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Systems Thinking Approach to Research for Health Systems Resilience

Michael Angelo Promentilla[1,2]

[1] *Center for Engineering and Sustainable Development Research, De La Salle University, Philippines*
[2] *Philippine Council for Health Research and Development, Department of Science and Technology, Philippines*
**Corresponding Author: michael.promentilla@dlsu.edu.ph*

Abstract: Health is underscored as one of the main priorities in one of the strategic goals of the Sendai Framework for Disaster Risk Reduction (DRR). It is imperative to institutionalize and mainstream disaster risk reduction and management in health policies, plans and systems. Accordingly, the Philippine Council for Health Research and Development (PCHRD) of the Department of Science and Technology identified "Health Resiliency" as one of the priority areas under of the National Unified Health Research Agenda for 2017-2022. This contextualize health resiliency as a goal and outcome from implementing disaster risk reduction and climate change adaptation (DRR-CCA) in the country. In spite of being dubbed as a "living laboratory" for climate-induced disasters and other natural hazards, the Philippines however have produced relatively limited publications and reports authored by our local researchers in the field of health resiliency. It is thus recognized that our scientists and researchers from across disciplines should play a role in providing the information, methods and tools needed to fully understand the health risk and resilience in the Philippine context, and export this knowledge capital to a global audience. This work thus proposes a paradigm shift in thinking which integrate, organize and prioritize research within a system of systems context. A systems thinking approach and a conceptual framework are developed wherein research programs can be designed that would lead to strengthening of health systems resilience with respect to emerging global and domestic threats. Such framework can then be applied in planning workshops to identify health-focused research opportunities in the context of climate change adaptation and disaster risk reduction. This will aid us in creating STI roadmap by identifying actors, key issues and research gaps, visualizing interactions within the systems, organizing information, developing computational models, and identifying health determinants and indicators, among others.

Key Words: health systems, Philippines, climate change adaptation, disaster risk reduction, resilience

1. INTRODUCTION

The Philippines is one of the most vulnerable countries in the ASEAN region in terms of multi-hazard exposure and risk according to the ASEAN Coordinating Centre for Humanitarian Assistance (AHA) on disaster management (AHA, 2019). With its commitment to pursue the strategic goals of the Sendai Framework for Disaster Risk Reduction (DRR), the Philippine government expressed its support to the Bangkok Principles of the Sendai Framework underscoring health to be at the center of DRR at the 2017 Global Platform on Disaster Risk Reduction. Furthermore, this recognizes the importance of Science, Technology and Innovation (STI) and encourages its application in the country's disaster risk reduction and management, and climate change adaptation and mitigation efforts at both the national and local levels. Accordingly, the Philippine Council for Health Research and Development (DOST PCHRD) of the Department of Science and Technology identified "health resiliency" in the context of disaster risk reduction and climate change adaptation (DRR-CCA) as one of the priority areas under the National Unified Health Research Agenda (NUHRA) for year 2017-2022 (PNHRS, n.d.). According to this NUHRA, health resiliency research aims to improve the country's health system by being resilient with respect to emerging global and domestic threats. PCHRD also organized a series of consultation meetings with experts on DRR-CCA to determine the current status, including the gaps and challenges of DRR-CCA in health research. Reports from these consultation meetings and scoping reviews commissioned by PCHRD suggest the scarcity of scientific publications authored by local researchers in these topics in spite of the country's being endowed by nature with "living laboratory" for natural hazards including climate-induced hazards. In addition, it was highlighted that existing research is seen as merely "scratching the surface", and is disorganized with no clear overall direction or not even part of any harmonized research agenda.

This work thus proposes a paradigm shift in thinking which develop a framework to integrate, organize and prioritize research in health resiliency within a system of systems context. A "system" can be understood as an arrangement of parts or components and their interconnections that come together for a purpose. Health system, according to World Health Organization (WHO), refers to the organizations, institutions, resources and people whose primary purpose is to improve health and illness-related poverty. It is imperative to understand each component and their interrelationships in the system before we try to develop research programs that will translate to health policy and practices for building community resilience. For example, looking at health system as a complex adaptive system, it can be described with the following attributes: 1) adaptable parts that can learn and change by themselves; 2) behavior of system emerges; 3) context matters as systems exist within the systems; 4) system has inherent order and self-organizing; and 5) changes may not predictable in detail (Plsek and Greenhalgh, 2001). On one hand, health system resilience is defined as the capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and, informed by lessons learned during the crisis, reorganize if conditions require it (Kruk et al, 2015). As a complex adaptive system, resilience is then viewed as an emergent property of health systems as a whole. Making health systems resilient lead not only to protect human life and produce good health outcomes for all during a crisis and in its aftermath, but also to become more responsive and deliver good services even without the crisis. Such double benefit which improve performance in both good and bad times is typically referred to as the "resilience dividend". Accordingly, expected output from research programs on health resiliency that are being funded by the Philippine government is envisioned to be utilized and yield resilience dividend in a form of innovative products, actionable policy and best practices for health systems. A harmonized research framework is thus needed to integrate, organize and prioritize research projects and programs.

2. SYSTEMS THINKING APPROACH TO RESEARCH PROGRAMS: A CONCEPTUAL FRAMEWORK

A research framework can be viewed as a

conceptual framework which denotes the representation of concepts that can aid in the design and development of research programs. It can thus be used as a tool for capturing, visualizing, and organizing connections among key factors in a complex system. Its taxonomy can be classified into three tiers namely structural, relational and operational (Knol et al, 2010). The first tier is a structural framework which is typically a pictorial representation or description of the system with its important domains. The second tier is a relational framework that provide interrelationship among the variables or components of the system through logical or functional links. On the other hand, the third tier is an operational framework which provide a more detailed operational model of the system under consideration which is used as a basis for analysis.

Figure 1 depicts a STAR (Systems Thinking Approach to Research) framework to describe the picture of the author's mental model of what a research program is. According to Wikipedia, research is the "creative and systematic work undertaken to increase the stock of knowledge, including knowledge of humans, culture and society, and the use of this stock of knowledge to devise new applications." The proposed STAR framework viewed research both as an iterative learning process; and a system of systems consisting of the domains of Goal, Problem, Data, Information, Knowledge and Decision. They are interconnected to each other to form a system for a purpose of increasing the knowledge capital and its application. In this model, research is primarily motivated by a "Problem" which is the perceived gap between the reality and the ideal, i.e., the society's aspiration or Goal. There will be a universe of problems, and complex problems may require lenses from different disciplines who would work together to properly contextualize and anticipate the problem situation to be elucidated and solved. Problem should be defined properly with conceptual models including the actors involved that will aid us in identifying variables, devising methods or process to collect data. These are the "whos", "whats", "wheres", "whens" and the "which" of the database. These data could be either tangibles or intangibles. However, these data will not be as useful as it is intended to be unless these are analyzed and assessed. There is plethora of toolbox from statistics and most recently from data science to process these data and produce information that are relevant to the receiver or audience. Likewise, Geographic Information System (GIS) allows us to analyze spatial data, and integrate to other data types and organize layers of information for better understanding and visualization. Information are thus contextualized data that are organized and structured as being applied and put into action to produce knowledge. Knowledge is thus perceived not only as contextualized information but also provide the "know-how" with an amalgam of framed experience, values, expert insights and grounded intuition (Gamble and Blackwell, 2001). Such knowledge provides the environment and framework to plan and design options or possible solutions.

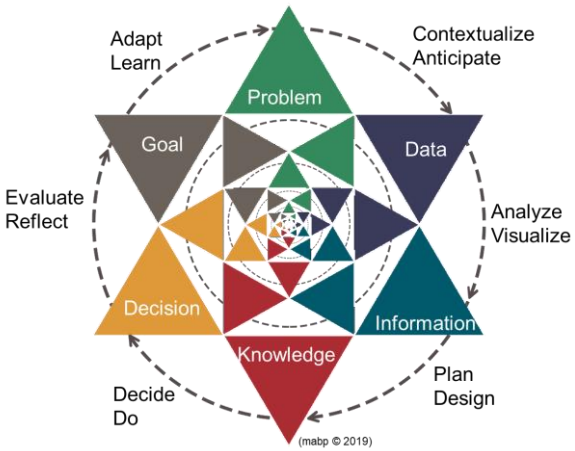

Fig. 1. Systems Thinking Approach to Research (STAR) Framework

With this knowledge management system, it can incorporate new experiences and information which help us to decide and do what is necessary to achieve the Goal. Decision making refers to human activity which is a deliberate choice among options on the basis of the acquired knowledge and experience. Note that an option of doing nothing is also a Decision. There are also decision support systems with set of tools such as soft computing and multiple criteria decision analysis that we can adopt from computer science, management science and operations research to aid us in the decision making process.

Our decisions and actions should then be evaluated to check whether we have achieved the desired Goal or not. And if not, then one should monitor on how near or far we are in reaching the

goal, and reflect on the "hows" to move forward. Whether we must redefine the target goal or problem, we adapt and learn from this first iteration of the research cycle. It is also possible that in the process, a feedback loop may exist, e.g., insights gained from the analysis of data may lead to redefining the problem, and the cycle continues. Systems boundary may change but the iteration continues, and knowledge accumulates through the process until the goal is reached which leads to more awareness and understanding. Such accumulated knowledge transformed to wisdom will hopefully enlighten us more on the "whys" and allow us to cope with the unknowns and uncertainty when we develop our research programs. Real research is therefore a nonlinear learning process that continuously adapt and improve to increase the stock of practical knowledge that can be used e.g., for policy development on health resiliency.

3. A CONCEPTUAL FRAMEWORK FOR HEALTH SYSTEMS RESILIENCE

According to National Economic Development Authority (NEDA)'s AmBisyon Natin 2040, one of the long-term developmental goals of the Philippines is for the country to have a healthy and resilient society. This is our society's aspiration and there is a universe of problems which we can think of as the "gap" or "barriers" to achieve that goal. For example, changes in climatic natural hazards are projected to become more frequent and intense, and their impact may adversely affect health and wellbeing of the Filipinos, directly via extreme weather events such as heatwaves, typhoons, floods and droughts, and indirectly via impacts on food security, air and water quality, and to other ecosystem services. Repeated exposures to extreme weather could also affect mental health and wellbeing due to reduced social cohesion, networks and support (Lindley et al., 2011). In fact, climate change is portrayed as the greatest public health threat of the 21st century (Costello et al, 2009) and disaster risk from the impacts of climate change are far-reaching in an uncertain environment. The Sustainable Development Goals (SDGs) also provide the basis to ensure that actions to increase health resilience to climate change take place within a comprehensive and integrative approach to development. In contextualizing our problem, a conceptual framework is thus needed to support NUHRA on health resiliency which can be used as guide for policy action and response. Figure 2 describes an example of conceptual framework which was a modified form of the DPSEEA framework of the World Health Organization (WHO) that focuses on vulnerability and the desired outcome of health systems resilience. DPSEEA stands for the Driving Force, Pressure, State, Exposure, Effect and Action, which was developed by WHO to support decision making about actions to reduce the burden of disease by describing environmental health problems from their root causes to their health effects, and by identifying areas of intervention.

Note that conceptual frameworks for climate change and health have been reported and reviewed in Fussel et al (2004), and are categorized into typologies of climate change assessments, guidelines for climates change risk assessments, conceptual frameworks for vulnerability and adaptation to climate change, among others. In addition, Birmbaun et al. (2015) developed several significant frameworks dubbed as the WADEM framework to structure the information and research of the health aspects of disasters. However, no single overarching framework is suitable yet for all social, economic, environmental, and policy environments. The proposed conceptual model in Figure 2 aims to differentiate the different levels of assessments while describing the interconnections among the drivers, pressures, state of the environment or disaster event, and the health and social impacts due to vulnerability.

One central feature in this framework is the differential vulnerability of the individual or community to health aspects of disaster whether it is climate-induced or not. Disaster will disproportionately affect socially, culturally, and economically vulnerable groups or sensitive

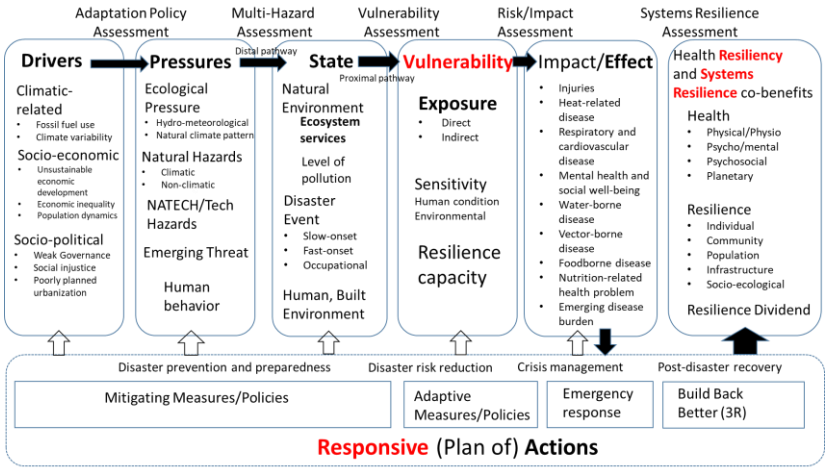

Fig. 2. A conceptual model for climate-smart and disaster-resilient health systems

individuals who may lack the resilience capacities such as social networks or resources to respond to exposure and shock events. The framework identifies vulnerability as a function of exposure, sensitivity and resilience capacity.

Resilience can then become an objective of design for systems using the 4R's principle to measure it, and can be applied as well to health systems as part of critical infrastructure systems. These "4Rs" refer to Robustness, Redundancy, Resourcefulness, and Rapidity (Bruneau and Reinhorn, 2006) in resilience engineering literature. Robustness is the measure of its capacity to withstand a given level of stress or shock. Redundancy is a measure of inherent substitutability for the system to provide its function in the event of shock or disruption. Resourcefulness is the measure of its capacity to identify problems, establish priorities, and mobilize resources in the event of shock or disruption. Rapidity is the measure of its capacity to contain losses, recover functionality and avoid future disruption in a timely manner. Health resiliency and health systems resilience is built with the understanding of the core resilience capacities namely anticipatory capacity, absorptive capacity, adaptive capacity and transformative capacity (Tanner et al., 2017). Anticipatory capacity is the ability to anticipate and reduce the impact of shocks through preparedness and planning, which include the design for redundancy. Absorptive capacity is the ability to absorb and cope with the impacts of shocks and stresses. This include the design for robustness and resourcefulness, and draws mainly on the available resources within human systems to recover from adverse conditions. On the other hand, adaptive capacity is the ability to take deliberate and planned decisions, even when conditions have changed or are about to change, to achieve a desired state. Transformative capacity is the ability to take deliberate steps to break away from the status quo or to change systems that create risks, vulnerability as well as inequality. Both adaptive and transformative capacity include the design for rapidity to build systems resilience.

In this resilience-thinking approach, both short-term and long-term research agenda enable the proper planning of data collection and the type of the analysis needed for hazard, risk and vulnerability assessment. Managing the database and processing those data to yield timely information can be used to understand the different types of health risk such as the heat-related disease, water-borne disease, vector-borne disease, among others alongside the information on the vulnerability of target

communities. Information is then used to develop systems for disaster risk management such as the early warning and real-time forecasting systems, surveillance and monitoring systems, and information and social communication systems. This leads also to the increase of know-how, i.e., the knowledge in strengthening and enhancing disaster risk management plans that will include multi-hazard management plan, risk governance and stakeholder cooperation, emergency action plan, among others. Both ex ante and ex post analysis using the common framework will also provide insights on how to adapt and improve the disaster risk management plans as we document and build database of historical data. The framework can systematically link efforts undertaken prior to a disaster, i.e. ex ante measures such as risk analysis with actions taken after a disaster has occurred, i.e. ex post measures such as the reconstruction activity and systems resilience analysis.

This framework also illustrates where different policy actions and responses can address the different stages of impacts and linked to the expected outcome, i.e., health resiliency and health systems resilience co-benefits. For example, such framework can be used to design research programs on building disaster resilience through policy-engaged mental health research, or other policies that address housing design to minimize heat exposure, social resilience strategies, mosquito monitoring and impacts of allergens (Boylan et al., 2018). Climate change mitigation and adaptation policies that have co-benefits are also made explicit in the framework. Consider research programs on green spaces in built environment and for instance, that will lead to policies that support urban green cover which not only have environmental benefits such as improving air quality and treating wastewater but also more direct health benefits. Thus, the structure of the framework encourages cross-sectoral participation and interdisciplinary studies that may lead to more options and more likely policy adoptions as multiple benefits of policies are made explicit.

Through this framework, interdisciplinary research programs with people-centered participatory approach can be developed that will lead to the following but not limited to:

- Improving sustainability, responsiveness and resilience in health systems while managing health emergencies, disaster and climate risk.
- Strengthening the capacity for surveillance and control of infectious and climate-sensitive disease as part of the knowledge management system.
- Strengthening the capacity for public health tailored early warning systems including the forecasting for extreme events/weather as part of the knowledge management system.
- Strengthening inclusive and gender-sensitive community resilience to disaster and climate change by raising awareness, and also prioritizing and implementing local/ecological public health interventions to the most vulnerable communities.
- Strengthening health systems in identifying and managing the environmental determinants of health through intervention in collaboration with other sectors that impact health such as the industry, energy, transport, water and agriculture.

These research programs are aligned with the proposed STI framework of action of the Philippine Government's Department of Science and Technology (DOST) for disaster and climate resilience with seven key result area (KRA) namely:

KRA1. Observation and monitoring networks
KRA2. Technologies for monitoring
KRA3. Modelling and simulation
KRA4. Hazards, vulnerability and risk assessment
KRA5. Warning and risk communication
KRA6. Technologies for disaster risk reduction and management
KRA7. Technologies for climate change adaptation and mitigation

4. CONCLUSIONS AND POLICY RECOMMENDATIONS

This work is motivated by the fact that health resiliency research is still in infancy in the Philippines, characterized by sporadic research, weak cross-sectoral and interdisciplinary collaboration, and limited scientific publications It is hoped that the proposed systems thinking approach and a resilience framework allows us to understand clearly the impacts of climate-induced disaster and other hazards on the health, wellbeing, and individual and social vulnerability. This also underscores where interdisciplinary research programs, cross-sectoral adaptation and response policies may be best implemented in the country. This framework could also complement with other existing frameworks reported in the literature (e.g. WADEM framework). The next step is for the proposed framework to undergo a series of in-depth consultations with the researchers and policy makers across a range of sectors and disciplines. The modified framework can then be used in planning workshops to identify health-focused research opportunities in the context of climate change adaptation and disaster risk reduction. This will aid us also in creating the Science, Technology and Innovation (STI) roadmap by identifying actors, key issues and research gaps, visualizing interactions within the systems, organizing information, developing computational models, and identifying health determinants and indicators, among others. Thus, the following are strategic action plans that emerge from the above discussion:

- *Establish consortium/research network which will implement the research framework and develop research programs of any of the four priority clusters that constitute the building blocks of a resilient health systems*: S&T support for strengthening the health information systems, S&T support for developing climate resilient and sustainable technology and infrastructure, S&T support for effective and efficient service delivery and S&T capacity for health workforce, financing, leadership and governance.
- *Establish sector baseline and vulnerable communities, including the catalogue of best practices, lessons learned and related publications, and build the knowledge management system.* Provide an e-portal and platform for maintaining data and information, and facilitate exchange of information such as the best practices in health-sensitive CCA/DRR.
- *Increase pool of technical people on health systems resilience research (MS, MA, PhD and others).* Capacitate communities, academic researchers and health professionals on the concepts and tools relevant to health systems resilience. Encourage the use of systems thinking with inter-disciplinary and multi-sectoral approach to understand and measure risk and resilience. Develop curricula and graduate programs pertinent to this emerging transdisciplinary field and provide scholarships and research fund to graduate students.
- *Increase research utilization in a form of products, evidence-based guidelines/policies and increased number of scientific publications.* Introduce incentives for projects/programs designed for research utilization to build resilience of health care facilities against climate/disaster risk.
- *Upgrade capacities/capabilities of communities, institutions and health care facilities through science-informed public health interventions.* Change "outdated" planning systems with one that incorporates a coherent and integrated framework for CCA/DRR in health.
- *Enhance inclusive community resilience through timely risk communication and science-informed public health interventions.* Building the resilience capacity of vulnerable communities require interventions that enables strong social cohesion and support networks between individuals and communities, and institutions.

These policy recommendations would hopefully lead to health systems that are responsive, anti-fragile and resilient with the capacity to protect human life and produce good health outcomes for all not only during a crisis and in its aftermath, but also during good times. After all, health is wealth, and the wealth of the nation is essentially its people first.

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