Action Science Approach to Nonprofit Housing Services using Web 2.0 Mapping Tools

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ABSTRACT
The study follows action science approach to the problem of nonprofit housing services. After 4 months of action science-based activities, such as organized participant observations, in-depth interviews, field work, and focus group studies, the main findings are (1) Web 2.0 suits nonprofit organizations better than traditional webs in terms of maintenance cost and usability, (2) mapping tools make better GUI with respect to web-based housing services, and (3) context-aware personalization can translate to better user experiences as an RDFS-based working prototype has been built and tested. A user survey shows high level user satisfaction. Although the case study was carried in a nonprofit housing organization, the practices in action research approach can be applied to other NPOs as well.

Categories and Subject Descriptors
H.5.2 [**Information Interfaces and Presentation**]: Group and Organization Interfaces - *Web-based interaction*

General Terms: Design, Performance, Human Factors

Keywords: Action Research, Context-aware services, Mapping tools, Web 2.0, RDFS.

1. INTRODUCTION
In a nonprofit setting, we study the processes how to unleash the power of Web2.0, and map mash-up services in particular. The project is collaboration with Tsuei Ma-Ma [9], the earliest and biggest Taipei-based nonprofit organization devoted to helping people with housing and apartment rentals, serving millions of people, especially those disadvantaged in Taiwan. The tasks of housing agents and realtors have been mainly labor-intensive until the rise of Internet. Because of the shortage of capitals and lack of human resources, the organization actually was ahead in applying Internet technology to providing housing information for people seeking to rent apartments. The technology enables a new paradigm that makes the housing information exchange efficient as well as streamlines the renting process even under the fact that the number of volunteer agents in such nonprofit organizations (NPOs) is small compared to that in commercial counterparts.

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The website of Tsuei Ma-Ma has been database-driven with mainly text oriented user interfaces since launched seven years ago. Both the landlords and tenants use the website to upload and find housing information and expect there are matches in the preferred apartment types, locations, price ranges, and so on. Aside from running the website, the organization has been in charge of verifying the identities of both parties and maintaining information about their credits from transaction history, including the correctness and legality of the papers. This responsibility is obviously labor intensive but makes the organization core value distinct from other acting organizations that just mainly set up the websites.

Among others, a well known housing service featuring Web 2.0 mapping tools is Housingmaps (http://www.housingmaps.com) which is a mashup of Craiglist and Google Maps. Our implementation also built upon mashup of housing data and a Web 2.0 mapping tool. However, the service is context-aware and personalizable that uses ontology to describe context and preferences. A component called Matchmaker acts as an agent to perform matching based on housing conditions and preferences, and once there is a match, a notification is sent to the client for a possible site visit arrangement.

Overall, the contributions of this paper are as follows. First, action science approach is applied in introducing a new technology to NPO and results in a satisfactory outcome for an NPO according to a user survey. Second, an ontology-based context-aware system is designed that takes into account personal preferences and static context with dynamic context extensibility. Third, housing data is mashed up with a map Web service which is stress tested with success in terms of user experiences and system performance. Fourth, theory of diffusions of innovations [4] is used to examine the practicability and usefulness of the renovated housing system.

The rest of the paper is organized as follows. The research methodology is detailed in Section 2. Section 3 describes the system architecture. In Section 4 we present the results and discussions regarding the solutions. We conclude the paper in Section 5.

2. METHODOLOGY
Action science is an established research discipline in use in the social, medical sciences and information systems [1]. Due to the closeness of nonprofit organizations and social services, action research, among other research methods, is a natural and good choice of conducting the organizational Web renovation project so that people in social services and information systems can speak the same language. Research methodologies of action science including in-depth interview, field study, focused group,

and participant observation [2, 3, 6] are adopted to collect data to analyze the needs of the front-line users as well as site administrators.

2.1 Participant Observation

Participant observation is for researchers to capture the native point of view instead of an outsider's. In order to familiarize ourselves with the routine works of the NPO, we conducted a field study where their services were delivered. We did so under the permission of landlords as well as the tenants. Interferences were deliberately constrained by limiting the number of researchers who refrained from talking or asking during observation.

2.2 In-depth Interview

In-depth interviews are for researchers to understand the subjective opinions of the research targets after the participant observations were made. It was done on a one-subject, per-person basis. We explored the experiences and difficulties the users had had in their process and confirmed what we saw in the field work. It helped identify the real problems behind and shed lights on the possible solutions.

While capturing the subjective opinions of the targets is the purpose of the interviews, the researchers should refrain from involving their own subjective point of views. The protocol of in-depth interviews should therefore be followed rigorously [7]. The agenda of the interviews were set beforehand and each interview lasted for no more than 2 hours. The interviews were recorded with consensus and the transcripts of the recording were reviewed by the interviewees to make sure they were correct and accurate.

2.3 Focus Groups

Focus groups are organized to collect and reflect the thoughts of the group through intense dialogues between researchers and the targets and among targets themselves. We conducted two focus groups with the users who came from different walks of the society. The purpose is to explore whether there were common grounds regarding their IT requirements. Before the focus groups started, briefings were made to the participants about the backgrounds and purposes of the study. The minutes were made public on the internal online discussion forums so that the dialogues were re-examined and re-thought through after the groups ended.

After the requirement analysis through action research, three types of needs were identified as the directions of our follow-up prototyping: (1) marketing tools using Web 2.0 to further promote the visibility of the organization, (2) introducing Web 2.0 map functionality to the core of user interfaces and experiences, and (3) including state-of-the-art instant messaging services. In the following section, only the Web 2.0 map service is described and discussed.

3. PROTOTYPING

We created a prototype [5] which was tested after the survey and extensive field study. The user feedback will be our guidelines to further improve the prototype.

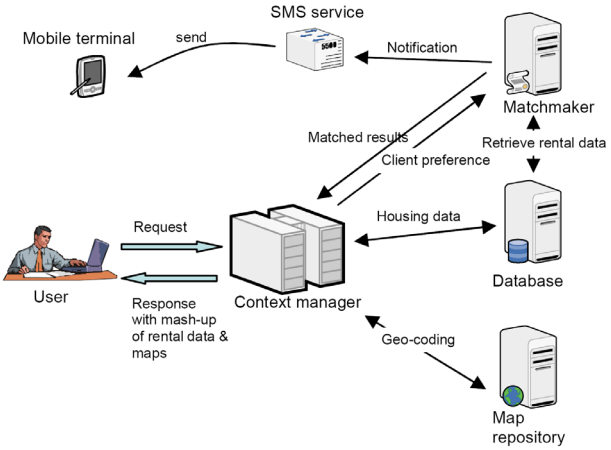

Figure 1. System architecture of Web 2.0 Map Services for Nonprofit Housing

3.1 System Architecture

In Figure 1, the proposed architecture includes: (1) Context manager, (2) Map Service, (3) Database, (4) Matchmaker, and (5) SMS Service. In the domain we study, the context manager provides the context needed to handle the requests from front-line users and coordinate the invocation of other functional components. Its front-end includes an application server that interacts with the user's Web browser and is responsible for authenticating and registering users by collecting user preferences in Web forms and forwarding this information to the context managing back-end. To personalize the delivered information, it maintains user profiles in a database. The profiles contain static/dynamic context and personal preferences. A mission-specific database is the housing database with raw data uploaded by landlords and tenants. Map repository is provided by a third party Web service with the capability of being mashed up like Google Maps APIs [13]. Matchmaker does its task by reading the client preferences in terms of ontology and context such as availability of preferred apartment locations, types, and price ranges. The database search results are filtered by the user interests as expressed in the user profile. A more formal description of Matchmaking is as follows.

3.2 Personalization

Matchmaker includes a heuristic by which it keeps refining their matching capability as it collects user ratings on the matched results. The ability to record a user's selections preference enables the matching module to be personalized to a user's likings, which are essential in the housing applications. A set of measurable attributes $\{ a_i \}$ could be associated with each person a in the database. Each user u, with $\{ u_i \}$ has an associated list of weights $\{ w_i^u \}$ that reflect the relative importance that she or he attaches to each attribute. The weight vector plays the role of a user model. The linear product of the difference of attributes and weight vectors represents a utility function whose value is a relative cost that the user u associates with the person a:

$$C_u = \Sigma_i \, (w_i^u * \mid a_i - u_i \mid)$$

In practice, the weights can be obtained by asking users about their priorities in making decisions.

Matchmaker is capable of context-aware personalization to improve the quality of the housing services. For example, preferences of apartments can also be given based on the purposes of the tenants. See Figure 3 for the context-aware personalization activity diagram. The model employs both static and dynamic user information to predict user features relevant to the application domain. It acts as a support for a semantic Web personalization system to tailor information services to the user. Our approach is exemplarily applied to the housing domain, to describe user information and identify user's needs.

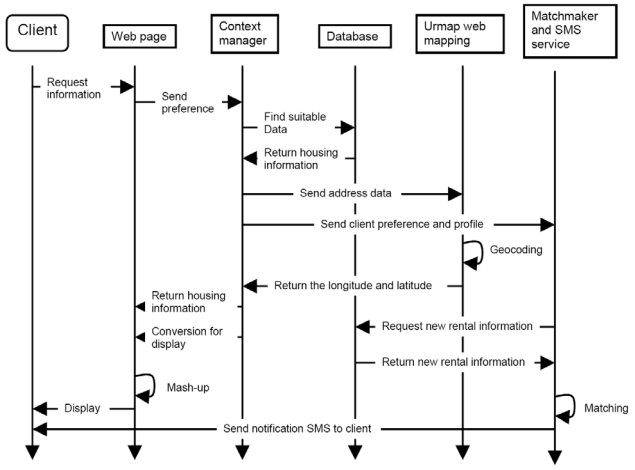

Figure 2. Sequence diagram showing the interactions between system components along the axis of time

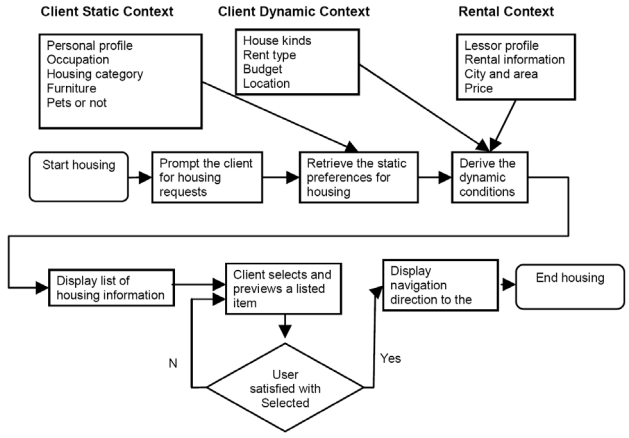

Figure 3. Activity diagram of Matchmaker with context elements for service personalization on the fly.

3.3 Ontology

The required context is described in terms of ontology, namely, Resource Description Framework Schema (RDFS). Resource Description Framework (RDF) has come to be used as a general method of modeling information, through a variety of syntax formats. See Figure 4 and 5 for the description of RDFS of client preferences and static context in housing scenarios. Static context and client preferences are both leveraged by the Matchmaker to generate the personalized outcome regarding the individual housing needs.

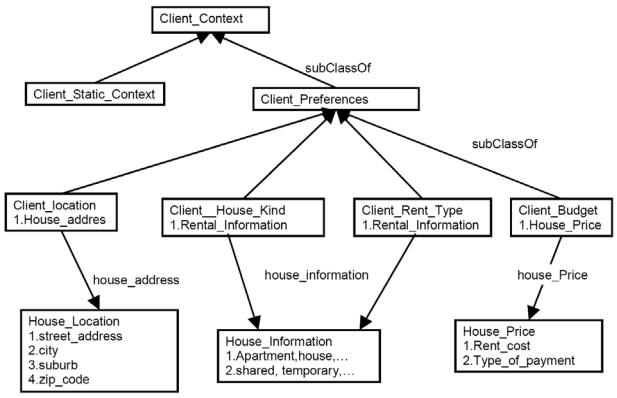

Figure 4. RDFS graph of client preferences used in housing scenarios

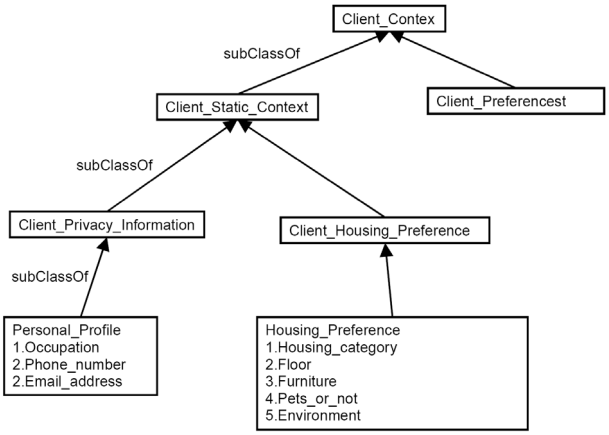

Figure 5. RDFS graph of client static context in housing scenarios

Although dynamic location content has not been employed in the current implementation, the architecture makes it straightforward to include dynamic context in the personalized services. Applications of using dynamic context can be in scenarios where users carry GPS-enabled handhelds and find houses to rent in their vicinity. If the apartments happen to be open house, a walk-in will be convenient. It remains a future work because people have expressed such needs in the focus group discussions.

RDFS has made the knowledge presentation more cohesive and flexible. For example, new knowledge, such as local housing regulations, can be incorporated by semantic integration [14]. Compared with traditional database query approach to housing information provision, the use of Matchmaker in combination with RDFS is a paradigm suited to personal needs by considering user profiles and static/dynamic context.

4. EXPERIMENTAL RESULTS AND DISCUSSIONS

Map repository is provided by Urmap [8], an AJAX enabled maps APIs which serve Taiwan-based e-map on demand with the capability of being mashed up. The ontology is designed by using the Protégé ontology editor [10] which uses RDF schema as its output format. The RDFS content data is stored at an Apache Xindice database [11], which is a native XML database designed

to store XML data directly. Access is available through a Java API defined by XML:DB [12]. For the implementation, data was collected from the greater Taipei area, and included about 150,000 rental items and 220,000 personal profiles.

4.1 Map GUI

The website of Tsuei Ma-Ma has been database-driven with mainly text oriented user interfaces as shown in Figure 6. Figure 7 shows the new user interface that enables users to search by moving around the map, where it is easier to get a bigger picture of the neighborhood near an apartment of interest, and become informed about the schools, metro stations, bus stops, and other points of attractions around the interested area. Comparisons can be more easily made when it comes to the decision about which to choose according to geographic information. Search based on price range, housing types, and locations can be done with results individually corresponding to markers in the map, which can be clicked through to show detailed apartment information including interior and exterior photos, if any.

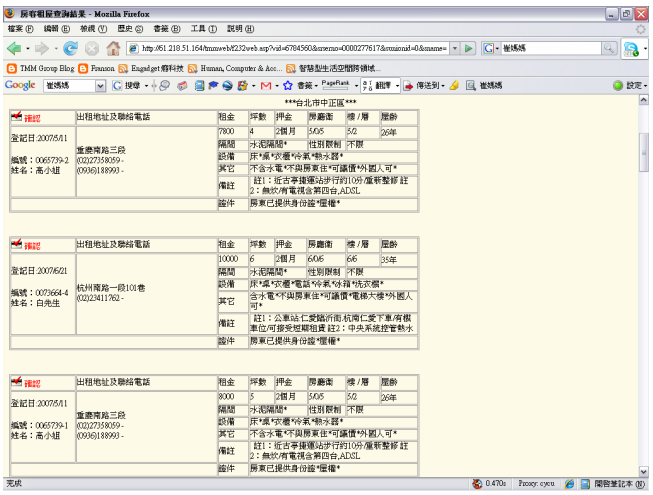

Figure 6. The user interface before Web 2.0 Map service.

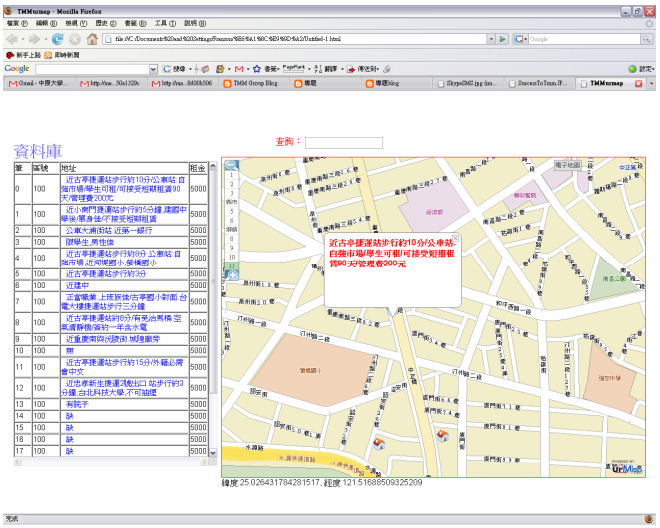

Figure 7. The user interface after Web 2.0 Map service. Bubbles stand for the matches as the outcomes of user search.

In addition to search from maps, a background matching is scheduled and carried out once each day by Matchmaker, which decides what apartment best fits whose needs according to the personal profiles and housing context. The users are notified of the result by e-mail and SMS at their choice. It is convenient for users who do not mainly rely on web interfaces to use the background matching services.

4.2 User Survey

A software project is hardly completed without end-user evaluation. A user survey was conducted to find out whether the system is fast, easy, and tangible, just to name a few. Tangibility means the extent to which the information on the webpage makes sense. A focus group consisting of 10 organization managers were used as subjects to solicit feedback to the use of the new system. Each person was surveyed according to their user experiences towards (1) old, text-based UI, and (2) new, map-based GUI, based on the same set of questionnaire. Therefore, the former servers as a control group to compare to the latter as an experimental group in a test of a causal hypothesis. The questionnaire was poised by a score on a 5-point scale, where SA (Strongly Agree) represents the maximum score of the scale and SD (Strongly Disagree) represents the minimum score. All the questionnaires are administrated anonymously.

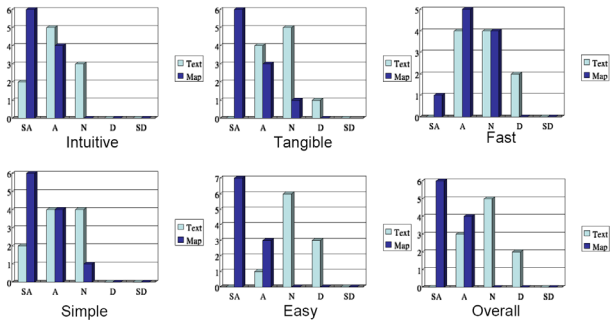

Figure 8. User survey regarding whether the text UI and the map GUI are intuitive, tangible, fast, simple, easy, and the overall experiences.

The survey results show consistence among the six metrics and the overall experiences favor the map GUI, except a close tie in answering "Is the system fast?" where 4 agree the text UI is fast and 2 don't comparing to the fact that 1 strongly agrees the map GUI is fast, 5 agree, and 4 take neutral. The users consider the map GUI significantly easier, more tangible and intuitive than the old text UI.

4.3 Stress Test

Tsuei Ma Ma has been a website receiving volume of traffic due to its popularity. Therefore, we measure the system response under stress using Microsoft Application Stress Tool [15]. The metric is in terms of requests per second at full load. We design the experiment by launching concurrent user access to objects of a target response page, where the former is modeled as number of concurrent users and the latter modeled as number of threads during the test. Depending on the number of matches returned by Matchmaker, the map GUI displays various numbers of apartments and houses within the map window users are seeing. We are interested in the effects of system load with respect to the

number of matched objects. Figure 9 summarizes the stress test experiment.

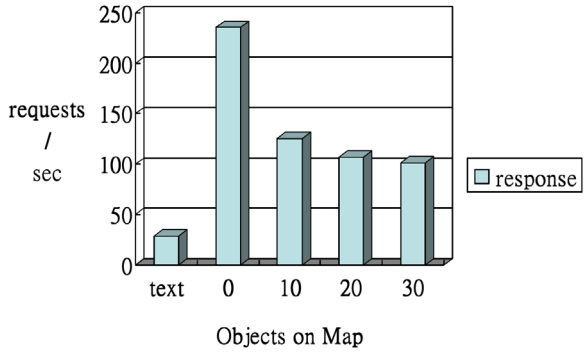

Figure 9. Stress test of response pages of text-UI and map-GUI with various objects on the map.

The maximum number of requests handled by the text-UI response page is 29 per second. For the number of objects on the map chosen as 0, 10, 20, and 30, the number of requests per second the system can process successfully is 236, 125, 107, and 101, respectively. The performance of the renovated map-GUI system is better than that of text-UI page. The former is implemented based on ontology-based matching while the latter was based on straightforward database query. It is found that the use of map-GUI does not cause noticeable system load issues. However, as the number of objects found and displayed on the map increases, the performance actually degrades sharply in the beginning but levels off after the number of objects is greater than 10.

4.4 Diffusion of Innovations

One of the major factors affecting people's attitudes toward a new technology is the attributes of the technology itself. Rogers [4] identified five main attributes of technology that affect its acceptance and subsequent adoption: relative advantage, compatibility, complexity, observability, and trialibility. Thus, a new technology will be increasingly diffused if potential adopters perceive that the innovation: (1) has an advantage over previous innovations, (2) is compatible with existing practices, (3) is not complex to understand and use, (4) shows observable results, and (5) can be experimented with on a limited basis before adoption.

The prototype system is a result of thorough action research and draws upon the need of routine tasks of nonprofit housing; therefore, it is compatible with existing practices. Observable results include better UI and faster response. Based on the existing technology such as Urmap and Web 2.0 mash-up, a fast prototyping method can be applied and limited pilot trial can be experimented before large scale systems are actually built and adopted.

5. CONCLUSIONS

We used the technology of Web2.0 in a nonprofit housing service system for the disadvantaged individuals. Action science approach has been used before prototyping to investigate the system requirement and user expectation as well as identify potential issues or problems. User survey in a focus group setting was conducted to further evaluate the effectiveness of the renovated system. Guided by principles of action science in 4 months of organized participant observations, in-depth interviews, field work, and focus group studies, a working prototype with context-aware capabilities and personalized matching has been built and tested with significant success.

6. ACKNOWLEDGMENTS

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