



**MA-NEE PROJECT**  
"Smart health in smart home"

## **Title: Fostering healthy community eco-system by smart technologies for the ageing society in Thailand**

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### **Context**

Due to the rising of the ageing population in Thailand, there is an urgent need to develop a supporting system to care for the elderly. This work presents a case study to develop smart technologies and implementation processes for fostering healthy community eco-system for the elderly in a real community. Comprehensive and systematic approaches were taken in technology selection, installation, and evaluation for 30 elderly households and retirement homes in a small community of Ban Nonghin, Khon Kaen Municipality, Thailand. Personal information, biography, technology expertise, behaviors, daily routine activities, medical problems, medical service behaviors, goals and frustrations were evaluated to determine the persona, elderly behavior patterns, stakeholder map and journey maps. The results revealed that health issue, environment, and past experience affect the elderly decision making. Therefore, the healthy eco-system was designed to provide real-time health status and

appropriate treatment in an emergency. Three to five health sensors were installed in the households to collect real-time data. The data collected from the model community will be evaluated with the basic health checkup data from the nearby Khon Kaen Hospital and local health centers. Using IoT infrastructure with cloud connection for the households and hospitals, the data can be analyzed to provide health predictions for the community. The ultimate goal is to create networks of healthy eco-system to communicate correct health information and transfer knowledge to the ageing population. This is the flagship project from Thailand Research Fund to support Thailand's health care policy for the Ministry of Public Health.

The main project is "Smart technology and connected community ecosystem for health aging society" with "Ma-Nee Project" as the Thai Nickname. This paper will provide an overview of concept, background and the execution on the Ma-Nee Project case study. The Ma-Nee Project was initiated from the Affordable materials and technology for health monitoring workshop co-hosted by Office of Naval Research Global, USA and The Thailand Research Fund in November 2015. The purpose of the workshop is to build research network in health monitoring technology. After the workshop, many brainstorm sessions were also conducted to include not only researchers but also stakeholders like representatives from Ministry of Public Health, Ministry of Digital for Economy, villagers, and local entrepreneurs to gather current situation and input about smart home healthcare technology and needs. The first draft of the proposal was approved for research grant from Thailand Research Fund in September 2017. It contains 4 platforms:

Platform 1 Health sensors and other health-related smart technology

Platform 2 IoT infrastructure and clouds

Platform 3 User experience and outcomes

Platform 4 Project integration and management

The above platforms are seamlessly integrated to have the first prototype of health sensor system that meets with user satisfaction and reasonably affordable. To finally achieve the sustainable system that do not stop after the granted is ended, we plan the project to span into 3 phases (up to 4.5 years):

**Phase 1 Development:** User requirement; Selection of the smart technology based on user experience design; System architecture and security to collect health

signals for personal health records (PHR); Cost analysis; Study site of 30 elderly households in a small community of Ban Nonghin, Khon Kaen Municipality, Thailand.

**Phase 2 Implementation:** The expansion of the system developed in Phase 1 in 5-10 more villages and nursing home; Health AI from long-term health signals collection; Market research and business model development; Policy initiation, especially in the context of Smart City model.

**Phase 3 Translation:** Option 1 Project deployment through public private partnership; Option 2 Project deployment through local administration public health policy with annual budget.

## **Rationale**

Thailand is facing the situation of aged society, where the population of age over 60 years old will reach 20% in 2021 and 25% in 2035. Thailand is also considered the second eldest nation in ASEAN countries, following Singapore. Additionally, the elderly support ratio shows a decrease trend from 4.8, 3.2, and 2.4 adults per one elderly in 2015, 2025, and 2035, respectively. This indicates the potential shortage of caregivers and also the breadwinner in the families. Regarding Healthcare system, Thailand has 1 physician per 4,200 people, while the world standard needs 1 physician per 1,500 people. Medicine and nursing schools produce graduates at their maximum capacity but most of these professionals tend to cluster in bigger cities for economic reason. This leaves the smaller cities and towns shortage of healthcare professionals, resulting in inequity of healthcare access. Thailand may need a new model of state welfare to avoid the burden of healthcare expense and healthcare personnel shortage in the next 20 years.

A whitepaper “Digital roadmap for aging society, agriculture, and tourism” from Roland Berger, launched in early 2017, states the urgent need of digital technologies in order to overcome the challenges in the context of aging society in Thailand. Those include: National Health Information System, Telehealth, Smart home and robotics, and Digital social interaction solutions. These technologies could enhance the life quality of the elderlies, especially those who need social welfare. Ma-Nee Project is aimed to fulfill such mission.

## **Objectives (Phase I)**

1. To find a suitable set of smart technology, mainly health-related sensors, for health monitoring and health analytic purpose.
2. To demonstrate the real-time health monitoring model and analytics in the household.
3. To create a connected community ecosystem for the elderly members to gain access, understand, and utilize smart technologies to increase the quality of their health.

## **Description**

### *1. The team*

Ma-Nee is a multidisciplinary project that require specialty from various fields. Dr. Rina Patramanon, the head of the project, is a biochemist who is familiar with biosensors including health sensors. Physiology and biochemistry of aging is also of her research interest. The vice-head of the project, Dr. Pawinee lamtrakul, is an urban planning engineer with expertise on urban design for a sustainable living community. Her current interest is to finding a suitable model of elderly community that can help the member being healthy and physically and mentally active. Dr. Sumonta Kasemvilas and Dr. Manida Swangnetre are helping the project with her expertise on user interface design to allow the elderly being comfortable with the report screen and also the feedback interface. Dr. Cholatip Pongskul, Dr. Panita Limpawattana, Dr. Naruemol Singha-Dong, and Dr, Patcharee Jearanaikoon, the health team, are helping with the disease mapping to the smart technology and the health parameters needed to analyze the risk level of the NCDs including CKD. The IoT infrastructure including cyber security and artificial intelligence is made possible by the IT team, Dr. Krerk Piromsopa, Dr. Bandit Thinkhamrop, Dr. Akarin Phaibulpanich, Dr. Uthumporn Domthong, and Dr. Virach Sornlertlamvanich. Dr. Worajit Setthapun and Dr. Tanyarut Rerkpattanapipat play a key role in international representation of the project and intellectual property management. Last but not least, Dr. Sompong Klaynongsruang is contributing for grant allocation.

The research assistant team include Ms Siripat Prukpaiboon, Thailand Research Fund; Ms. Pawinee Siritongsuk, a PHD candidate; Ms. Nattaphorn Natteerapong, a master student; Ms. Jirawan Klaylee, an urban planning graduate, and Ms. Punpimol Dejsiri, a biochemistry graduate. All the documentation and

administration process regarding the Ma-Nee Project are neatly arranged with their help.

## *2. Volunteer subjects and study site*

Khon Kaen province is 1 of 76 provinces in Thailand. It is the metropolitan of the northeastern region of Thailand, with population of 1.8 million people. Khon Kaen has 26 Districts (Amphor), 198 Sub-districts (Tam Bon), and 2,331 Villages (Moo Ban). The site of Ban Nonghin Moo 22, under Sila Sub-district, Muang Khon Kaen District has been chosen to as the study site. It locates at the skirt of the Khon Kaen municipal area, about 20 minutes to the city center (5 km). It has about 1,200 residents. The Head Ban Nonghin Moo 22 is Mr. Boonsanong Piroonsoontorn, age 53 years old. He helps in calling for 30 elderly volunteers from Ban Nonghin, Moo 22 village. The volunteers need to use smart technology in their households for the total of 180 days. All the processes and research conducted are under supervision of The Khon Kaen University Ethics Committee in human research, where the review process is under the SIDCER system (Strategic Initiative for Developing Capacity for Ethical Review).

## *3. User experience design and health status-living status matrix*

The center of this project is the elderlies. The more we know about them the better we can design the smart technology for them. In this user experience study, the independent variables: behaviors and lifestyle, and dependent variables: elderly grouping. The data collection includes background research, contextual interview, and ethnographic observation. In the design thinking process, we can extract stakeholder map, persona, a day in a life, and then a journey map of the interviewee.

Another set of interviews include questions about everyday life and physical and mental ability. Those includes: overall living status, household appearance, technology adoption skill, ability to ask for help when needed, chronic disease, physician visit, risk to fall, mental condition, and cognitive function. The results are mapped as matrix called health status-living status matrix.

## *4. Smart technology selection and system infrastructure*

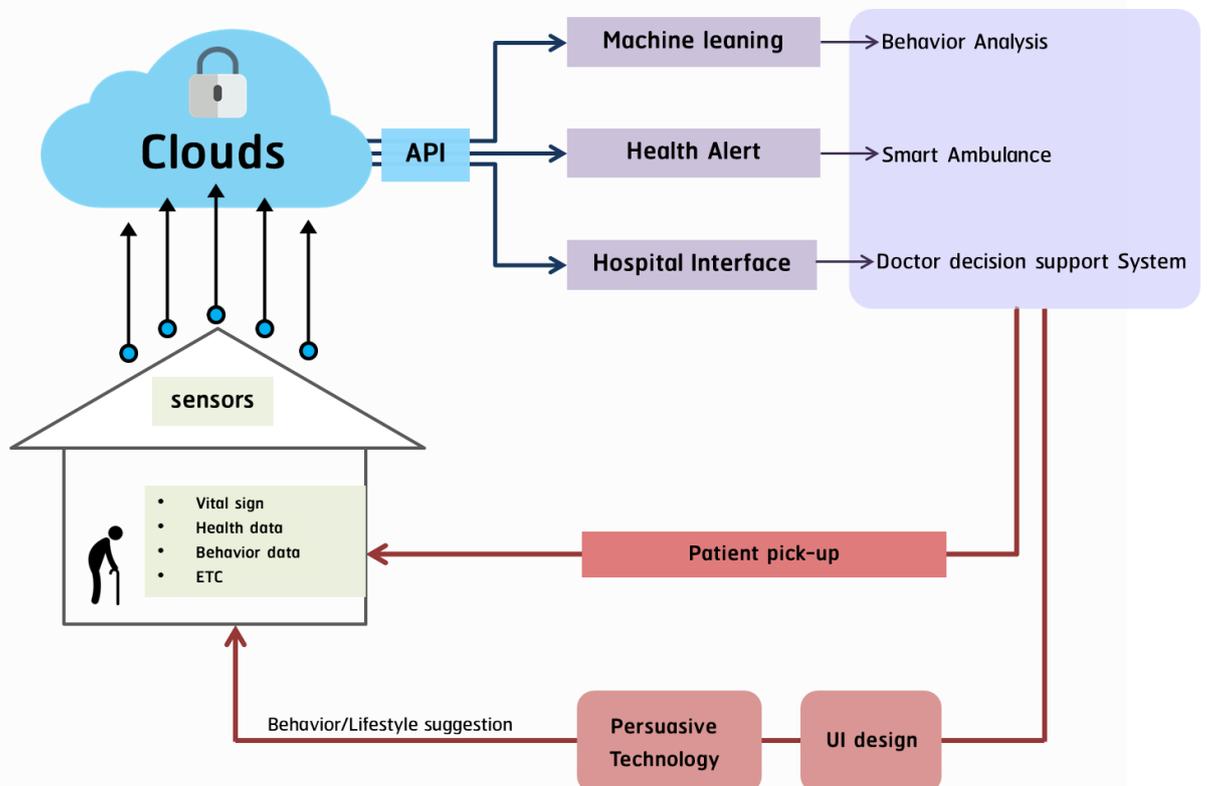
The collection of smart technology is listed for the team to rationalize and select as the first set of smart technology to be used in the project. Besides 13 research members, we invited 4 external specialized guests to help with choosing. Those are 1. The manager of Digital Economy Promotion Agency, Middle northeast region, Ministry of Digital Economy and Society; 2. Director of the Information and Communication Technology, Office of the Permanent Secretary, Ministry of Public

Health; 3. President of Thailand Healthtech Association; and 4. President of North Eastern Software & Business Innovation Association, Thailand.

## Achievements

### 1. Smart technology selection and system infrastructure

From 13 smart technologies, the team and also the external specialized guests selected 5 technologies, based on the situation and the background of subject volunteers. Those include smart wristband, Wi-fi location sensor, blood pressure monitor (cuff), smart mirror/TV/dashboard for health report, and salt detector. The system infrastructure is shown in Figure 1.



**Figure 1.** Ma-Nee Project system infrastructure. The design is based on user experience and user interface preference. The system architecture is an integration of several types of data including signals from health sensors (vital signs, health data, behavior data) and data from medical record.

### 2. Health status-living status matrix

The overall demographics of 30 subject volunteers are shown in Table 1. The incidence of disease is shown in Table 2 and Table 3. Most of the subjects has one or

more chronic diseases. They have medication regularly and visit doctors regularly. However, the living situation is not ideal for elderlies. About one third of the subjects stays alone during the day, and most of them have to rely on family or neighbors for help. More than half is home-bound. They know very little about using phone in case of emergency. The health status-living status matrix (Figure 2) indicates the degree of dependency of these elderlies that most of them are self-sufficient. Also, almost of the subject would like to know more about smart technology for aiding their life quality.

**Table 1** Demographic information of 30 subjects

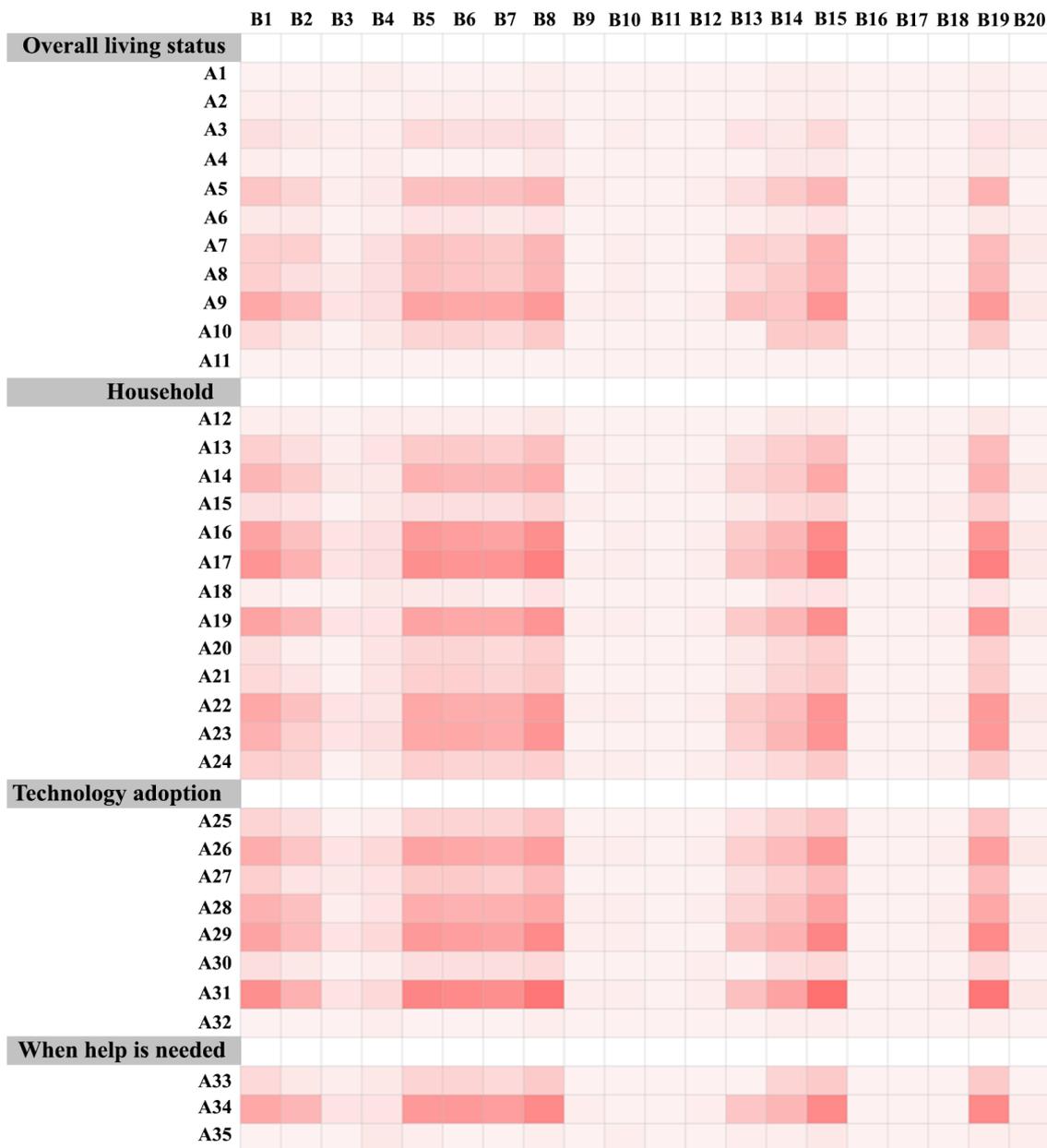
<b>Variable</b>	<b>Frequency</b>	<b>Percent (%)</b>
<b>Gender</b>		
Female	21	70.0
Male	9	30.0
<b>Age (year)</b>		
Lower than 51	0	0.0
51 – 60	6	20.0
61 – 70	11	36.7
71 – 80	10	33.3
Higher than 81	3	10.0
<b>BMI</b>		
18.0 – 22.9	12	40.0
23.0 – 24.9	4	13.3
25.0 – 29.9	6	20.0
Higher than 30	8	26.7
<b>Education</b>		
No education	1	3.3
Elementary School	24	80.0
High school	3	10.0
Diploma	1	3.3
Bachelor's Degree	1	3.3
<b>Income (THB/month)</b>		
Lower than 1001	14	46.7
1001 – 5,000	10	33.3
5,001 – 10,000	3	10.0
10,001 – 15,000	2	6.7
Higher than 15,000	1	3.3

**Table 2** Medical conditions

<b>Variable</b>	<b>Frequency</b>	<b>Percent (%)</b>
<b>Diabetes</b>		
Yes	14	46.7
No	16	53.3
<b>Hypertension</b>		
Yes	20	66.7
No	10	33.3
<b>Heart</b>		
Yes	3	10.0
No	27	90.0
<b>Others</b>		
Yes	17	56.7
No	13	43.4

**Table 3** Disease incidence

<b>Variable</b>	<b>Frequency</b>	<b>percentage (%)</b>
<b>Diabetes</b>	14	26.0
<b>Hypertension</b>	20	37.0
<b>Heart</b>	3	6.0
<b>Others</b>	17	31.0



**Figure 2.** Heath status-living status matrix. Codes are as followings.

**Overall living status**

- A1: Alone D/N
- A2: Alone D/N but relatives nearby
- A3: Alone D only
- A4: Alone N only
- A5: With spouse
- A6: With relatives
- A7: With child
- A8: With grandchild

**Disease**

- B1: HBP
- B2: DM
- B3: Heart
- B4: Others

**Physician visit**

- B5: Visit due to disease
- B6: Visit regularly
- B7: Medication regularly

- A9: home-bound
- A10: social-bound
- A11: bed-bound

**Household**

- A12: Wooden house
- A13: Cement house
- A14: Half wooden/cement
- A15: 1 Storey
- A16: 2 Storey
- A17: ADL at first floor
- A18: ADL at second floor
- A19: Bed in first floor
- A20: Bed in second floor
- A21: Use stairs
- A22: Do not use stairs
- A23: In-house bathroom
- A24: Outdoor bathroom

**Technology adoption skill**

- A25: Use smartphone
- A26: Do not use smartphone
- A27: Has internet
- A28: Do not have internet
- A29: Descendants use Line app
- A30: No descendants uses Line app
- A31: Interested in Ma-Nee smart
- A32: Do not interested in Ma-Nee smart technology

**When help is needed**

- A33: Use cellphone for ambulance
- A34: Call family or neighbors for help
- A35: Do not know

**Physical condition**

- B8: Self-sufficient
- B9: Partially self-sufficient
- B10: Little self-sufficient
- B11: Very little self-sufficient
- B12: High risk to fall
- B13: Risk to fall
- B14: No risk to fall

**Mental condition**

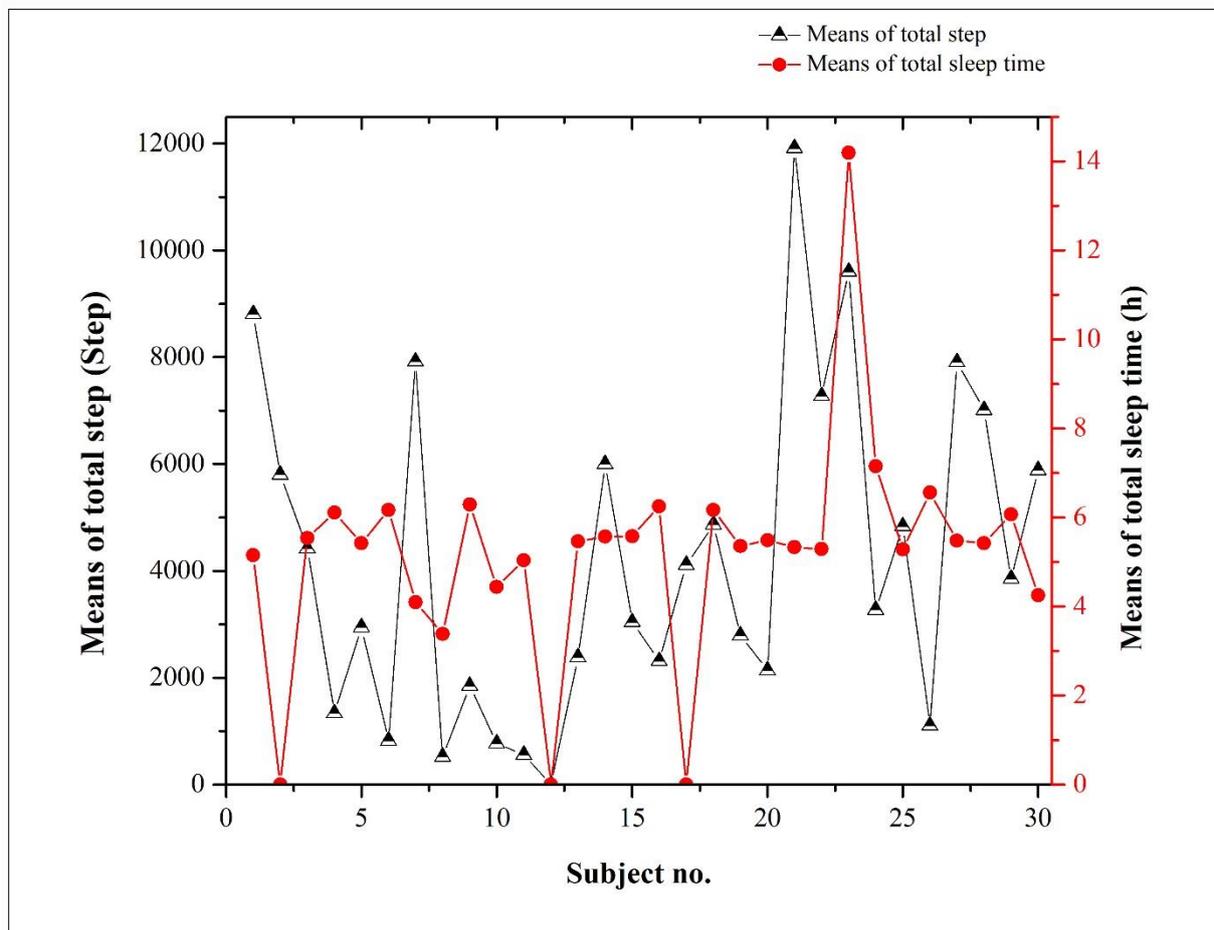
- B15: No depression
- B16: Mild depression
- B17: Moderate depression
- B18: Severe depression
- B19: Normal cognitive function
- B20: Dementia

*3. First set of data (smart wristband)*

We first launched smart wristband, version 1, for the subjects to observe the utilization. The criteria to include the subject to further using 4 more smart technology is 80% compliance to use the device (days count). The statistics are shown in Table 4. The average total steps and total sleep time in 7 days are shown in Figure 4.

**Table 4** Percentage of smart wristband wearing

Activity	Number	Percentage
<b>Daily activity (step)</b>		
Everyday	24	80.0
Sometimes	5	17.0
Do not wear	0	0.0
N/A (device broken)	1	3.0
<b>Sleep</b>		
Everyday	16	53.0
Sometimes	11	37.0
Do not wear	2	7.0
N/A (device broken)	1	3.0



**Figure 3.** Average total steps and total sleep time in 7 days of 30 subjects.

## **Conclusion**

This is our effort to help the elderly in a semi-suburb area, with low income, to live their life with technology assistance. The characteristic of this group is representing about 80% of Thai population, which is relying on a complete coverage healthcare from the government (30 Thai Baht for all diseases). With chronic diseases they are having, all of them need medication. Medicine adherence is not a problem, but better health literacy from our smart technologies may help the family and their own aware of the health condition. In addition, the physician will have the health and behavior information for better take care of their patients.