

Designing emergency support functions for functional exercise. A case study in field of firefighting in Haiphong, Vietnam

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Abstract. Hazard and risk of accidents exist all over the world as part of human life. From developed countries as United State of America and Japan to developing countries as Indonesia and Vietnam; governments, organizations and communities share their specific responsibility in emergency management depending on history of disasters, policy structures and cultures. Emergency training and exercise are important programs to enhance the resilience of society. The Deming cycle known as Plan-Do-Check-Act (PDCA) cycle is effective instrument for continuous improvement of management. Therefore, doing preparedness exercises play a significant role of emergency plan improvement. Our research focuses on how to evaluate adequacy of emergency plans and resources of organizations through table-top and functional exercises. In particular, we research on designing effective exercises for emergency relief organizations. Through reviewing different styles of functional exercise, we introduce and verify idea of Kitakyushu functional exercise (KFEX) in Vietnam. KFEX is a new style of doing functional exercise by providing methods of exercise design, data observation and results analysis. It provides possibility to evaluate quantitatively trainee performances through timing each task of participants and utilizing a cloud support-software tool for functional exercise. To apply KFEX in context of Vietnam, we designed a functional exercise in considering the structure of emergency relief organizations. Haiphong Police of fire prevention and fighting (Haiphong PoFF) has been defined as a case study to expand KFEX idea. Because emergency support functions (ESFs) are foundation to design exercise, we proposed and checked ESFs for functional exercise in Haiphong city, Vietnam. In March 2017, we implemented the demonstration of function exercise as a feasible study for applying idea of KFEX. Participants in the demonstration include Controller group, Evaluator group and Player group, those belonged to Haiphong PoFF. Task processing network and time consumption for each task were recorded by software support tool. In this paper, we will explain process of exercise design and share results after the demonstration in Haiphong PoFF. Keywords— emergency management; functional exercise, firefighting; emergency plan.

1. Introduction

An emergency is defined as exceptional event that exceeds the capacity of normal resources and organization to cope with it [1]. Exceptional events are objective factors affecting to organizations and communities that generated by nature and in the process of economic development. Human being has to learn how to prevent and face with the hazardous things than escape from them. In an organization, safety level is known with the resistance and resilience capacities. Resistance is the ability of an organization to cope with disasters through existing infrastructures and equipment while resilience of the organization is human capacity in preparedness and effective response, recover from toughness. When overall impact of hazardous higher than safety level of the organization, it becomes a disaster with specific consequences. Emergency events are becoming more complexity due to climate change, increase carbon emissions and deforestation [2]. Therefore, there is high demand to enhance safety levels of organizations against higher risk of disasters.

According to report of each nation, Japan, Indonesia and Vietnam are defined as most disaster prone countries in the world. In Indonesia, recently earthquake and landslide in West Sumatra in 2009 killed 1,100 people and approximately 265,000 collapsed houses [3]. In Japan, the Great East Japan Earthquake with multi-disasters including earthquake, tsunami and nuclear accidents caused huge damage of human casualties and damage costs estimated about 14,508 deaths and 11,452 missing people; 76,000 collapsed houses [4]. In Vietnam, as report from General Statistics Office, Vietnam has lost 0.4% of Gross Domestic Product per year by natural disasters. In 2016, more than 3000 fires accidents were occurred in Vietnam.

Emergency response exercise is a key component of a good emergency preparedness program through providing unique insight in the stage of preparedness of emergency response organizations [5]. To improve readiness for emergency response, it is considered through evaluating plans and operations, reinforcing teamwork, demonstrating a community's resolve to prepare for incidents. Other potential targets of exercise are clarifying roles and responsibilities, improve interagency coordination, find resource gaps, develop individual performance, and identify opportunities for improvement [6]. Figure 1 shows PDCA cycle for continuous improvement of an organization.

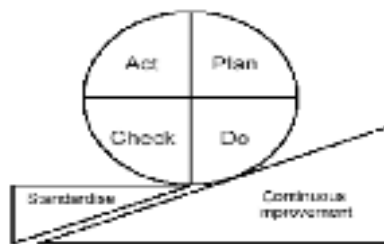


Figure 1. PDCA cycle (Job connect the right people, 2010)

In emergency management, “Do” in PDCA cycle implies practicing in disaster events or exercises. Therefore, conducting a comprehensive exercise program in emergency management is better than waiting for an actual disaster with damages. From PDCA cycle, preparedness plan, exercise and its evaluation play significant roles for emergency management. Currently, there are various types of exercise including seminars, workshops, tabletops, drills, functional exercise and full-scale exercise. Among them, functional exercises mainly are used for strength cooperation and collaboration among sectors during emergency cases. Hence, we are going to suggest better functional exercise for emergency relief organization. In field of firefighting and rescue, we are cooperating with Haiphong Police of fire prevention and fighting (Haiphong PoFF) to verify KFEX idea to apply in structure of organization. To create background for functional exercise as KFEX idea, one of the most important task is to create Emergency Support Functions (ESFs) and task processing network among sectors. In our study, an ESF refers to a group of actions or operations required in emergency response.

2. Case Study And Research Approach

2.1 Case study

Considered as the gateway to the sea of Northern Vietnam, Haiphong city is an important port city, industrial center and the largest seaport in the North of Vietnam. The geographical location of Haiphong has many advantages for economic development but it also prone of high risks of natural disasters and incidents. Together with process of industrialization and urbanization, Haiphong city faces with high risk of fire accidents. Total number of fire accidents was increasing from 205 cases in 2012 to 355 cases in 2016. During this period, number of fire cases were increased 1.5 times but property damage in 2016 was 5 times as high as it was in 2012. It reveals that more serious damage from larger fire scale in Haiphong city. Therefore, it requires better co-operation among local and professional forces, communities and relevant organizations in this field of firefighting and rescue.

In emergency management, main type of exercise in Haiphong city is the drill exercises that focus on field responders in firefighting and rescue. Fire-fighting plans are developed by local areas as

guidelines to implement drill exercises. However, functional exercise that focuses on enhancing cooperation among forces in large disaster has not been conducted in Haiphong city. In this direction, we are designing functional exercises for the field of firefighting and rescue in Haiphong city, Vietnam.

2.2 Research approach

As research diagram in Figure 2, we firstly reviewed current implementation of functional exercise. Then, typical functional exercise and Kitakyushu functional exercise (KFEX) in Japan were compared. Secondly, organization structure and information connecting network in responding to fire cases were reviewed before we proposed ESFs for Haiphong city. After that, we designed and conducted a demonstration for functional exercise in Haiphong PoFF.

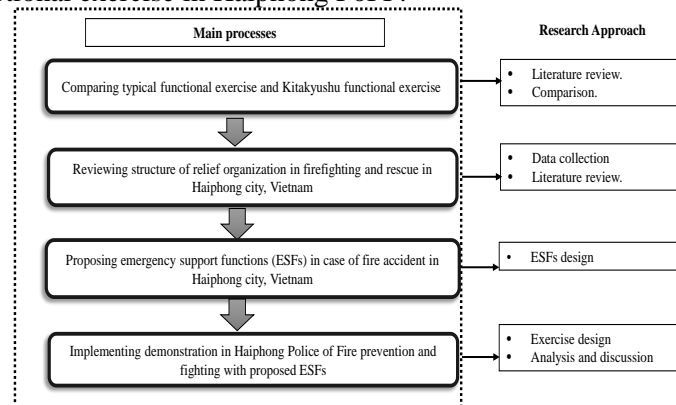


FIGURE 2. Research Diagram

3. Functional Exercise And Kfex

3.1 What is functional exercise?

Functional exercise is simulated perform exercise where players are requested to fill in their tasks in emergency events in simulated rooms. Functional exercises are typically focused on exercising plans, policies, procedures, and staff members involved in management, direction, command, and control functions [7]. The functional exercise is designed to simulate realistic scenario develop in actual incidents. As the name suggests, this type of exercise is conducted to evaluate the capability and performance of trainees in the exercise. In United State of America, ESFs are contained in emergency operation plan (EOP) of each organization. In Japan and Vietnam, understanding about ESFs is still limited. By referring document of Federal Emergency Management Agency (FEMA), we simple define ESFs as groups of action or operation required in emergency response.

Compared with other types of exercise, functional exercise is more realistic and stressful, time-constrained environment; but it does not require deploying the field teams and equipment as drill exercise. More complexity than discussion-based exercise as seminar or table-top exercise, functional exercise is operational-based exercise that requires players making decisions, simulating the deployment of resources, and responding to new development of incidents. In functional exercise, facilitator sends the initial scenario and injects as decided timeline while players are requested to respond to the scenario and implement their tasks. Evaluators record and evaluate actions of players to compare with their assigned tasks of emergency operation plan. After exercise, a hot-wash section and review processes provides lessons to participants.

Typical functional exercises have following characteristics: 1). Exercise events are driven by scenario updates that reflect ongoing events and problems that might occur in a real emergency, 2). Performance analysis is part of the overall exercise, 3). Established policies and procedures, expected actions that pertain to the scenario are inspected, 4). Cooperative and decision making network are examined, 5). A Master Scenario Events List (MSEL) is the primary tool that drives exercise play. MSEL includes list of events, event time, event description, expected player action.

3.2 Typical functional exercises and their evaluation

The success of an exercise ultimately rests on the evaluation process that is used [8]. Evaluation process includes how well the exercise met its priority objectives and what is possibility improvement point of an organization for emergency response. It supports concept of PDCA cycle for continuously improvement of emergency management. A comprehensive exercise management program should involve exercise evaluation program (EEP) as an instrument to improve capability of the organization. Appropriated EEP will contribute to effectively conducting emergency exercises to achieve its goals. However, there are various difficulties and barriers during planning exercise program.

After action report (AAR) is common used to measure the performance and provide lessons learned after conducting exercise. However, AARs are common in descriptive style other than quantitative or standardized assessment. In the United State of America, an exercise evaluation guide (EEG) form was developed by Homeland Security Exercise and Evaluation Program (HSEEP) for functional exercise. Moreover, functional exercises in public health emergency frequently conduct in hospitals with long history of development in evaluation checklists. However, they have not used evaluation checklists with time measurement and clear task processing network among sections. Currently, evaluators make observation notes and explanation of rating from his/her own thinking through a range of rating for critical tasks. The range of rating is decided following exercise evaluation method.

3.3 Kitakyushu function exercise (KFEX)

As above discussion, functional exercise includes exercise design, exercise implementation, observation and evaluation. KFEX style has two main differences in comparison with typical functional exercise. Firstly, there is difference in designing steps of functional exercise. In KFEX, ESFs are defined before creating disaster narrative and list of major events. Each ESF is group of critical tasks in the exercise that intend to evaluate player's performance. After considering ESFs, critical tasks and task processing network are defined as next steps. All information is summarized in master list of functions and task networks. Exercise narrative and list injects, expected actions are followed up. Secondly, KFEX style is available for quantitatively evaluating player's performance. Through recording start and end time for each task in functional exercise, evaluators can measure performance quality of participants in quantitative ways.

KFEX was conducted in Kitakyushu city in 2014 for responding and recovering from an earthquake. Exercise designers created 19 ESFs for emergency management in Kitakyushu city. From 19 ESFs, disaster narrative and major injects were provided. KFEX in 2014 involved 488 participants from organizations to practice in two sections including response and recovery with 503 injects. Table 1 shows 19 ESFs of Kitakyushu functional exercise.

Table 1. 19 ESFs In Kitakyushu Functional Exercise.

ESF	Title	ESF	Title
1	Command and control	11	Public facility safety
2	Backup request	12	National relief law application
3	Volunteer coordination	13	Livelihood support
4	Communication	14	Health support
5	Evacuation warning	15	Body recovery
6	Shelter preparation	16	Epidemic prevention
7	Shelter operation	17	Garbage treatment
8	Logistics	18	Sanitation
9	Rescue	19	Water supply
10	Recovery		

Annually, training exercises with KFEX idea are applied for Disaster Medical Operation Center in Kitakyushu city from 2014. Five groups of tasks are established in exercise including coordination

group, logistics group, shelter group, site group and hospital group. According to given injects, players in each group cooperate with each other to decide how to deal with issues. By clear defining task processing network for each inject, KFEX style provides chance to record time spent on each task of participants. Hence, quantitatively and objectively observed data is high valuable for exercise managers to create AARs for “quality improvement” purposes.

4. Emergency Management In Fire Accidents In Vietnam

4.1 Relief emergency organizations for responding to fire and rescue activities.

In general, emergency management in Vietnam is decentralization system and single-hazardous approach. Moreover, national government emphasizes on the principle of “Four on the spot” which includes leadership, forces, means and logistics. The principle requires local authorities to actively prepare for responding to disasters in their territories. In the field of firefighting and rescue, forces of fire prevention and fighting are established at local levels and city levels. The relief organization in responding to fire accidents is dealing by Haiphong PoFF with professional forces. In fire accidents, several of organizations are co-operated to response but Haiphong PoFF is defined as primary force to lead and respond in firefighting and rescue. Therefore, Haiphong PoFF needs to co-operate with other relative organizations including grassroot firefighting teams, local people committee, medical department, polices and so on.

4.2 Proposing ESFs for city level in fire accidents

From idea of KFEX to design functional exercise, creating ESFs for exercise is first step in exercise design. Firstly, we proposed ESFs for case of fire accidents in city level based on the current co-operation among organizations. Figure 3 shows six typical ESFs in responding to fire accidents in Haiphong city. ESFs in fire accidents include not only function of firefighting and rescue but also other functions. An ESF is operated through co-operation among primary organization and support organizations. The figure also provides an example of task processing network in ESF “Firefighting and Rescue” with three sections: information gathering and discrimination; decision making; execution. Task processing networks and number of involved sections are different among organizations. The example of task processing network is created for processes in headquarter of Haiphong PoFF.

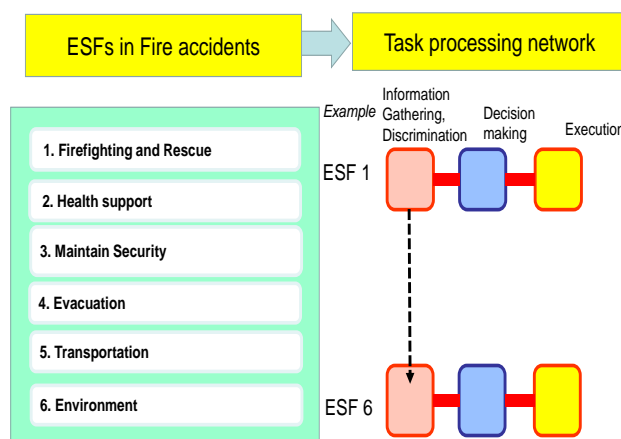


Figure 3. ESFs in fire accidents for city level

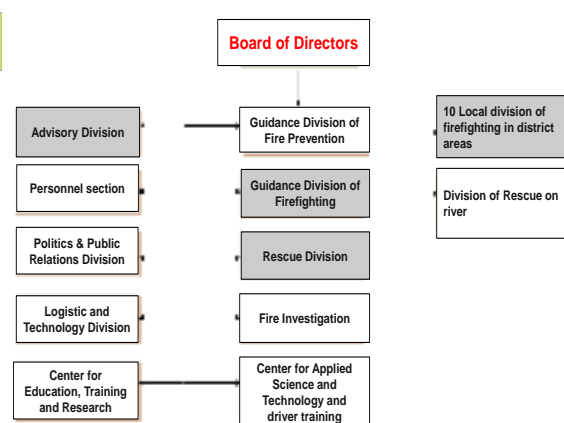


Figure 4. Organization structure of Haiphong PoFF

During exercise design, carefully reviewing ESFs and task processing networks are compulsory tasks for designers. Depending on scale and objectives of functional exercise, some other ESFs could be added and eliminated. If exercise focuses on a specific organization, mini ESFs for that organization could be necessary to design exercise and its evaluation.

4.3 Designing mini ESFs for relief organization in ESF “Firefighting and Rescue”

Haiphong PoFF is primary relief organization in ESF “Firefighting and Rescue”. Firstly, organization structure of Haiphong PoFF is represented in Figure 4. Haiphong PoFF includes 21 divisions with

their specific roles in which 14 divisions are in charge of directly responding to fire accidents. These divisions are advisory division, guidance division of firefighting, rescue division and 10 local divisions of firefighting.

As the emergency relief organization in case of firefighting and rescue, organization structure of Haiphong PoFF can be compared with Incident Command System (ICS). ICS represents "best practice" and has become the standard structure for emergency management in the United State of America [9]. Figure 5 presents typical ICS structure with five major functional areas: command, operations, planning, logistics, and finance and administration.

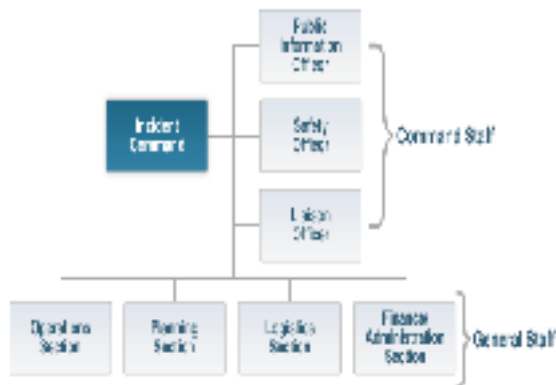


Figure 5. Typical ICS structure

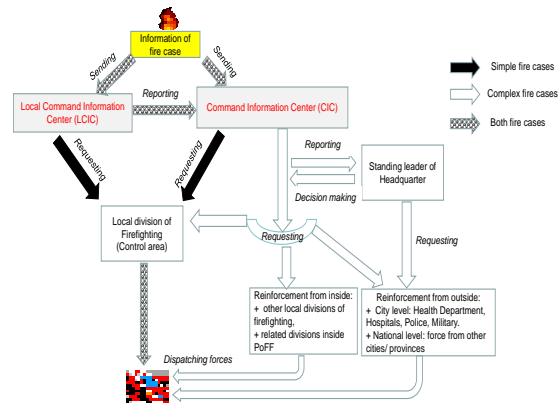


Figure 6. Receiving and Handling Information in Haiphong PoFF

By reviewing ICS structure and responsibilities of divisions in Haiphong PoFF, we could find the differences between structures (Table II). Five major functions of ICS structure are assigned to mission of several divisions in Haiphong PoFF. Logistics and Finance/Administration are tasks of one division "Logistics and Technology" in Haiphong PoFF. The differences of structures explain diversity of emergency management system among nations.

Table 2. Organization Structure Of ICS And Haiphong Poff

No	ICS structure	Haiphong PoFF
1	Command	- Board of Director, - Information Command Center
2	Operation	- Rescue Division. - Guidance Division of Firefighting. - 10 Local Division of firefighting
3	Planning	- Advisory Division, - Guidance Division of Firefighting, - Rescue Division
4	Logistics	Logistics and Technology Division
5	Finance/ Administration	Logistics and Technology Division

Therefore, to design appropriate functional exercise for Haiphong PoFF, we need to review responsibilities of each division and task processing network. Moreover, mini ESFs were proposed inside Haiphong PoFF to design functional exercises.

Figure 6 explains how the information processing takes place from receiving information of fire case to handling and dispatching forces to the scene. The process is implemented in headquarter of Haiphong PoFF. Depending on scale of fire case, task processes network and activated forces will be different. When fire accident becomes more complicated, reinforcement notices will be sent to other support divisions inside and outside Haiphong PoFF. Command Information Center plays core role in information process of headquarter. By reviewing structures, networks and responsibilities of divisions, mini ESFs for Haiphong PoFF were proposed in Table III. This table also explains role of

Haiphong PoFF as primary organization to response fire accidents while other organizations support Haiphong PoFF during incidents. Information network is defined from operation of headquarter in Haiphong PoFF when they receive fire information and processing to dispatch forces to the scene. The same network is also used when field commander contacts headquarter of PoFF for forces reinforcement. However, it is to note that when temporary headquarter is established in the scene in the situation of large fire scale, information network will be different.

Table 3. Mini Esfs At Organizational Level

ESF		Firefighting and Rescue
Involved Organizations	Primary organization	Haiphong Police of fire prevention and fighting (Haiphong PoFF)
	Support organization	- Grassroots and specialized forces of firefighting - Firefighting forces of other provinces - Health department, Hospitals
Information network	Information gathering, discrimination	- Local Command Information Center - Command Information Center
	Decision making	- Leader of local division of firefighting - Standing Leader of Haiphong PoFF
	Execution	- Force of local division of firefighting, Rescue division - Other co-operated forces
Mini ESFs of PO	ESF 1	Command
	ESF 2	Coordination
	ESF 3	Field response
	ESF 4	Firefighting instructions
	ESF 5	Logistics, facility management
	ESF 6	Public relation
	ESF 7	Fire investigation

In March 2017, we conducted a demonstration of functional exercise in Haiphong PoFF to explain idea of KFEX and test networks for ESFs “Command” and “Coordination”. In the demonstration, three groups including exercise controller, evaluator and player were assigned from officers of Haiphong PoFF. During the demonstration, a support-software tool was also used to measure processing time in each task.

4.4 Exercise scenario and results of the demonstration in Haiphong PoFF

From objectives of the demonstration, ESFs: “Command” “Coordination” was chosen to evaluate and measure time of task processing. Exercise scenario and three injects were designed to check task processing network for those ESFs. Scenario: Fire accident is occurred in “Sat” market at 206 QuangTrung street, Hong Bang district, Haiphong city. Local Police Station No. 2 came to the scene with two fire engines. However, the fire has growing more complexity. It needs to reinforce forces to the scene. Inject 1: Field commander contacts to local Command Information Center for reinforcing 02 aerial ladders, 04 tank cars, 02 car carrying firefighting forces.

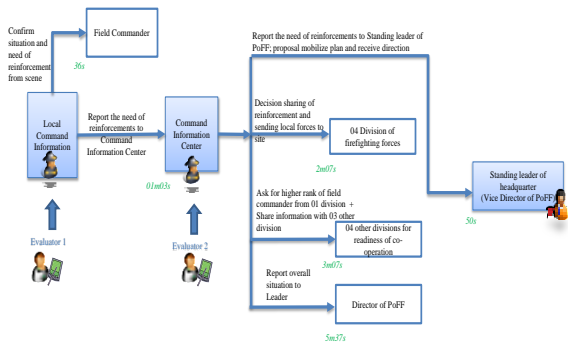


Figure 7. Task process and recorded time of Inject 1

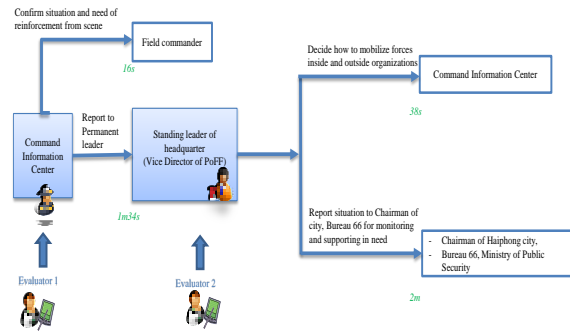


Figure 8. Task process and recorded time of Inject 2

Inject 2: Fire spreads to surrounding areas, water pressure of fire hydrant near the fire area is reduced. Water in the car tank is low. Field commander requests to Command Information Center for supporting experienced staffs and facilities to pump sea water from 1 km away. Inject 3: At the scene, many buildings were collapsed that caused trapping and injuries to 20 and 50 people. Field commander asks Command Information Center to support for setting first aid stations and reinforcing firefighting cars and ambulances.

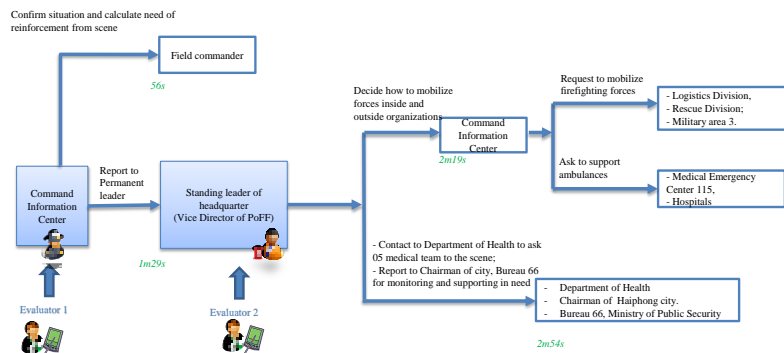


Figure 9. Task process and recorded time of Inject 3

5. Discussion And Conclusion

5.1 Discussion

Three main groups of player who were representative for local Command Information Center, Command Information Center, Standing Leader of headquarter were recorded task processing time. Inject 1 focuses on tasks of Command Information Center while Inject 2 and 3 is used to consider tasks of Standing Leader of headquarter. Three evaluators were assigned to record time for each task of main players. Because the demonstration was designed to test ESFs “Command” and “Coordination”, other players were simulated to be interactive with main players. Tasks of main players were divided into four types: confirm, report, co-ordinate, decision making. Table IV and Figure 10 explain task list for ESFs and average spent time for each type of task.

Table 4. Task List In Mini Esfs And Types Of Task.

ESF	Division	Task list	Type of task
Command	Standing Leader of headquarter	Decision making for mobilizing forces.	Decision making
		+ Report situation to leader of city and Ministry of Public Security + Ask for support from other organizations (high level)	Report
	- Local Command	Confirm current situation and	Confirm

Information Center,	information from field commander	
- Command Information Center	+ Define needs of reinforcement + Report to Standing Leader of headquarter	<i>Report</i>
	Sharing decision of Standing Leader of headquarter to other divisions	<i>Co-ordinate</i>
	Ask for support from other organizations (medium level with approval coordination mechanism)	<i>Co-ordinate</i>

In the demonstration, longest average time was used for task “decision making” while seven times of “report” were implemented. Since it was first time for officers from Haiphong PoFF get experiences in functional exercise, script was provided in advanced to players. Through the demonstration, players were obtained systemic knowledge of their task connection and “evaluators” were introduced first time in emergency exercise in Haiphong city. They practiced on support tools to record processing time of tasks of players.

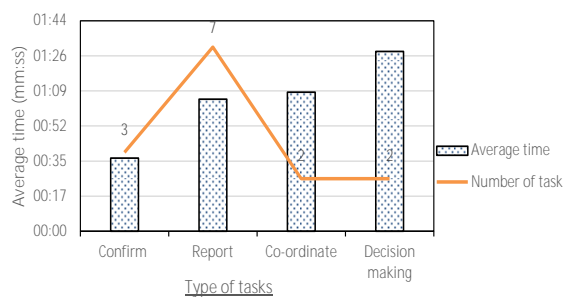


Figure 10. Average spent time for each type of task

Meanwhile, we defined some limitations of the demonstration in March 2017. In particular, the demonstration used small number of injects (03) because of constraints of time and preparation. Among seven mini ESFs, we reviewed networks of tasks in only two ESFs. We also found type of task that is “Report” which was conducted by both command and co-ordination functions. Therefore, better exercise design and larger number of injects are required for the next functional exercise in Haiphong city.

5.2 Conclusion

In this paper, we explain roles of functional exercises in emergency management system. An effective functional exercise for training requires good exercise evaluation program. There are different approaches in designing and evaluating functional exercises. In compassion with typical functional exercise, KFEX applies new idea in exercise design and quantitative evaluation method. In KFEX style, ESFs are foundation for the designing of functional exercises.

ESFs were proposed for functional exercise in field of firefighting in Haiphong city, Vietnam. In fire accidents, six ESFs for city level and seven mini ESFs for Haiphong PoFF were considered. In March 2017, the first demonstration was conducted to consider mini ESFs “Command” and “Coordination” in headquarter of Haiphong Police of Fire prevention and fighting. Moreover, software-support tool for functional exercise was also used in this demonstration to record and observe exercise data. This result creates possibility for quantitative analysis performance of players. In our next activity, larger number of injects and more comprehensive exercise design are going to be prepared for functional exercise in Haiphong city.

References

- [1] A. David, “*Principles of emergency planning and management*” in Terra Publishing, 2012, pp. 1.

- [2] R. Few, “*Health and climatic hazards: framing social research on vulnerability, response and adaption*” in *Global environmental change*, 2007, 17 (2), pp. 281-295.
- [3] Fesneau, “*Assessment and options for disaster risk reduction program in Indonesia*”. ISAID/Indonesia Jakarta, 2011.
- [4] N. Mimura, K. Yasuhar, S. Kawagoe, et al., “*Damage from the Great East Japan Earthquake and Tsunami*” in *Mitig Adapt Strateg Glob Change*, 2011.
- [5] International Atomic Energy Agency. “*Preparation, conduct and evaluation of exercises to test preparedness for a nuclear or radiological emergency*”, 2005.
- [6] Federal Emergency Management Agency, “*IS-120.A: An Introduction to Exercises*”, 2008.
- [7] Federal Emergency Management Agency, “*Community Emergency Response Teams (CERT) Functional Exercises*”, 2014.
- [8] L. G. Canton, “*Emergency Mangement: Concepts and Strategies for Effective Programs*” in Wiley Interscience, 2007.
- [9] Federal Emergency Management Agency, “*IS-200.b - ICS for Single Resources and Initial Action Incidents*”, 2013.