Achievement of SIP Social Resiliency against Natural Disasters

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Local Disaster Mitigation Technology with Travel Support Application

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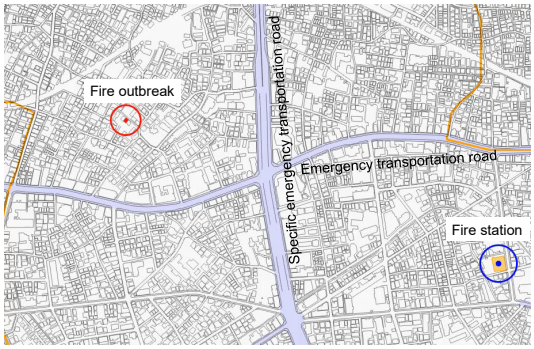
Outline

- Web Application System for Real-time Collection, Sharing, and Use of Disaster Information
- Travel Support Application for Local Disaster Mitigation

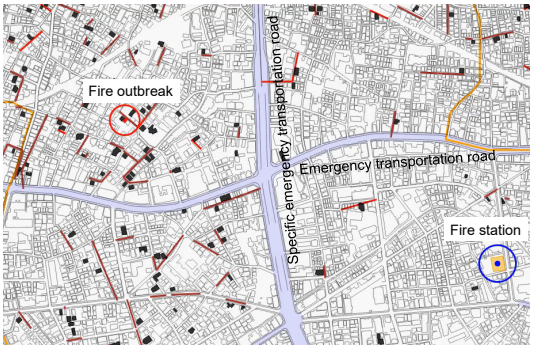
Normal Time (without Blockage)

Access time: 2.1 minutes



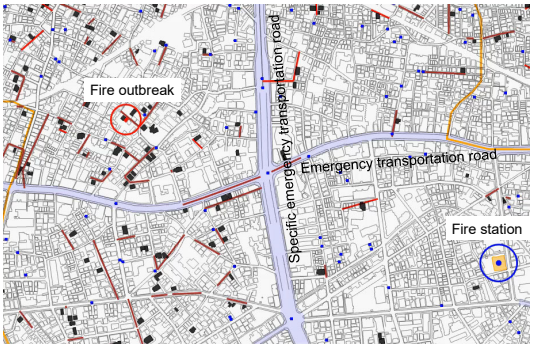
Street Blockage by Collapsed Buildings

Access time: 5.7 minutes

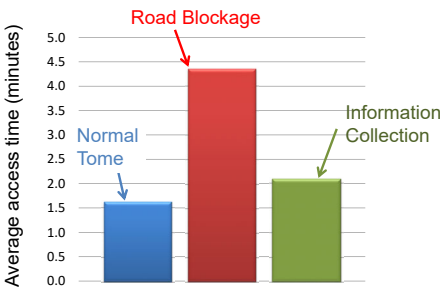


Disaster Information Collection (5 minutes by 0.5% of residents)

Access time: 2.4 minutes

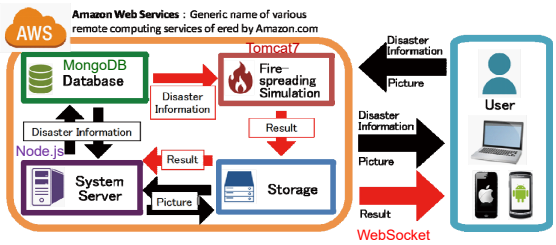


Average Access Time



IT for Disaster Mitigation

Users access to the system using their own information-devices through a Web browser, and they post disaster-information (building-collapse, street-blockage, fire outbreak), and pictures.



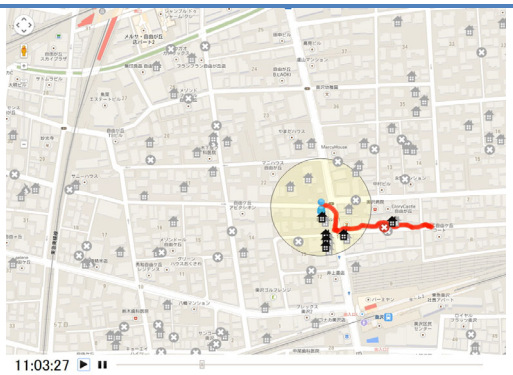
Usage of Web Application System

Virtual Disaster by Simulation

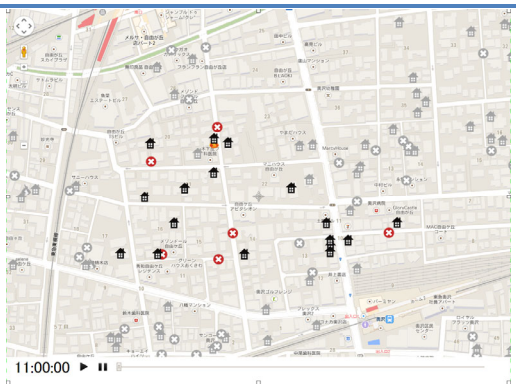
Experiment	Collapsed Buildings	Street Blockage	Fire outbreak	Burned down building
1st	6,942 (4.04%)	3,194 (6.73%)	74 (0.04%)	19,914 (11.6%)
2nd	6,985 (4.07%)	3,323 (6.99%)	74 (0.04%)	13,724 (8.00%)
3rd	6,910 (4.03%)	3,192 (6.72%)	70 (0.04%)	19,708 (11.5%)
4th	7,069 (4.12%)	3,280 (6.90%)	84 (0.05%)	17,928 (10.4%)
5th	7,054 (4.11%)	3,228 (6.79%)	66 (0.04%)	16,769 (9.77%)
Tokyo Metropolitan Government	6,020 (3.51%)		62 (0.04%)	21,727 (12.7%)

(Estimation of earthquake damage in Tokyo, 2012)

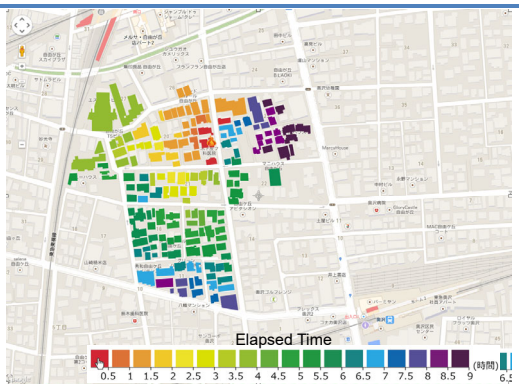
Example of Information Collection



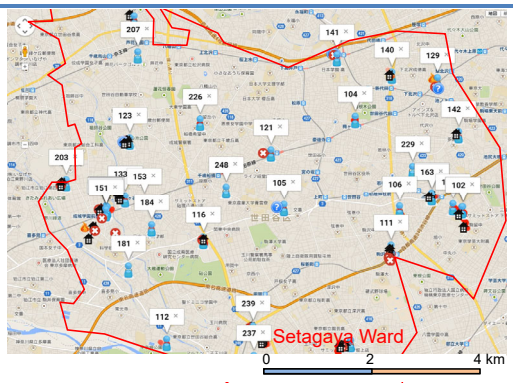
Example of Information Collection



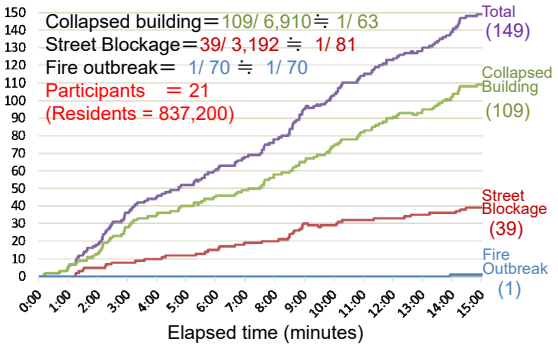
Example of Fire Spread Simulation



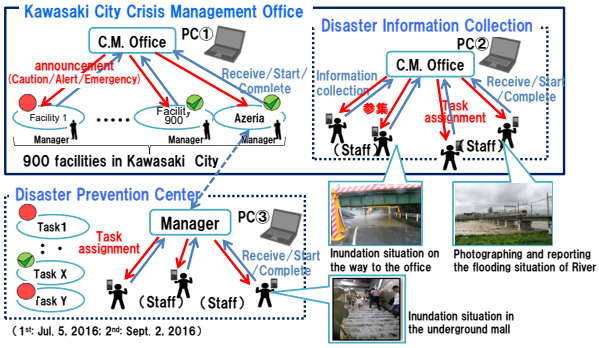
Example of Information Collection



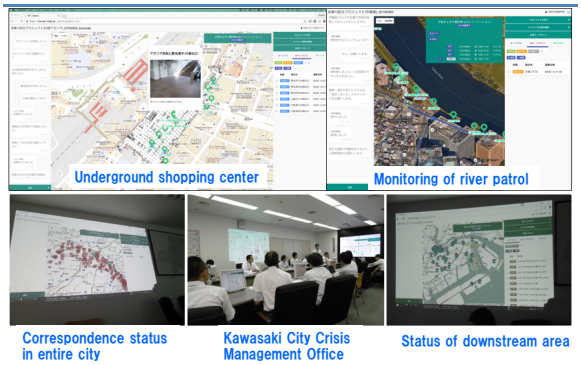
Performance of Information Collection (3rd)



Demonstration Experiment



Demonstration Experiment



Outline

- Web Application System for Real-time Collection, Sharing, and Use of Disaster Information
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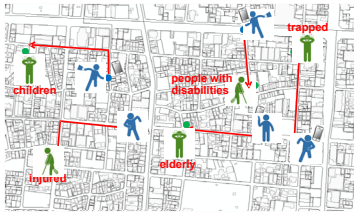
Demanders and Responders in Disaster

Demanders:
those who are requiring rescue/ relief/assistance immediately after a disaster

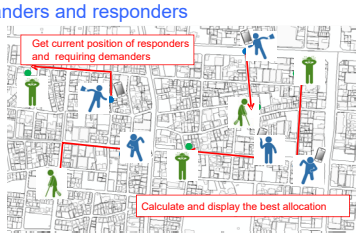
Responders:
those who are responding to these demands



Necessity of Efficient Regional Travel

- Spatial divergence between demanders and responders
- Advance arrangements (action rules) are not enough

✓ Support system for efficient and effective cooperation activities by adjusting the spatiotemporal distribution of demanders and responders



Objective Function for Optimal Assignment

Objective function for optimal assignment
Minimize [Total travel-distance / time]
Minimize [The longest distance / time of the worst case]
Maximize [The number of evacuation success], etc.

Options to be considered in evaluation function
Attribute of Demander: Gender, age, degree of care required, disability grade, etc.
Attribute of responder: Special skills, qualifications, the number of responders, etc.
Urgency: Degree of injury, evacuation from fire, etc.

Technical Issues

◆Formulation of problem and Method to solve
Fuzzy c-means clustering & Genetic algorithm

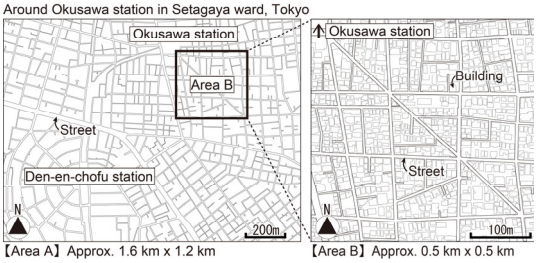
◆Compatibility and Urgency
Priority for assignment and travel order

◆Workload Differences
Work assignment by multiple responders

◆Validation/Evaluation
Field experiments using Web app

Study Areas for Field Experiments

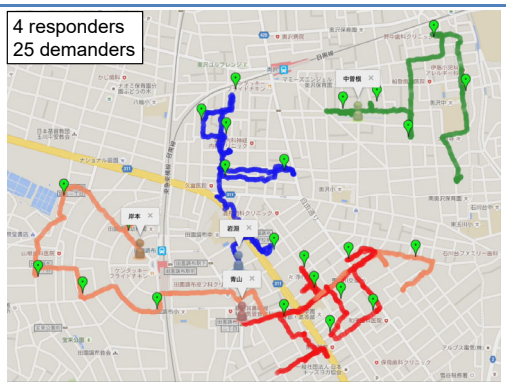
Around Okusawa station in Setagaya ward, Tokyo



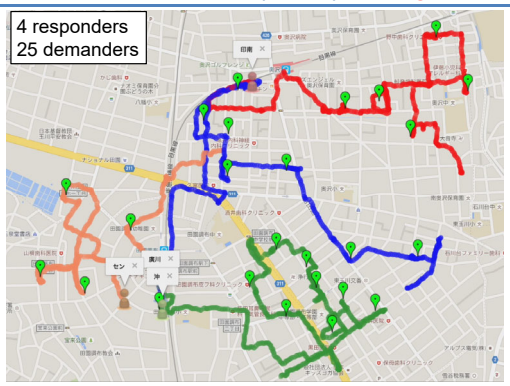
【Area A】Approx. 1.6 km x 1.2 km
【Area B】Approx. 0.5 km x 0.5 km

Area A **Area B**

Field Experiment ① (LINE) Students

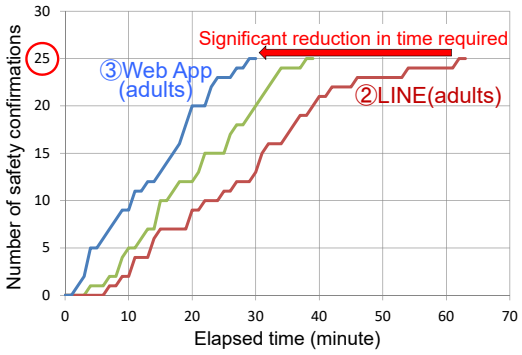


Field Experiment ② (LINE) Young adults



Field Experiment ③ (Web App) Young adults

Comparison of Travel Efficiency

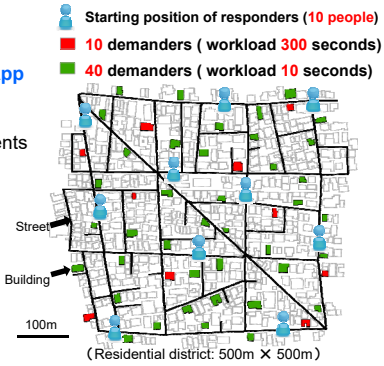


Field Experiment of Workload Differences

Field experiment
④ Travel using **LINE**
⑤ Travel using **Web App**

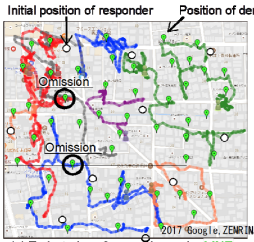
Simulation experiment
⑥ Virtual travel by agents

Comparison of work completion time (Moving time, working time)

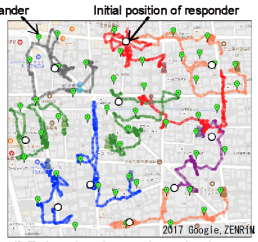


Field Experiment of Workload Differences

	Number of demanders		Average of travel distance
	omissions	Duplications	
④ LINE	2	4	1,108 m
⑤ Web application	0	0	820 m

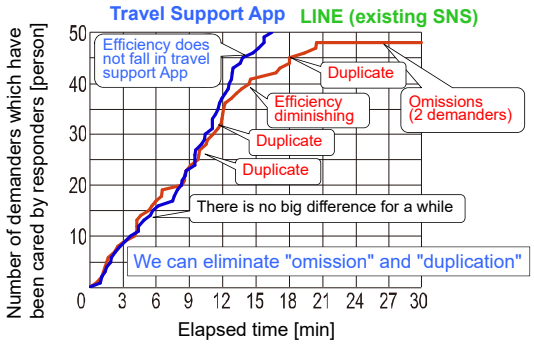


(e) Trajectories of responders using LINE in the experiment ④

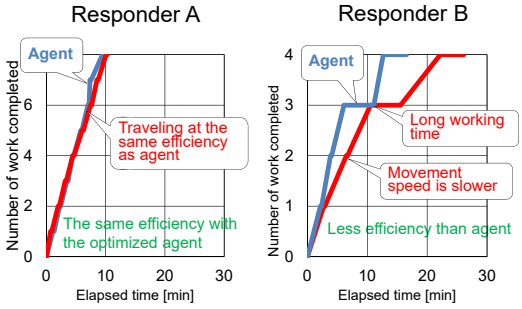


(f) Trajectories of responders using the Web application in the experiment ⑤

Evaluation of Travel Support Application



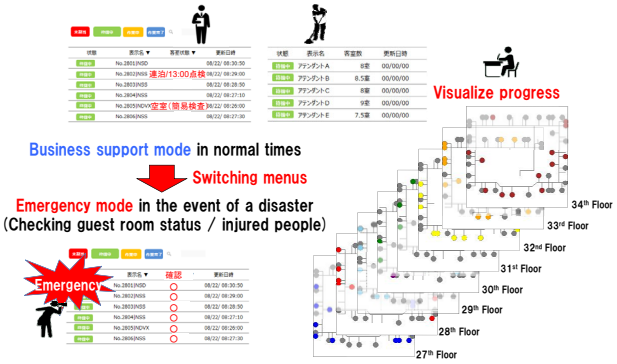
Personal Work Log Data and ABM



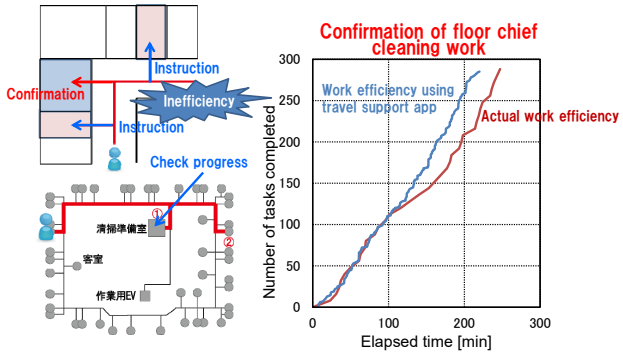
Flexibility of Travel Support App

- Demanders and responders can register themselves with their attributes including special demands or capabilities respectively
- Responders are automatically assigned to demanders by the system considering multiple conditions/ requirements
- Any changes in demanders or responders, the system can recalculate the optimum result in real time

Implementation at High-rise Hotel



Experiment assuming Normal Times



Experiment assuming Disaster

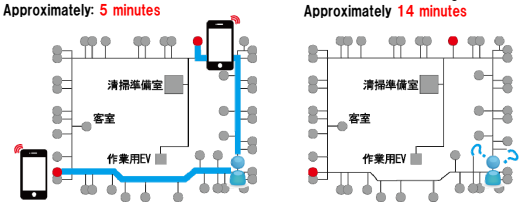
Emergency response to injured people, safety confirmation, dangerous materials, etc.

⇒ Difficult to deal with troubles occurred at the same time

⇒ Optimal assignment of adequate person

Use of travel support app
Time for situation grasp + optimal patrol:
Approximately: 5 minutes

Current management
Unknown who is in charge of where:
Approximately 14 minutes



Summary and Conclusions (1)

- **Web application system**, which enables users to post, share, and utilize the disaster-information in real time through the cloud server
- Quantitatively **demonstrated the high performance of Web application system** for disaster-information collection, by performing the field experiment by local residents under the assumption of a devastating earthquake
- The system can be **easily arranged or customized for other disasters** (such as flood, typhoon, etc.) by slightly modifying its User Interface

Summary and Conclusions (2)

- Discussed the problem of a limited number of responders traveling efficiently to a large number of demanders in the aftermath of a disaster for rescue/relief as a **regional travel problem**
- Upgraded Web application by incorporating the proposed solution (**Travel Support App**)
- Demonstrated that efficient regional travel can be achieved by **Travel Support App** by conducting **field experiments**
- **Implementation of App** for hotels enhancing the usefulness of App **by using it in the normal times.**