

Applications of Systems Thinking for Health System Research: A One Health Perspective

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Abstract

The complex health challenges are increasingly demanding multisectoral approaches for their solution. Possible solutions are further complexed by the health system structure and its different degrees of resilience, which differ from setting to setting. One Health guiding principles may help facilitate the actors across the different systems to address these complex issues; however, challenges remained in implementing such principles in a health system of a developing nation. For understanding the factors influencing the system complexity and dynamics of a health system, systems thinking is a suitable approach. As it is directed against fallacies of linear causalities, it might help avoid blind spots in the study of social fields. This case study discusses the applications of systems thinking to develop One Health strategies in a local setting in Ahmedabad, India. Furthermore, the systems thinking skills were applied to improve convergence at the local level by identifying the entry points.

Learning Outcomes

By the end of this case, students should be able to

- Understand the core concepts of systems thinking and its application in One Health
- Perceive systems thinking skills and tools in mapping One Health actors and interactions and create solutions to problems with practical strategies
- Comprehend One Health systems thinking skills to improve interprofessional, interdisciplinary, and cross-sectoral collaboration on the prioritized diseases
- Follow One Health guidelines with the help of the principles and tools of systems thinking at the local level
- Use systems thinking skills to improve convergence at the local level with identification of enabling factors

Project Overview and Context

It has long been recognized at the global level that the innumerable complex health challenges require multilateral and multidisciplinary approaches to resolve (Bennett et al., 2018; Tangcharoensathien et al., 2017). The burden of recent pandemics of emerging, reemerging, and endemic diseases fashioning the complexity among the human–animal–ecosystem nexus is increasing (Gebreyes et al., 2014; Jones et al., 2008). To tackle this emerging burden, there is a global movement to syndicate all relevant stakeholders from this nexus from all over the world to work together for early detection and prevention. This is popularly known as the One Health (OH) guiding principle (Asokan et al., 2011; Kakkar et al., 2011; Lee & Brumme, 2013). “One Health” is an important global activity based on the concept that human, animal, and environmental/ecosystem health are interdependent, and professionals working in these areas best serve the population by collaborating to better understand all the factors involved in disease transmission, ecosystem health, the

emergence of novel pathogens and emerging zoonotic agents, as well as environmental contaminants and toxins that are capable of causing substantial morbidity and mortality, and impacting on socioeconomic growth ([American Veterinary Medical Association, 2008](#); [Centers for Disease Control and Prevention, 2006](#); [Lerner & Berg, 2015](#); [One Health Global Network, 2015](#)).

Operationalization of the One Health principles endures challenges in both developing and developed nations ([Conrad et al., 2013](#); [Kakkar et al., 2014](#); [Lee & Brumme, 2013](#)). Although there are instances of OH collaboration across the globe, there is no one that fits to all the health systems ([Harries, 2015](#); [Supper et al., 2015](#); [Yasobant et al., 2019](#)). Implementing OH at a larger health system level makes the scenario further complex because of the involvement of the multiple actors from diverse sectors. However, developing resilience in a health system is quite complex and one needs to understand the complexity of the system ([Blanchet et al., 2017](#)). For understanding the factors influencing the system complexity and dynamics of health systems, systems thinking is one possible approach ([Atun, 2012](#); [de Savigny & Adam, 2009](#); [Leischow et al., 2008](#); [Peters, 2014](#)), which has also recently been applied to the OH approach ([Xie et al., 2017](#)).

Systems thinking is primarily a way of thinking in approaching problems and designing solutions and is often applied where the role and influence of actors and the context are still unclear ([Adam & de Savigny, 2012](#); [Checkland, 1985](#); [de Savigny & Adam, 2009](#)). It is the process of understanding how those units which may be regarded as subsystems influence one another within a complete entity or a larger system ([Vester, 2007](#)). In a system, an interaction of parts and their connectedness comes together for a purpose and the change in one part or connection affects the other elements of the system. Systems thinking differs fundamentally from traditional analytical or statistical methods which focuses on separating the individual components of what is being studied or analyzed, whereas systems thinking, in contrast, focuses on how the “object” being studied interacts with other components and constituents of the system. In systems thinking, an organization and its respective environment (context) are viewed as a complex whole of interrelated and interdependent parts rather than separate entities ([Atun, 2012](#); [Koskinen, 2013](#)). Systems thinking takes into account the structures, patterns of interaction, events, and organizational dynamics as components of larger structures, helping to anticipate rather than react to events, and to better prepare for emerging challenges.

The solution of OH problems requires a systems thinking approach. Within the health system, systems thinking can help address the linear and reductionist approaches, which prevail in health systems, by enabling the testing of new ideas in social systems ([Atun, 2012](#)). Looking at the complexity of actors' involvement in the domain of OH, it is very important in generating relevant information, especially when the issue being analyzed is dynamic or complex with feedbacks from both internal and external sources, as in a diverse health system.

Therefore, this study aims to understand the generic structure and complexity of interaction between the various actors including the factors responsible for their interaction in various situations of a local health system, here in one of the cities in India.

Section Summary

- Understand the principle of systems thinking and its scope of application.
- Understand the key concepts of OH and its principal guidelines.

Research Design

The overall principle of systems thinking was applied to understand how the actors within the health system of Ahmedabad city are interacting currently and how convergence can be enhanced between these actors, for effective prevention and control of zoonotic diseases. This demands understanding the complexity of the human and the animal health system in reference to the OH approach. Applying the principle of systems thinking, that is, being systematic about prevention, working across different systems, and setting a comprehensive system to improve the system practice, remained the mainstay of this research. The research project was named Research to explore Intersectoral Collaborations for “One Health” Approach (RICOHA).

As there are many theories that have been embedded within systems thinking, for this research we are adapting the general systems theory (GST) which was outlined by [Ludwig von Bertalanffy \(1969\)](#). The goal of systems theory is discovering a system’s dynamics, constraints, and conditions and elucidating principles that can be applied to systems at every level of nesting and in every field. It can be used for achieving optimized equifinality between different constituents such as subsystems or individual actors. Changing one part of the system usually affects other parts and the whole system, sometimes with predictable patterns of behavior. For systems, especially those that are self-learning and self-adapting, the growth and adaptation depend upon how well the system is adjusted with its environment. Some systems function mainly to support other systems by aiding in the maintenance of the other system to prevent failure.

According to these principles, when the RICOHA project objective was decided, we kept in mind that the complex problems should be solved through a simplified process systematically. It provided a means of analyzing the human–animal–environment interactions and the different disciplines engaged and how these disciplines work together as a system to solve complex health problems. It systematically covers the policies, processes, practices, and people, the roles each play, and how they interact to function effectively for solving public health threats. The OH systems thinking, like other Public Health approaches, always attempts to answer the questions of “who” (Who has the disease, who is impacted, and who are the stakeholders?), “where” (Where was the index case and where has it spread?), “when” (When was the index case?), “how” (How is the disease transmitted, how serious is it, and how can it be controlled?), “what” (What are the implications?), and “why” (Why did the outbreak occur?). Although it takes time to investigate and answer all these queries, the RICOHA project attempts to answer all these questions on the components in a comprehensive way at a local setting through its five objectives.

The specific research objectives were as follows:

1. To identify zoonotic diseases of public health importance in Ahmedabad city;

2. To identify and categorize the stakeholders within the human and the animal health systems responsible for prevention and control of zoonotic diseases in Ahmedabad city;
3. To examine the current strength of convergence at various levels of the health system among the identified stakeholders;
4. To develop the convergence strategies for effective prevention and control of zoonotic diseases;
5. To document the factors for enhancing convergence between the human and the animal health systems.

The RICOHA study was conducted in Ahmedabad, India during July 2018 to October 2019. Ahmedabad is the seventh most populous city in India and is the largest city of the western state Gujarat, India ([Ahmedabad Municipal Corporation \[AMC\], 2017](#)). It is located on the banks of the Sabarmati River with a population of 7,650,000 ([Ministry of Home Affairs, Government of India, 2011](#)). For administrative purposes, the city is at present divided into six zones, that is, central, east, west, north, south, and new west zone. Each zone is further split into wards. There are at present a total of 64 wards. About 1,191,843 households spread across the city. About 2 lakh dogs in the city ([Sehgal et al., 2011](#)) and about 0.7 million lakhs livestock and 0.2 million poultry population spread over both the city and the rural areas of Ahmedabad ([Ministry of Agriculture, 2014](#)).

Section Summary

- Reflection on the synthesis of study objective based on the systems thinking principle.
- Understanding about the system and subsystem of the study area including the system boundary.

Research Practicalities

The RICOHA study was a mixed-methods study which collected data from diverse samples to fulfill the objectives. [Table 1](#) reflects on the type of method used and sample with sampling strategy.

Table 1. Methods, sample, and sampling strategy used in the RICOHA study in Ahmedabad, India during July 2018 to October 2019.

Objective	Target	Key method	Sampling strategy	Sample and size
I	Identifying zoonotic diseases of public health importance	Participatory workshop	Purposive sampling	19 local experts
II	Stakeholder identification	In-depth interview	Purposive sampling	30 actors from managerial and provider level
III	Examining the current strength of convergence among actors	Community survey	Cluster sampling	460 households at the community level

Objective	Target	Key method	Sampling strategy	Sample and size
		System survey	Saturation of the population	6 managers, 60 providers, 363 community health workers
		Focus group discussion	Purposive sampling	6-8 community health workers per focused group
IV	Ideal convergence strategies and validation	Vignette	Purposive sampling	08 actors from city, district, and state/national level
		Policy Delphi	Online survey	23 actors from state and national level
V	System factors for enhancing convergence	Participatory workshop	Purposive sampling	09 influential actors

RICOHA: Research to explore Intersectoral Collaborations for “One Health” Approach.

Phase I

Prioritization of zoonoses is becoming an integral step for initiating the OH collaboration and is being vitalized in both developed (Ng & Sargeant, 2016) as well as developing nations (Pieracci et al., 2016). The purpose of this joint prioritization was to rank the zoonotic diseases that were especially important for the Ahmedabad city. About 19 experts were invited for the participatory workshop and through the *One Health Zoonotic Disease Prioritization (OHZDP) tool* (Rist et al., 2014) prioritized top five zoonotic diseases for the Ahmedabad city, i.e., rabies, brucellosis, avian influenza (H5N1), influenza A (H1N1), and Crimean–Congo hemorrhagic fever. The detail on the same is published elsewhere (Yasobant et al., 2019).

Phase II

Stakeholder identification is important to understand diverse stakeholders in relation to OH principles for prevention and control of zoonotic diseases within the human and animal health system. Stakeholder identification is an iterative process in health system research, as it provides better insights to system complexity with their engagement (Leventon et al., 2016; Schiller et al., 2013). This method is used extensively in various fields of science, for example, identifying stakeholders for a specific project (Kumar et al., 2016; Mulvaney & Tenbrink, 2015); however, this method is found to be rarely used in a system perspective, especially for an OH approach at a local governance level (Achterkamp & Vos, 2007; Pacheco & Garcia, 2012). Through in-depth interview of about 30 system actors, an OH stakeholder list for Ahmedabad was developed with their impact and influence on each other.

Phase III

To understand the patterns and the strength of convergence among the actors during various situations, the network survey was conducted. Network surveys have been extensively used not only in public health research (Long et al., 2014; Luke & Harris, 2007; Schoen et al., 2014) but also in health system research (Blanchet & James, 2012). This phase was conducted among the system actors as well as the households in the community. Among the system actors, the three strata were considered such as managers at the local governance level, providers such as medical officers, physicians, and veterinarians, and the community health workers such as accredited social health activists (ASHAs), malaria multipurpose health workers (MPHWs), or malaria sub-inspectors (MSIs). The system survey captured data from 6 managerial actors, 60 provider actors, and 363 community actors on their interaction pattern at various situations such as during the outbreak, epidemic of any disease, and disease specific which was prioritized earlier (rabies, brucellosis, H5N1, and H1N1). Further, the OH preparedness and preventive practices among the community health workers were documented through 6 focus group discussion (6-8 workers per focused group). To understand the OH entry point, that is, active actor at the community level, the RICOHA project conducted a community-based household survey among 460 households in 23 wards of the city in the high-density (higher human–animal contact) zones. This also attempted to document the health-seeking behavior for the human and the animal health in addition to understanding who is the prime actor at the doorstep.

Phase IV

Ideal convergence strategy development is the iteration process exploring the best possible options of establishing horizontal collaboration between two vertical systems. In this phase, through vignette the ideal convergence among the actors was documented from the 08 influential actors from the city, district, and state/national levels. Vignette methods were being used not only in clinical settings (Evans et al., 2015) for decision-making but also in public health setting (Jackson et al., 2015) to solve the complex issues. About 36 strategies that have emerged from vignette, keeping on a look at the current convergence strength, were prepared for the validation process. The validation of these strategies was performed through the policy Delphi technique with health system experts. The Delphi methodology was developed at the RAND Corporation in the 1950s (Helmer-Hirschberg, 1967); however, with certain basic principles this technique changed so far. The key difference of policy Delphi from the traditional Delphi is that the objective is not to develop consensus but to identify the widest possible range of valid options/solutions to a policy problem (de Meyrick, 2003; Turoff, 1970). Thus, the top feasible strategies were developed for the local setting.

Phase V

System factors are that are essential to transform the developed strategies into action in the form of policy guidelines. These factors have an influential role within the health system, which were captured through a sensitivity model during a participatory policy workshop. The sensitivity model (Vester, 2007) provided to visualize the relationships between the various factors and aids with the analysis of the feedback system.

Thus, the heterogeneous data were collected in the aforementioned five phases of the project from the diverse actors of the health system.

Section Summary

- Understanding about the sampling strategy and complexity of the system actors.
- Comprehension about the complex and heterogeneous data collection strategies.

Method in Action

As other projects, the RICOHA project also had two flips. There were some advantages or positive aspects as well as there were some challenges during the various phases as mentioned below.

Looking at the Positive Aspects

Among others, one key strength was that the researcher was well known to the study setting. That resulted in ease of mobilizing the imperative actors of the system for various activities as when needed. As this was a translational research, the actors of the system were much fascinated toward the project activities, especially the outcomes. As this research was a first of its kind on health system at a local setting with focus on OH, there was a huge potential of this research to translate its findings in the form of policy recommendations. Without support from the local governing body, that is, AMC, the activities of this project might not have been completed on time. To facilitate this process, there were regular project update meetings conducted with AMC officials, which made them engage actively on the progress of the project. While working with the systems thinking principle, it is important to gather all the potential actors to a single platform and this is much crucial even with OH. Therefore, it is essential to keep updates about the progress of the activity to the key actors.

Looking at the Challenges

There were challenges in each phase of the project, which can be understood as typical phenomena of social systems. During the participatory workshop, initially all the important actors were invited for the zoonotic disease prioritization; however, due to the last moment cancelation, three actors were nominated differently from the original list. Although those actors nominated were the identical authorities for the workshop, it might have been better to have had them as planned as the representatives of the workshop for the system was thus diminished by lacking constituents. Further, there are few actors, who are dominating to others, which indicates that to keep in mind on how to manage these issues while planning a participatory workshop. During the stakeholder identification, there were a large number of suggestions from the actors, which might not be relevant to the project aim. Subsystems like individuals, professional groups, or health institutions have their own finality besides the common finality of the system. In such a case, researchers must be focused enough to accept the relevant information, whereas there should not be any negligence toward the nonrelevant information. The reduction of complexity in a system must always be reflected carefully in any research. Some interviews might lead to a lot of irrelevant discussion; however, that is required to do so to gather

relevant information. Therefore, patience is highly essential to conduct this type of research. Systems do not demonstrate all their features at any time. During the community household survey, the nonresponse rate was about 20% and a researcher must accept this in any kind of survey. Again, a subsystem like a household has its own logic and goals, which do not necessarily accord to overarching goals. In addition, as there was no direct benefit provided to the surveyed households, it was a great challenge to convince people to participate in the survey, especially the illiterate population, which was about 25% among the surveyed population. Initially, it took a bit longer to convince the targeted households; however, when approached by the community leaders, it became easier to capture them. During the system network survey, the higher nonresponse rate as documented was from the community health workers, which was about 40%. This might be the reason of work overload or non-significance toward OH awareness. Among the providers, the nonresponse rate was 30%. Another issue was getting appointment from the national or state officials during the vignette and policy Delphi. However, this did not constrain the project outcomes. The modification planned for the policy Delphi method was inviting actors for a workshop who responded to the online survey, which is one among other potential way to overcome this challenge.

Section Summary

- Engaging the stakeholders in the research updates, which made the problem half-solved.
- Speculating the field challenges and preparing strategies for overcoming the challenges.

Practical Lessons Learned

Undoubtedly, this health-system-based translational research with the principle of systems thinking taught many lessons while implementing at the ground. Among others, important lessons learned are mentioned as follows:

- Participatory workshop is not in control of the researcher, but it is highly influenced by the actors attending the event. Therefore, the researcher must be cautious enough on selecting and inviting actors for the participatory workshop.
- When the nonresponse rate becomes higher as compared with the plan, there is a need to revise the strategies of approaching the target population.
- Engaging key actors on the progress of the project made it easier to sensitize other actors when needed.
- System survey and community survey must be planned as per the requirement of the information. Initially, we planned to conduct the system survey; however, we were not able to identify the key actor at the community level and therefore switched to the household survey first followed by the system survey.
- Policy Delphi seems easier to conduct, but it is very critical to conduct, as all the actors should agree to a single strategy. Therefore, we have fixed the criteria that if two-thirds of the actors agree to a strategy then that should be considered.

Beyond this scope of learning, we have also some recommendations about dimensions of systems thinking, which emerged from this project.

- **Dynamic thinking:** This refers to framing a problem in terms of a pattern of behavior over time. In this case, we observed that actors make active interactions only during the outbreak, whereas interactions during non-outbreak or epidemic time are minimal. Therefore, we sought to examine their strength of interaction at various points of time.
- **System-as-cause thinking:** This refers to placing responsibility for a behavior on internal actors who manage the policies and “plumbing” of the system. Therefore, the project intended to understand the key influential actors at the various levels of the health system, that is, OH entry points for the collaboration at the managerial level, provider level, and community level.
- **Forest thinking:** This refers to believing that to know something requires understanding the context of relationships. The context was well understood through various sources such as the previous experience of the researchers from previous projects in the same study site. In addition, this project also attempted to document the OH network among those actors.
- **Operational thinking:** This refers to concentrating on causality and understanding how a behavior is generated. This was realized while the data collection was active. Therefore, a qualitative component, that is, a focus group discussion among the key community health workers, was planned to understand their current challenges and scope to become an OH liaison actor at the community level.
- **Loop thinking:** This refers to viewing causality as an ongoing process, not a one-time event, with effect feeding back to influence the causes and the causes affecting each other. Each project must have a sustainable plan, so that after its completion there must be some impact at the system level. The RICOHA project has submitted the OH guidelines and/or validated strategies that have emerged from the data to the local governing body (AMC) and expected to implement the same in the near future.

Section Summary

- Understanding about the practical lessons during various phases and recommendations.
- Comprehension about the dimensions of the health system research project with systems thinking principles.

Conclusion

In much of public health and medicine, we use research evidence on the efficacy of interventions to inform decisions with an expectation about their future effect. Yet, linear expectations of effects often fail as they have neglected systemic factors. Here systems thinking methods and tools have a huge potential, which can also be used to explicitly forecast future events or where the complexity is least understood. Especially in the case of OH approaches in a resource-constrained setting, the principles of systems thinking could be of great

help in identifying where to invest and in which way to move ahead. Our analysis of the heterogeneous data indicated that the findings of one objective could be used as the base of the following objective, if planned systematically. Systems thinking approaches can also provide guidance on where to collect more data, or to raise new questions and hypotheses. Within the domain of OH, systems thinking methods and tools can be used to explain how to initiate the OH strategies and the future expansions.

Section Summary

- Applications of systems thinking in the domain of OH.
- Future scope of systems thinking applications.

Classroom Discussion Questions

Classroom Discussion Questions

1. Discuss the dimensions of systems thinking with your own example.
2. Discuss the principles of systems thinking in the domain of One Health, where the OH principles need to be initiated.
3. Discuss the advantages and challenges of the health-system-based systems thinking research.

Declaration of Conflicting Interests

The Authors declare that there is no conflict of interest.

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