Veterinary Integrative Sciences 2023; 21(3): 899 - 912 DOI; 10.12982/VIS.2023.065

Vet Integr Sci

Veterinary Integrative Sciences

ISSN; 2629-9968 (online)

Website; www.vet.cmu.ac.th/cmvj

Research article

The social return on investment of participatory digital disease detection system for One-Health problems in community

Terdsak Yano[1], Tossapond Kewprasopsak[2], Kannikar Na Lampang[1], Charuk Singhapreecha[2,*] and Lertrak Srikitjakarn[3,*]

[1]Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai 50100, Thailand
[2]Faculty of Economics, Chiang Mai University, Chiang Mai 50200, Thailand
[3]PODD center, Chiang Mai University, Chiang Mai 50100, Thailand

Abstract

Participatory One-health Digital Disease Detection system or PODD was developed for human health, animal health and environmental problems surveillance in communities since 2015. It was implemented in Chiang Mai, Thailand, as the pilot area. PODD was expanded throughout Thailand with the support from funders. It seems to be the successful system, but the evidence has never been demonstrated. Thus, this study aimed to evaluate the impact of PODD system during 2015-2016, which was implemented in Chiang Mai, Thailand before expanding to other areas. The Social Return on Investment or SROI was performed to evaluate the impact. The Social, economic, and environmental impact were determined by interviewing the direct stakeholders. The results showed that SROI ratio was 2.46. The farmers, including backyard chicken, pigs, and dairy cattle farmers, were the stakeholders who received the highest impact (31.98%). The reduction of livestock loss was the highest impact from PODD implementation in community. While the local government and PODD volunteers, who were the intended stakeholders, received the impact 26.84% and 20.04%, respectively. The PODD system created social and economic impact 73.89% and 26.11% respectively. The environmental impact did not occur in during the study period. This study indicated that the participatory surveillance system, which using digital technology, as PODD system established the socio-economic impact on community, and it is successful when implemented in the pilot area. The PODD should be promoted to be used widely, either in Thailand or other countries.

Keywords: One-Health, Participatory Disease Surveillance, Socio-economic impact, SROI, Stakeholder

Corresponding author: : Charuk Singhapreecha,Faculty of Economics, Chiang Mai University, Chiang Mai, 50200, Thailand. Tel.+66 81-8680306, E-mail: charuk.s@cmu.ac.th.
Lertrak Srikitjakarn,PODD center, Chiang Mai University, Chiang Mai, 50100, Thailand Tel. +66 87-185-0280 Email: lertrak.s@cmu.ac.th

Article history; *received manuscript: 1 June 2023,*
revised manuscript: 2 July 2023,
accepted manuscript: 4 July 2023,
published online: 11 July 2023
Academic editor; *Nguyen Trong Ngu*

INTRODUCTION

The disease surveillance is the key element that monitor the absence or presence of disease. The data related with health or diseases are collected, compared analyzed and interpreted continuously to monitor the absence or presence of disease or infection. Moreover, that information indicates risk population and risk area. (WHO, 2006). There are several types of disease surveillance that based on the context of data sources or activities such as active surveillance, passive surveillance, sentinel surveillance, syndromic surveillance and participatory surveillance (Rodriguez-prieto et al., 2015).

The participatory disease surveillance is a novel disease surveillance type which engage public to provide health and diseases data with public health practitioners, actively. It is a bidirectional flow of information between data providers and data collectors, generally they are community (McNeil et al, 2022). This surveillance type can be conducted in large scale, population-based monitoring at low cost. In participatory disease surveillance, general people in community are key stakeholders who share heath data with willingness for rapidly response. They can provide insight data about their health behavior. The participants can involve in many kinds of participatory disease surveillance including Syndromic system (Influenza-like illness (ILI), Mass gatherings and Vector-born diseases) Event-based and One health surveillance system and Integration of modeling and forecasting (Smolinski et al., 2017).

Since mobile and internet have been used widely, large data is stored electronically, often in accessible form and amenable to analysis. Researchers analyzed the spatiotemporal movements of millions of people during disease outbreak, and they detected an unusual respiratory illness in a remote village anywhere on the globe, rapidly. Digital technology allows general people to participate in reporting their symptoms directly to the system. It takes time and cost less than conventional disease surveillance. Public health authority can use the digital data to estimate vaccine effectiveness and explore vaccination coverage in participants, including specifically those with patient contact (Dalton et al., 2017).

In Thailand, the participatory surveillance system has been developed to initiate a One Health approach to leverage community participation in the detection of emerging animal and environmental health threats in a timely manner. The system, called Participatory One Health Digital Disease Detection or PODD has been implemented in 75 local governments in sub-districts level (LG) in Chiang Mai Provence.

Chiang Mai is a province in northern Thailand. It is a unique place in South-East Asia; It holds deep roots of community culture and a hybrid landscape of rural and urban city development. Unlike other urbanized areas that hold high individualism. It has a variety of livestock and population densities, throughout the province. Chiang Mai has different terrains, mostly a mountainous area, so some area has limited mobile signal penetration.

The mobile application has been used for reporting unusual disease events in backyard animal raising situations as well as in wild animals by community volunteers, while the dashboard has been used for monitoring any abnormal event by LG. The prompt response plan has been prepared for reported event in terms of contingency plan (Yano et al., 2018).

These results are an indication that achieving the system's ultimate goal, dealing with disease outbreaks at their source quickly to avert animal origin pandemics, is feasible. The PODD system applies a participatory approach grounded in One Health concepts combined with digital tools to enable early detection of abnormal events in humans, animals, and the environment. PODD functions as a community-owned participatory surveillance system which includes data collection, analysis, and response functions. It focuses on immediate community benefits, including timely disease control and health problem solving with technical support, rather than the longer-term goals found in traditional surveillance systems. Community leaders in local governments at the sub-district level were identified and empowered to lead PODD activities for their jurisdiction.

The PODD has been implemented in Chiang Mai, Thailand since 2015 and has been expanded to other provinces after 2016, however it needs to be evaluated to ensure that the system is working effectively. Previously, the cost-effectiveness, cost-utility and cost-benefit analyses have been applied to value for the money and evaluate the effectiveness of public health intervention, but those method did not engage stakeholders into the process (Banke-Thomas et al., 2015). The PODD system integrated participatory approach in the system, thus the stakeholders in the system should be engaged in evaluation process. A social and economic evaluation of disease surveillance system can be applied to assess the effectiveness and efficiency of the system. It indicates the worthiness of the system. It provides the information to decision makers before investing any intervention. The Social Return on Investment (SROI) is a method that assesses social impact and transform to be financial capital. This method focuses on social impact but attempt to describe in financial capital. The concept of SROI is measuring social, environmental and economic outcomes and uses monetary values to represent them. SROI is used to evaluate the outcomes of intervention that implement in society and to predict the social value in case that if intervention is implemented in society or community (van Dijk, 2012).

This study aimed to determine the impact of the participatory digital disease detection, which used to monitor One-Health problems in community, and provide the recommendation to LG, where desire to implement in their communities.

MATERIALS AND METHODS

Scope of the study

This study focused on the impact PODD system which implemented in 75 LGs in Chiang Mai, Thailand, during January 2015-December 2016. The participated LGs were selected and recommended by Chiang Mai Livestock officers. A total of 3 LGs in each district, from 25 districts in Chiang Mai, were purposive selected. The volunteers in each LGs were recruited and trained about PODD system and health problems, either human or animal health. The impact evaluation was scoped within the implemented community and its spillover effect outside the communities.

Stakeholder identification

The stakeholder who was included in this study was the individual people, group of people or organization who has got the direct impact and changed in their thoughts, behaviors, or status. The change included social, economic and environment. The individual people, group of people or organization who live or relate with participated communities and realized the impact, either positive or negative, were included to be considered in the study. The stakeholder analysis was performed to identify the stakeholders who got the direct impact. The number of included stakeholders depended on the number of outcomes. The stakeholder that has a greater number of outcomes was recruited more than the others. The data which was collected from stakeholders by individual interview and focus group discussion and the data from PODD project final report was analyzed and used to identify the outcome, indicators and some financial proxies.

Impact mapping

The SROI evaluation focuses on the impact that effect on stakeholders. The impact mapping is a technique that reveal the root or source of impact. The impact map establishing started with identifying input and valuing it. The outputs were the results or products of intervention which used those input. The outcome was the effect of those output either short- or medium-term effect. Finally, the impact was contributed by outcome (OECD, 2010). Describing the outcomes was the final process of impact mapping to ensure that the intervention or activities changes the stakeholders.

Evidencing outcome and giving them a value

Outcome indicators were developed for guiding to collect outcome data. It indicated and assured the occurrence and amount of outcome. The indicator of individual outcome was provided by stakeholders and PODD project final report. The financial proxies in this study were obtained from stakeholder consultation and related resources that can reflect the market value of the outcome. The period effect of each outcome and relative importance will be assessed by consulting the stakeholders to value individual outcome.

Establishing impact

This stage was the process that estimates how much of the outcome would have happened anyway and what proportion of the outcome can be isolated as being added by the activities. The process reduced the overclaiming the outcome. It was only by measuring and accounting for all these factors that a sense of the impact that the activity was having can be gained. The establishing impact may also help researcher to identify any important stakeholders that have missed. There are 4 parts of establishing impact: Deadweight and Displacement, Attribution, and Drop-off

The Deadweight is the percentage of outcome that would occur anyway even without PODD system implementation. The Displacement is the percentage of outcome that replace other outcomes or effects. The Attribution is the percentage of outcome that is a result from other projects or organization. The Drop-off indicates the percentage of outcome in the future may be less or if the same (Social Ventures Australia, 2014; Lind Foundation, 2022).

The result of monetary value was multiplied with percentage of Deadweight and Displacement, Attribution, Drop-off, individually. After that the impact result was multiply the period that the outcome last after end of the activity with discount rate 3.5%. Normally, the period of outcome was not more than 5 years. Before calculating the SROI ratio, the present value in each year was computed.

Calculating the SROI

The previous data, either qualitative or quantitative, will be used to summarize the financial information in this stage. The financial value of the investment and the financial value of the social costs and benefits will be calculated. The calculation consists of inputting the costs, inputting the social return, calculate the SROI ratio, projecting into the future and sensitivity analysis (SROI ratio = the net present value / input value).

RESULTS

Stakeholder identification

The stakeholders were beneficiaries who directly involved and got benefit. They were identified and established the reason of inclusion. Total of 5 stakeholders, including Local governments (LGs), volunteers, farmers, communities, and Ching Mai University (CMU), were included in the evaluation. While the Department of Livestock Development (DLD) officer was excluded (Table 1). The direct impact was a main reason that was used in consideration process.

Impact Map

The impact map was created after getting the data from selected stakeholders. In SROI, some stakeholder had input, activities, output, and outcome, but some stakeholder had outcome without input, activities, or output. The intended stakeholder were LGs and volunteers, however farmers, communities and the university can obtain the impact from the system (Table 2).

Table 1 Show the list of stakeholders.

Stakeholders	Included/Excluded	Reason
LGs	Included	They were key stakeholder and key element of the system
Volunteers	Included	They were key stakeholder and key element of the system
Farmers	Included	They received the direct impact when animal disease was detected
Communities	Included	They received the impact from human and environmental problems were monitored and detected in their community
Chiang Mai University	Included	They can use the PODD system as a showcase for general people and funders to gain more collaboration and support
DLD officers	Excluded	They were technical people who help LGs and volunteers to defend with animal disease outbreak in community, but they did not change in any aspect.

Table 2 Show the impact map of the PODD system.

Stakeholder	Input	Activities	Output	Outcome
LGs	Time and resources for participation	Responded any abnormal event and supported community volunteers	75 LGs had participatory disease surveillance system	1. Save the budget for outbreak prevention 2. Increase the confidence of their ability 3.Increase community acceptance 4. Gain more reputation 5. Create change agent in community 6. Concern about workload increasing (Negative impact)
Volunteers	Time for training	Trained and reported abnormal event	4436 trained volunteers	1. Gain more reputation 2.increase technology skill 3. Increase the confidence of their ability when approach to farmers 4.Conflict with local officers (Negative impact)
Farmers	Time for meeting		26 backyard chicken raiser groups	1. Reduced the animal loss from disease 2. Raise an awareness about animal disease 3. Get the strong network among backyard chicken raiser groups
Communities			500 villages had the disease surveillance system	1. Reduce the loss from Dengue fever 2. Maintain food security in community 3. Reduce the risk of Rabies 4. increase internet accessibility
Chiang Mai University				1. Gain more reputation

Valuation

The data from stakeholders were collected by focus group discussion, in-depth interview and report review. The stakeholders were asked about the changing in their thoughts, behaviors and status. Those changing need to be an effect from PODD system implementation during January 2015-December 2016. After getting the data from stakeholders, the indicator and financial proxy was used to calculate the monetary impact of each individual as show in Table 3.

Table 3 Show the outcome valuation according to the stakeholders.

Outcome	Indicators	Quantity	Source of data	Financial proxies	Quantity (Thai Baht)	Source of data
	Local governments					
1. Save the budget for outbreak prevention	Number of participated LGs	75	PODD final report	Average budget that LGs used for disease prevention	30,000	Interview
2. Increase the confidence of their ability	Number of participated LGs	75	Interview	Cost of building self-confidence course	15,000	Pichawee Academy
3.Increase community acceptance	Number of participated LGs	75	Interview	LG Public relationship cost for one event	240,000	Cooperative Auditing Department
4. Gain reputation	Number of participated LGs which showed outstanding results	26	PODD final report	LG Public relationship cost for one event	240,000	Cooperative Auditing Department
5. Create change agent in community	Number of outstanding officers	75	Interview	Cost of building leadership course	11,700	SeminarDD Academy
6. Concern about workload increasing (Negative impact)	Number of officers that reported their concern	150	Interview	Cost per head of meeting for making understanding among officer	360	Interview
	Volunteers					
1. Gain more reputation within community	Number of volunteers who report that they get reputation	436	PODD final report	Cost of building self-esteem	12,000	Pichawee Academy
2.increase technology skill	Number of volunteers who report that they have more skill	3016	PODD final report	Cost per head of basic digital mobile technology training course	890.25	Nakhon Sawan Rajabhat University
3. Increase the confidence of their ability when approach to farmers	Number of volunteers who report that they have more confidence	436	PODD final report	Cost of building self-confidence course	15,000	Pichawee Academy
4.Conflict with local officers (Negative impact)	Number of LGs that report the conflict	3	Interview	Cost of meeting for making understanding between volunteers and local officers	-5,000	Interview

Table 3 Show the outcome valuation according to the stakeholders. (Cont.)

Outcome	Indicators	Quantity	Source of data	Financial proxies	Quantity (Thai Baht)	Source of data
	Local governments					
	Farmers					
1. Reduced the animal loss from disease	Number of chickens that can be protected	43,355	PODD final report and DLD livestock statistic	Backyard chicken price per head	95	Maejo University
	Number of FMD outbreak that can be controlled	1	PODD final report	The economic loss of FMD outbreak in dairy cattle farms	5,049,425	Laiya et al., 2020
	Number of pigs that can be protected	1,169	PODD final report	Backyard pig price per head	5,696.80	The Swine Raisers Association of Thailand
2. Raise an awareness about animal disease	Number of farmers that report their awareness	8,000	Interview	Cost per head of animal disease training for farmers	2,000	Chiang Mai University
3. Get the strong network among backyard chicken raiser groups	Number of Chicken that increase within backyard chicken raiser groups	31,661	PODD final report	Backyard chicken price per head	95	Maejo University
	Community					
1. Reduce the loss from Dengue fever	Number of patients in pilot area that decrease when compare between 2016 and 2015	198	Nakhon Ping Hospital Chiang Mai	Cost per head of Dengue fever treatment	27,760	Shepard et al., 2013
2. Maintain food security in community	Number of backyard chickens that increase in pilot area	75,016	PODD final report and DLD livestock statistic	The difference price between chicken in community and outside	10	Interview
3. Reduce the risk of Rabies	Number of populations in pilot area that decrease the risk of Rabies infection	3,396	Thai Red Cross and DLD livestock statistic	Cost per head of animal bite for Rabies prevention	8,000	Expert opinion
4. increase internet accessibility	The population in Huay Sai, Mae Rim, who reported that internet provider company expanded the service after applying PODD system	4,637	Huay Sai Local government	The increased income per head caused from increase internet accessibility	188.65	Punyasavatsut, 2019
	Chiang Mai University					
1. Gain more reputation	Number of awards	5	PODD final report	LG Public relationship cost for one event	240,000	Cooperative Auditing Department

Establish impact

After the indicator and financial proxy were identified, the adjustment with Deadweight, Displacement, Attribution and Drop off were added for calculating. The data in adjustment part was collected and validated by stakeholders. The stakeholders were asked to indicate the percentage of individual adjustment criteria. The results of each outcome were showed in Table 4. The PODD system was a disease surveillance system which complement with traditional system. Thus, many outcomes occurred by the contribution of other organizations. Particularly, the reduction of animal loss from the disease was achieved by the contribution from PODD system and DLD surveillance system. In this study also indicated that outcome of PODD system implementation did not replace another outcome. The outcome of LGs and volunteers, including LG officers concerned about workload increasing and volunteers conflicted with the local officers, were negative impact. The negative value was applied and occurred in the table. Eventually, those negative value deducted overall impact.

Estimate the SROI ratio

After valuated the impact, the total input was 61,220,000.00 Thai Baht, while the return of the outcome was 150,726,452.07 Thai Baht. Thus, the SROI ratio was 2.46 times. This number indicated that the developer invested money in the system development for 1 Thai Baht, they got impact (in money term) back 2.46 Thai Baht. When divided the impact according to the stakeholder (Figure 1), it showed that farmers received the highest positive impact 31.98%, while LGs and volunteers received the impact 26.84% and 20.04%, respectively. The community and Chiang Mai University got the impact from the system 18.13% and 3.01%, respectively. The main impact of PODD was social impact. It was 73.89%, while economic impact was 26.11%. This study indicated that during 2015-2016, PODD system did not create the environmental impact (Figure 2).

Table 4 show the adjustment of outcome impact and calculated impact of individual outcome.

Outcome	Deadweight	Displacement	Attribution	Drop off	Impact
Local governments					
1. Save the budget for outbreak prevention	0%	0%	0%	0%	2,250,000.00
2. Increase the confidence of their ability	20%	0%	0%	0%	900,000.00
3.Increase community acceptance	30%	0%	50%	0%	6,300,000.00
4. Gain reputation	30%	0%	30%	0%	3,057,600.00
5. Create change agent in community	0%	0%	0%	0%	877,500.00
6. Concern about workload increasing	0%	0%	0%	0%	-54,000.00
Volunteers					
1. Gain more reputation within community	30%	0%	30%	0%	2,563,680.00
2.increase technology skill	10%	0%	30%	0%	1,691,815.43
3. Increase the confidence of their ability when approach to farmers	0%	0%	30%	20%	2,609,460.00
4.Conflict with local officers	0%	0%	0%	0%	-15,000.00
Farmers					
1. Reduced the Chicken loss from disease	0%	0%	0%	0%	4,118,711.43
2. Reduced the Dairy loss from disease	0%	0%	0%	0%	5,049,425.00
3. Reduced the Pigs loss from disease	0%	0%	50%	0%	3,329,189.57
4. Raise an awareness about animal disease	10%	0%	30%	0%	6,610,132.6
5. Get the strong network among backyard chicken raiser groups	20%	0%	0%	0%	2,406,236.00
Community					
1. Reduce the loss from Dengue fever	50%	0%	50%	0%	7,234,807.33
2. Maintain food security in community	10%	0%	0%	0%	675,142.71
3. Reduce the risk of Rabies	30%	0%	30%	0%	775,600.00
4. increase internet accessibility	30%	0%	30%	0%	428,646.36
Chiang Mai University					
1. Gain more reputation	0%	0%	0%	0%	1,200,000.00

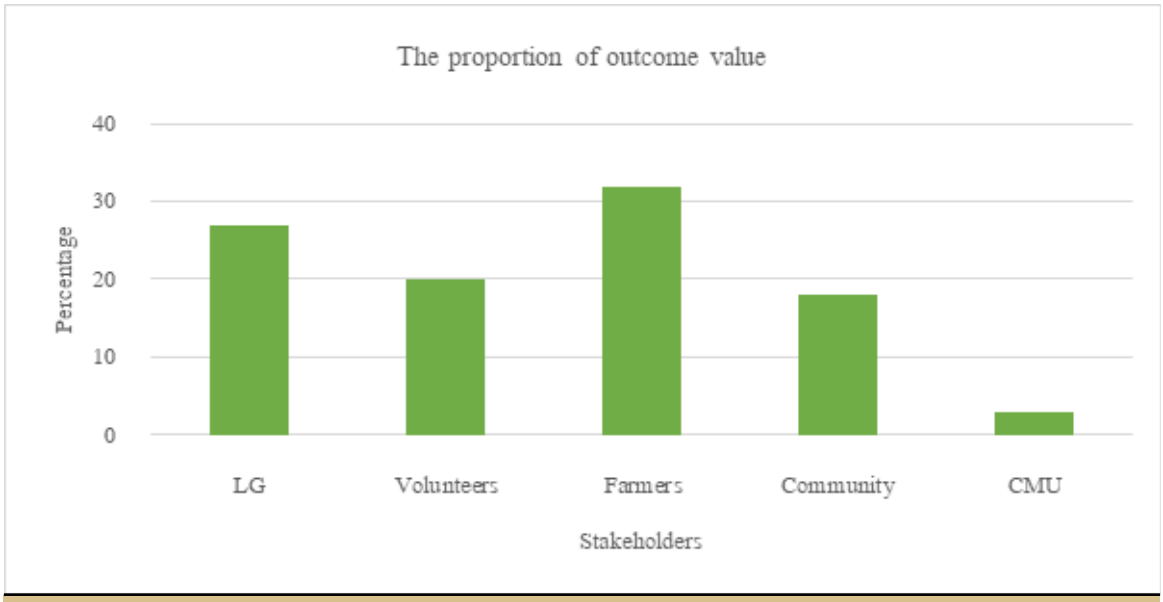

Figure 1 Show the proportion of outcome value, divided by stakeholders.

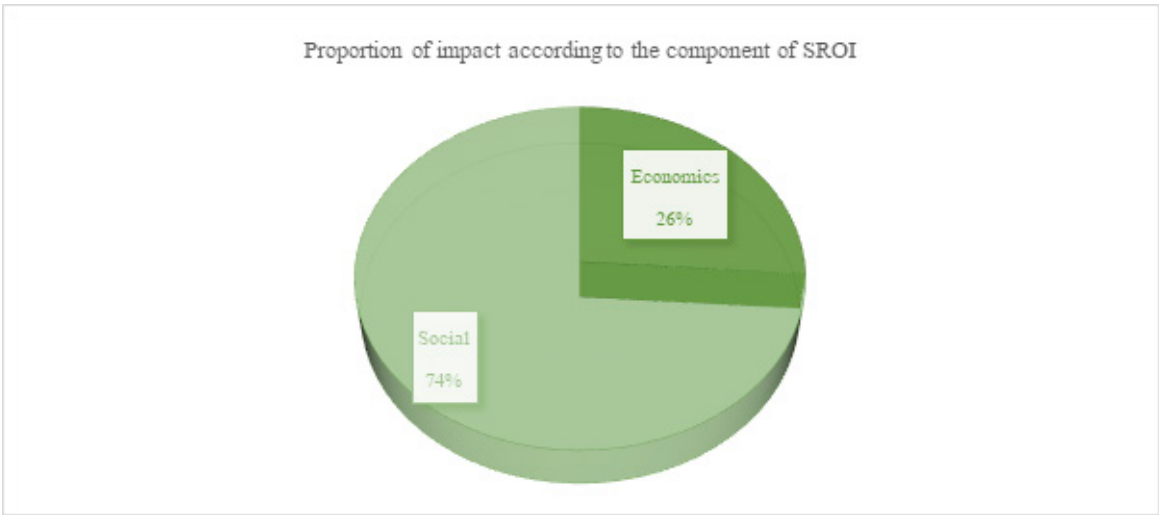

Figure 2 Show the proportion of impact, divided by the component of SROI.

DISCUSSION

The PODD system has been implemented in Chiang Mai Thailand, since 2015. This study indicated that PODD system created positive impact, especially social and economic impact, on community. The impact was evaluated during the early stage of system implementation. The SROI ratio of PODD system was 2.46. It was in the range of SROI ratio in public health area, which range between 1.1-65.0 (Banke-Thomas et al., 2015).

Originally, The PODD system aimed to empower community, mainly LGs and volunteers, to encounter the health problems primarily with their capacity and facility. The contingency plan has been provided to control the sudden death in backyard chicken. LGs and volunteers had been monitored and received the recommendation to improve their performance. The results indicated that LGs played got an impact in several aspect. They increase

their capacity in disease control and can prevent the outbreak in either human or animal. The volunteers also gain more knowledge and skill in disease surveillance, especially in livestock.

Even though, LGs and volunteers got huge impact from the system, the farmers in the study area got the highest impact among related stakeholders. This was spillover effect of the system. The PODD surveillance system was created for volunteers and LGs. They can use the system for monitor the health problems in their community. Not only human health but also animal health was focused. The LGs and volunteers using PODD system to prevent the livestock diseases, including chicken, pigs and cattle. Its impact occurred directly the farmers because it can prevent the loss of their animal. The infectious animal diseases could create the negative impact on UN Sustainable Development Goals and effect to global (Charlier et al., 2022). The PODD can early detect outbreak in animal and encourage the community to control the outbreak rapidly. It has potential to prevent the emerging disease at the lowest level.

Community was another stakeholder that did not provide input or get the output, but they got the positive impact, especially Dengue and Rabies prevention. The people in community should be inform about the role and utility of PODD system. This activity will engage the regular people in community to be part of the system. Farmers, who lives closely to their animal, and regular people in community could be recruited into the system by encourage them to be volunteers and report their animal disease to the system. They can be a system driver together with LGs and volunteers.

PODD system got many awards from different organization, either national or international level. It can be a flagship system that Chiang Mai University can utilize. The system can be promoted in Southeast Asia. It would create strong collaboration between country in the region to prevent transboundary diseases.

The SROI also recommended that social impact can be established in community. The impact of PODD system should be announced to community members. It will engage the key stakeholders in the future. The government, especially Department of Livestock Development (DLD), should invest the disease surveillance system at community level. This study indicated that the return was higher than the investment and the cost of prevention always cheaper than the cost of problem solving. The participatory disease surveillance should be performed in community level to prevent pandemic. It can be easily adapted for communication and data sharing between public and authority to prevent specific disease outbreak (McNeil et al., 2022)

In the future, PODD system could be adopted by community to be a tool for One-health problem control and prevention. LGs can be a key component who facilitates PODD system in community. They can create new feature of the system to solve their own problems. The individual community has different problems and different solving. They can share their experiences and learn from the others.

ACKNOWLEDGEMENTS

The authors would like to thank the key stakeholders who provided valuable data, the PODD center, Chiang Mai University for providing the information and opportunity of the study. Special thanks also go to Ending Pandemic (former was the SKOLL Global Threats Fund) for supporting the funding for PODD development.

AUTHOR CONTRIBUTIONS

TY: data management; conceptualization; methodology; data collection; data analysis; writing original draft preparation; paper framework and scope; manuscript preparation.
TK: data collection; data analysis; interpretation; manuscript preparatio.
KN: conceptualization; interpretation.
CS: data collection; interpretation; conceptualization.; manuscript manuscript preparation.
LS: interpretation; conceptualization; validation; supervision.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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How to cite this article;

Terdsak Yano, Tossapond Kewprasopsak, Kannikar Na Lampang, Charuk Singhapreecha and Lertrak Srikitjakarn. The social return on investment of participatory digital disease detection system for One-Health problems in community. Veterinary Integrative Sciences. 2023; 21(3): 899 - 912.