi-hazard approach on geological and hydro-meteorological hazard, Tzu Chi Foundation (Tzu Chi [33], International NGO) and NCDR collaborate to organize the 2020 International Training Workshop (2020ITW) - Youth Leadership Camp on Disaster Risk Management [34], the 15th ITW, focusing on capacity building for disaster preparedness to seek the new globalisation model for capacity buildings on cross-border PPP approach. The workshop targeted at meeting college junior, senior, graduate and post-graduate international students majoring in disaster management or relevant disciplines who are enthusiastic fast learners with mobility and creativity to join the training. The international participants from 21 countries with broad-spectrum backgrounds are depicted in Fig. 4.

Country	Female	Male	Sum
Bangladesh		1	1
Belize	2		2
Colombia		2	2
France	1		1
Guatemala		1	1
Haiti	2	3	5
Honduran	3		3
Hungary	1		1
India	2	2	4
Indonesia	9	5	14
Malaysia	1	1	2
Myanmar		1	1
Nepal		1	1
Paraguay		1	1
Poland	1		1
South African	1		1
St Vincent and Grenad	1	1	2
Taiwan	13	16	29
The Philippines	3	1	4
Turkey	1		1
Viet Nam	3	7	10
Grand Total	**44**	**43**	**87**

Fig. 4. International participants of 21 countries with broad-spectrum backgrounds, Source: NCDR.

Through scenarios simulation and on-site hands-on operations, 2020ITW are designed to empower future leaders to involve in science and technology on decision making and deployment. The challenging missions during the whole event, including

smart DRR through strategic process, is the highlights of the training. Scenario-based information intelligence in delivering humanitarian assistance is critically important to ensure quality decision-making in the case of emergency operations.

3.2 A Large-Scale Earthquake Scenario

Take the case of magnitude 7.1 earthquake in Miaoli County, the Shihtan Fault movement [35], depicted in Fig. 5 as a scenario that hits the central Taiwan nearby HsinChu Science Park [36] where the world-leading semiconductor company, Taiwan Semiconductor Manufacturing Company Limited (TSMC) [37], located for 2020ITW Youth Camp on-site training. The scenario of estimated damage (to building, to public and critical infrastructure), casualties, demands of short-term sheltering, population distribution (and estimation by mobile phone data) are provided to the trainees for planning and action in GIS [38] based information (Fig. 6). We utilized the situation assessment smart technology, Decision-making Support System for Emergency Operation Center (EOCDSS) [39] in Taiwan for central operation (Fig. 7). We have another lesson learnt and plan for the staff safety for remote workers, work at home with also monitor the staff families' safety.

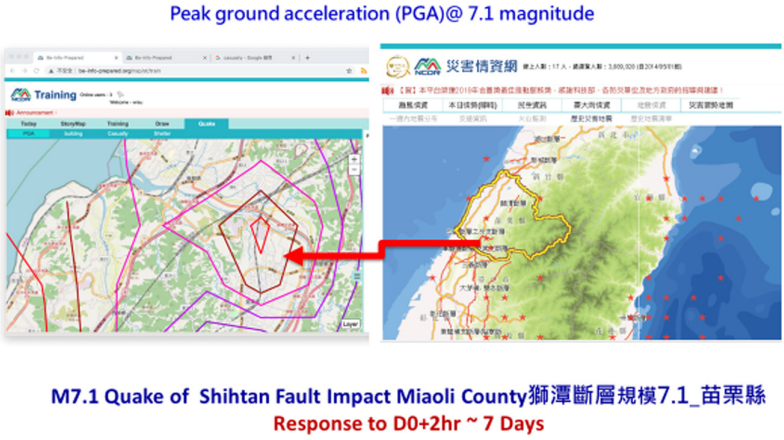

Fig. 5. A large-scale earthquake scenario, Source: NCDR

3.3 Incorporate United Nations' Cluster Approach into 2020ITW

2020 ITW embedded the concept of Cluster Approach [40]. The expected goals of the 4-day training program are aimed at capacity building on: 1) Understanding of disasters from impacts to operations, 2) Observing the needs of the affected people, 3) Picturing the "situation awareness" as if trainee is one of the affected people after an earthquake and could suffer from its aftermaths; alternatively, trainee play a role of leader by formulating feasible solutions and allocating resources to tackle each challenge, 4) Streamlining the

data, photo and information collected for situation assessment through Information and Communication Technology (ICT) [41] devices and consolidating them into a GIS-based system for emergency response and risk communications, 5) Mobilizing the tangible and intangible resources for emergency preparedness, 6) Integrating team efforts on the scenario simulation for operations, and 7) Delivering effective and efficient operation.

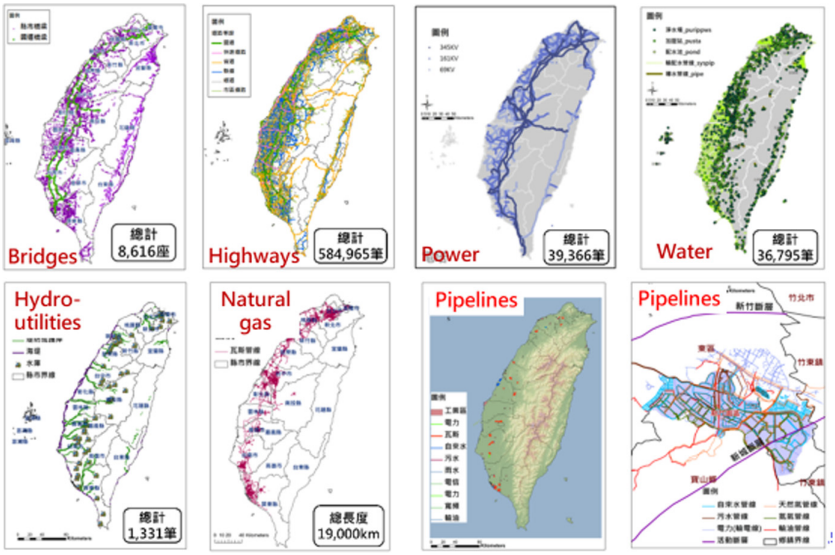

Fig. 6. Geo-spatial distribution maps of lifeline systems, Source: NCDR

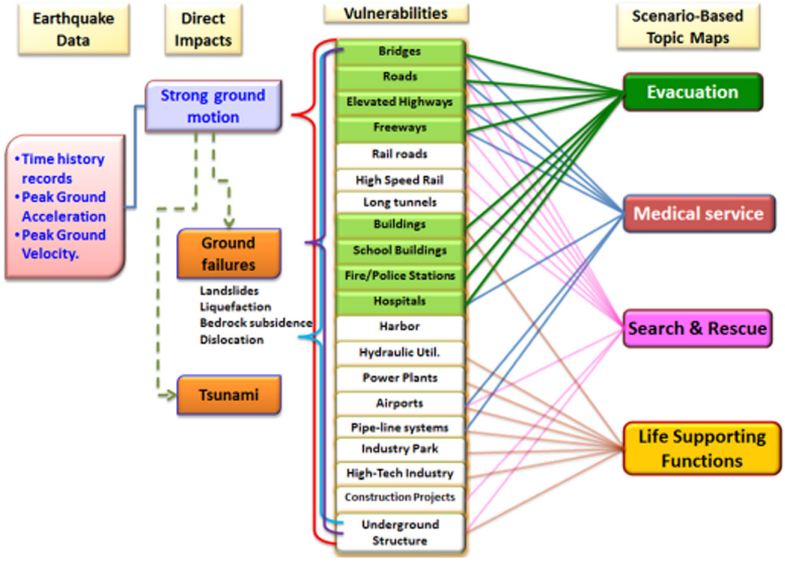

Fig. 7. Components of information-based preparedness and scenarios, Source: NCDR

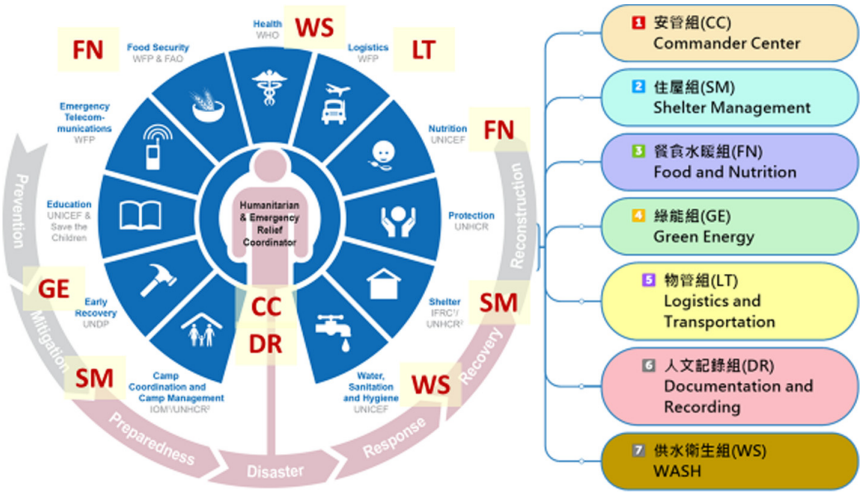

Fig. 8. UN cluster approach and 2020ITW, Source: UN OCHA [42] & NCDR

3.4 Applied Smart ICTs Through PPP for DRR

Taiwan is a very dynamic mobile market with strong coverage and intense competition among its five operators. A collaborative framework of 38 government agencies for sending the public warning messages through mobile system operators covering 29.29 million of 4G subscribers [43] set an example for PPP for DRR. It is free of charge for 4G subscribers in Taiwan to receive 22 types of warning messages such as the big thunderstorm, earthquake, debris flow, dam discharge, pandemics as well as the international outbreak, road closure, terrorist attack, suspension of school or public services at both central and local level by the end of October 2020. NCDR initiated the Cell Broadcast System (CBS) project, a public warning system, in 2016 to kick-off and maintain the operations of the Cell Broadcast Entity (CBE) and consolidate the real-time data received from government authorities into the Cell Broadcast Center (CBC) for mobile system operators to further sending the warning message through mobile to their 4G subscribers.

Only one channel for communications cannot target all the people living in Taiwan. Despite Short Message Service (SMS) sending through CBS, Taiwan took multiple approaches to send public warning message through radio, television, email, internet, loudspeakers, counter liquid-crystal display (LCD) panel of 7–11 convenience stores and social media such as google alert, Facebook and line [44, 45]. The message sent in SMS, GIS-based, visual image, chart, sound and graphic can to some overcome the language barrier to service the diverse of population and activities in Taiwan to pay attention to the potential risk involved if emergencies. Taiwan took the advantage of the existing digital capacity for networking and developed contingency plans for COVID-19 preparedness and response. A part of daily life in Taiwan to receive all-hazard including pandemic public warning through multi-media communication channels for emergency preparedness and response can be expected. Getting ready to people to people connectivity via smart technology and team-up to contribute to the global society is the

core value in preparing cross-border PPP in terms of sharing the best practices for resolving the regional crisis.

3.5 The On-Site Hands-On Drills and Exercises Through Virtual Operation in Action

2020ITW adopt a local to global approach to utilize smart technology and environment here in Taiwan as well as followed the international guidelines and countermeasure for delivering capacity building. Microsoft story map and Line group are handy for sending GIS data. In a Wi-Fi available environment, the trainees divided into groups for scenario-based on-site hands-on drill of M7.1 earthquakes.

A panorama of a whole drill in actions shown in Fig. 9. From situation assessment at the command center, the trainees worked together in the field to deliver missions on shelter management and planning, food and nutrition, logistics and transportation, documentation and recording and Water, Sanitation and Hygiene (WASH) [46] for COVID-19 countermeasure to respond to around 200 affected people earthquake incident.

Fig. 9. Cluster approach in action for 2020ITW drills and exercises, Source: NCDR

4 Global Social Change

4.1 Cross Border PPP Approach for DRR on Common Goals

In 2020, managing risks and impacts of natural disasters under COVID-19 pandemic spreading is inevitable. The international society seeks for collaboration over competition amidst COVID-19 pandemic. We incorporate the appropriate PPP approach for collaboration [47] and using ICT Technology into the information-intelligence knowledge platform to provide the single common operational picture for emergency response by adopting open data approach for scenario-based join drills, exercises or operations. Mobilising regional science and technology & research and development for capacity building at the local level, it is very challenging on transferring knowledge and the best practices to share information. Provide solution package and toolkits on challenges are critical to succeed the daily emergency preparedness for better emergency preparedness. This approach shared how to apply information technology for cross-border PPP admits COVID-19 spreading. Wi-Fi [48] Readiness and Cloud Computing/Technology [49] are two pillars to sustain the regional virtual operation and local drills and exercises in action. The best practices of the team efforts (BCP, PBB and 2020ITW) provide valuable information and reference as well as fruitful and inspiring outcomes in conjunction of further perspectives of cross-border PPP approach over the future DRR challenges.

Nowadays, we are more or less connect each household by internet, social media for emotional demand powered by code. Robot, internet or AI technology came to help to provide remote medical service with zero-touch or no-touch policy amidst COVID-19 for mental and physical health in communities even across the border. Wi-Fi readiness is critical. Virtual operation for operational risk management to ensure business continuity for financial resilience for a living is the long-term goal amidst Covid-19. Connecting people through science and technology is inevitable amidst COVID-19. Smartphone is an easily accessible device in connecting the urban and rural community as well as in distance across the borders.

4.2 Cross Border PPP Approach for DRR on MOU

Legal Harmonization and Environment Enablement

Increasing threats from the infrastructure resilience draw our attention for future resilience. Emergency preparedness and recovery rely on daily operations of water and energy supply, telecommunication and etc. To resolve the structural issues and harmonise the cross-border legal framework, MOUs are critical for building consensus on common goals and enable the environment for change. In this context, boosting economic activities on SDGs is fundamental for DRR to uphold livelihoods, business continuity and supply chain connectivity. To gauge implementation of the region's disaster-resilient trade and investment, public sector involvement is crucial to shielding local economic platforms such as business operations, employment and legal flexibility environment over disruptions after a disaster. Taking account of human behaviour as a core value to involve science and technology, Fig. 10 illustrated how to engage cross border PPP approach for DRR at regional level for capacity building, emergency preparedness and

pandemic crisis. Building common goals and partnerships under MOU is the top priority to kick-off the cross-border PPP in the context of **whole of society's participation.**

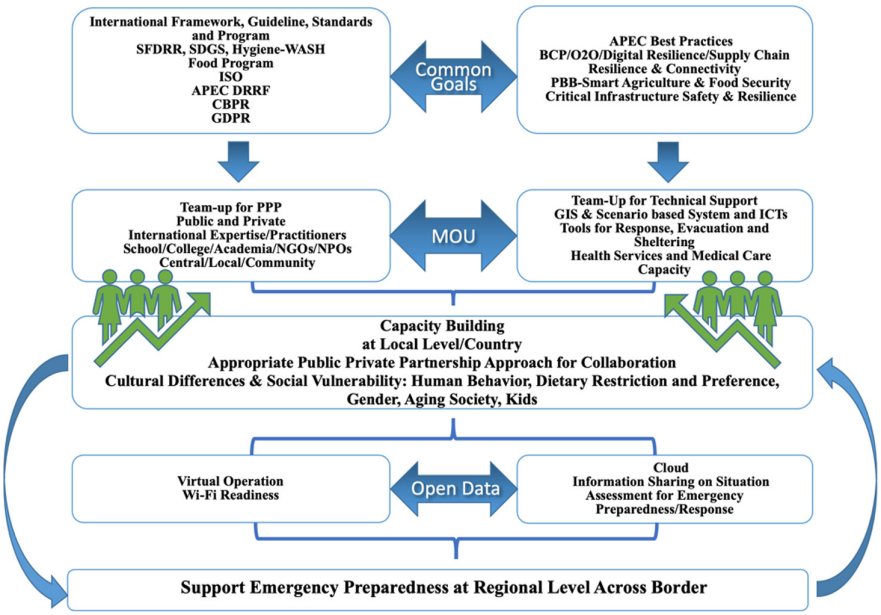

Fig. 10. Cross-border PPP approach for DRR

4.3 Cross Border PPP Approach for DRR on Open Data

Infrastructure Readiness for Smart Appropriate Technology

We utilize innovative ICT tools as well as big data and open data for vulnerability assessment at the regional level for emergency preparedness. It is convenient to apply on cascading disaster interactive with COVID-19 spreading. The consolidated picture of emergency and pandemic provide a comprehensive picture for preparedness, response, search and rescue as well as recovery. While adopting cross-border PPP approach, the effective investment from the public and private sectors for integrating information into a single operational for multi-hazard and pandemic can ensure synergy and avoid crowding out effect [50] to provide all-hazard approach including pandemic decision-making support. Thus, building a robust GIS-based system to incorporate COVID-19 into emergency preparedness is cost-efficient and operation effective for the global community in the sense of supply chain resilience. The critical beneficiary of a cross-border PPP approach will be stakeholder involvement among the public and private sectors in achieving the SDGs.

In the case of PBB project, we use Facebook for connecting Taiwan and the Philippines to deliver real-time emergency preparedness, response and recovery according to

the local availability of easy access on smartphone device. In the case of 2020ITW, we adopt Line and Window Story Map for communication in Taiwan. Understanding the appropriate technology in terms of easy access and availability at the local community is critical to be embedded science and technology into daily life operation. It contributed to the sufficient transmission of the data and feedback from the field for study, assessment and circle of experience learning and local knowledge sharing to better off regional operation for capacity building as a whole. On demand, regional science and technology research and development can better fit in the local capacity building in support of local capacity building for secure livelihoods and sustainable growth in disaster-affected areas and beyond.

4.4 Future Perspectives - Challenges or Opportunities

Social Coherence

The investment in efficient BCP can effectively confront emergencies even countries at a relatively low-income level. The emergent COVID-19 became critical which jeopardised the daily operation in the marketplace. Quarantine, regulations, border control, lockdown to great extent change the business conduct for operation and human behaviour. Cyber Security also listed as a priority for Cross-border PPP Approach. Cyberworld does not abide by any rules or guidelines. Fake news, adverse comment or input can jeopardize the partnership and collaboration in a great deal. Panic escalated while the fake news or rumor spreading. The in-time real-time truth and facts are the cure and solution to calm down the general public. Challenges and hard works fall at building trust and bridge the gap of social value difference and the level of economic development including income, racial or gender discrimination, language barrier, cultural difference and conflict while conducting cross-border PPP.

Protecting Privacy Information and Space for Social Good

Cyber security issue draws the attention of the global society on how to regulate a better internet environment for human good and business friendly. It is more than critical for us to ensure the use and abuse of modern technology. Thus, APEC CBPR [51] and EU GDPR [52] provide us clear guidance on cross-border activity in sharing information. Most of the activities interrupted by the COVID-19 measures such as border control, movement restrictions, home/community isolation, business operation control, media and public relations, remote education, remote working, can be tackle by IT technology application. Base on APEC CBPR and EU GDP develop a voluntary GIS-based information-sharing network on emergency preparedness and COVID-19 measures (particularly measures related to emergency preparedness) for pursuing facilitative measures and strengthening regional connectivity and resilience.

Build Back Stronger for Recovery Through Cross-border PPP Approach for DRR over New Normal

Globalization is a trend for nowadays social and economic benefits in synergising the global resources for sustainable development especially in the digital world. Although the COVID-19 spreading has seen a dramatic decline in trade, investments and the

movement of people, a new type of globalisation is emerging, the "new globalisation" for "new normal". The change is based on systematic changes of digital services, research and development, data, ideas, and other intangibles for sharing information and resources over crisis across the border for PPP under APEC.

To sum up, for succeeding cross-border PPP Approach, we need to pay special attention to improve the governance by ensuring: 1) consensus on common goal and interests in respect of culture difference, gender, language and etc.; 2) whole society participation; 3) stakeholder empowerment; 4) accountable local practitioners endeavour; 5) effective coordination across units of governments (public sector); 6) effective coordination across levels of INGOs, NGOs [53], academia, community, SMEs and MSMEs (private sector); 7) technical competency of the bureaucracy; and 8) smart use of technology (effective ICTs tools, Cloud and Wi-Fi readiness.

Better governance, smarter technology and stronger partnership networking are three elements toward a cross-border PPP approach for DRR. Make it as simple as possible for users and lower the entry barrier to call for greater participation and contribution to enhance global resilience. Taiwan's experiences and best practices can contribute to resolving the situation of the climate extremes amidst COVID-19 spreading. Pre-disaster deployment on local knowledge is not only cost efficient and operational effective. Regional science and technology can help vulnerable areas to promote capacity building with synergies. Constantly looking out each other in distance, consolidating 10 years of best practices on capacity building of BCP and PBB, the cross-border PPP approach on utilizing smart technology do effectively connect the world for better governance on emergency preparedness. Team up on cross-border PPP approach is cost efficient to bridge local into the international communities. Cross-border PPP for DRR is a cost effective and efficient strategy for resilience in delivering emergency preparedness, response and quick recovery from disaster impacts while COVID-19.

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