

# Designing Ubiquitous Shopping Support Systems Based on Human-Centered Approach

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**Abstract.** We introduce our human-centered approach for the purpose of developing a ubiquitous computing system aiming at providing better experiences for shoppers at a supermarket. We focus on shopping processes by using ethnographic research techniques, understand the process with details, and construct TPM which classifies a shopper's behaviors and states of mind change into three phases. We also describe our concept design of service types for a prototype system and deal with allocation and configuration of the service types corresponding to TPM.

**Keywords:** ubiquitous computing, human-centered design, ethnographic research, shopping experience, shopping process.

## 1 Introduction

Retail outlet is a promising application area of ubiquitous computing systems. There have already been a variety of systems developed not only as research purposes but also as business purposes [1]. One of the most famous cases is the Extra Future Store by Metro AG (<http://www.future-store.org/>). The store has been employed a variety of embedded and mobile computing systems to improve a shopper's experience during his/her shopping trip within the store as well as to track and manage grocery store inventory from the distribution center to and within the store [2]. From the view of a shopper's experience, he/she has come to exploit the services as everyday activities, for instance, some 24 percent of shoppers utilize PSA (personal shopping assistant), which is a mobile kiosk terminal embedded with a shopping cart, and some

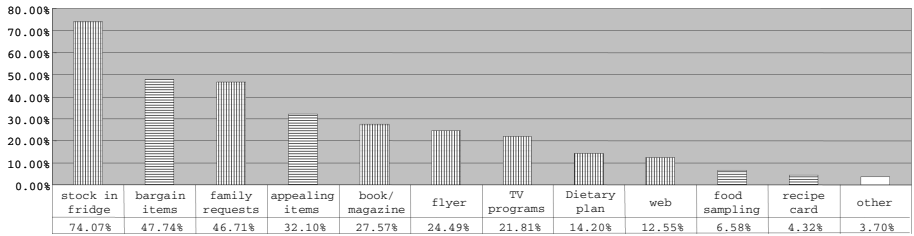
48 percent use the interactive kiosks furnished at a constellation of places throughout the store including greengrocery, meat, and wine floor [2].

On the other hand, not a few shoppers have rejective feeling to the service automation at a storefront due to anticipating that it will further decrease human touch services [1]. One of the reasons yielding such the affection is that the services provided by the systems are not fully suffusive for what the shoppers have expected. For instance, several systems proposed in this area adopted shopping list management as a principal service to enhance a shopper's experience [3], [4], although every shopper does not necessarily buy items according to his/her list. Rather, as [5] revealed, 93 percent of shoppers do not shop to their specified lists. It was also noted that, "on average, purchases by list shoppers exceeded the categories on their lists by about 2.5 times". Then what are the promising alternatives? We, consequently, came to believe that we had to investigate into shoppers' behaviors and states of mind change during their shopping trips for the purpose to lead design implications which would get to the point to make worthy experiences for shoppers.

Since 2003, we have promoted an empirical design project of ubiquitous computing systems at a supermarket, named SSA, or smart shopping-aid. We have secured an operating store, Bonrepas Momochi-branch (<http://www.bonrepas.co.jp/>) in Fukuoka City located at south-west region in Japan, as the project site. We had aimed at SSA to be truly a human-centered design project, so that we conducted a general survey regarding grocery shopping both in quantitative and in qualitative manner, thorough ethnographic researches, moment-to-moment analyses, and systems development and deployment according to the research results. In this paper, we introduce our design process and implications which will contribute to afford intrinsically useful ubiquitous computing systems at supermarkets.

## 2 Investigation in Shopping Process

Shopping process is a long-lasting research topic in retail marketing. According to Takahashi [6], about 70 percent of items at a supermarket and about 80 percent at a supercenter were bought without preexisting plans. Meanwhile, according to our survey conducted in the Tokyo metropolitan area in 2005, respondents who were homemakers ranged from their 30s to 40s answered that about 62 percent of them mostly planned their dinner menus at home and about 27 percent at storefronts [7]. These two facts implied a question: "Why grocery shoppers buy such many items without plans regardless majorities of them already have had their plans?" We speculated that grocery shoppers tended to gradually articulate their plans along with their shopping trips which were neither necessarily limited to at-home nor in-store but extended to the consolidation of both. One of the reasons came from another result of our survey which showed that there were almost the equal effects of major factors from both sides to their dinner menu planning (Fig. 1.). Past works had already pointed out that there existed a same kind of phenomenon, although the mechanisms



**Fig. 1.** Influential factors for dinner menu planning; Bars with vertical stripes are relevant to "planning at home" and ones with horizontal stripes are relevant to "planning at storefront". The survey was conducted in the Tokyo metropolitan area in January 2005. (Sample size 486, multiple answers allowed of this question)

were still at all unapparent [6]. We, therefore, decided to investigate in shopping processes which occurred widely from at-home to in-store and vice versa, and conducted thorough ethnographic researches on them.

### 2.1 Research Design

In-depth researches were conducted one by one with eight observees from August to September 2005. The observees were all female, were ranged from their 30s to 50s, and were chosen from trusted customers of Bonrepas Momochi-branch. We informed them that we would observe their holistic shopping processes for dinner arrangements, and requested that they should shop as same as usual. The research procedure was consisted of four steps described as follows:

- *Pre-interview at home (30-60min.):* to interview with an observee regarding their behaviors and states of mind to everyday grocery shopping, to check whether she had her shopping plan or not, and to observe her preparation for the expedition (i.e. searching in the refrigerator),
- *Participatory observation at the storefront (20-50min):* to take a participatory observation with her shopping trip by using contextual inquiry techniques [8],
- *Participatory observation at home (30-120min.):* to take a participatory observation again regarding her storing, using, processing, and cooking purchased items with contextual inquiry techniques, and
- *Post-interview at home (30-60min.):* to debrief what had not been clarified in the previous steps.

We also asked each observee to take a wearable video recording system on during the participatory observation at the storefront for posterior analysis. The camera, named Encolpia (Fig. 2.), had originally been developed for the purpose with the feature of 150-degree wide vision and real time MPEG-4 encoding functions.

### 2.2 Findings from the Observations

A series of observations uncovered that a shopping process at the storefront was never uniform but the process dynamically changed corresponding to each shopper's



**Fig. 2.** Encolpia: our original wearable video recording system equipped with 150-degree wide vision CCD. The system was designed for minimally-invasive to an observee's behavior. The bottom right is a snapshot of recorded images.

context; her behavior and state of mind abruptly transformed along with her shopping trip. Even if she had her shopping list, she never just did a rundown of it. Rather, it was used as one of the artifacts including articles, price tags, and in-store signs, with which she iteratively interacted to articulate her plan till the end of the shopping.

We discovered that there were generally three phases across two major context shifts. Observed cases which implied existence of the first phase are shown below.

- Right after starting her shopping, the observee directly went to the deli floor, closely looking at some items, saying “they’re very helpful to plan my dinner menu as well as to know how to cook it!” (a homemaker in her 30s)
- As the observee already had planned her dinner menu by reference to a magazine article at home, she just looked around the meat floor right after initiating her shopping, then went to the greengrocery floor and started choosing items referring to the assortment of the meat floor in her memory. (a homemaker in her 40s)
- (An utterance from an observee) “I basically start shopping from what I don’t have to forget to buy”. (a homemaker in her 40s)

There seemed to exist the warm-up phase right after initiating her shopping regardless whether she had her plan or not at the moment. In this phase, she mainly replenished what she had already recognized as well as worked her plan for a main dish of the day. She was so enthusiastic to buy what she had to buy without omission that, we could speculate, she felt pretty tensed during this phase.

Observed cases which implied existence of the second phase are shown below.

- (An utterance from an observee) “Because I had decided to cook hashed rice as today’s main dish, I wanted to choose an appropriate packaged beef for it. I compared several packages with each other, and decided to choose one because it seemed the most fresh.” (a homemaker in her 30s)

- (An utterance from an observee; after picking up a package of aroids) “As I had decided today’s main dish which packed a hard punch, I think up boiled aroids with soy and sugar as a side dish will go nicely with the main dish.” (a homemaker in her 40s)

This phase was the closest to what we had conceived as the typical grocery shopping: Each observee implemented her plan by choosing and picking up specified items. In this phase, she fulfilled the plan which had been made in the previous phase as well as developed and carried out her plan for a side dish which was going to nicely with the main dish. We could see that she concentrated her mind on how she could fully suffuse her plan during this phase: i.e. to buy higher quality items with cheaper prices. We could also confirm that her state of mind in this phase got less tensed than that in the previous phase.

Observed cases which implied existence of the third phase are shown below.

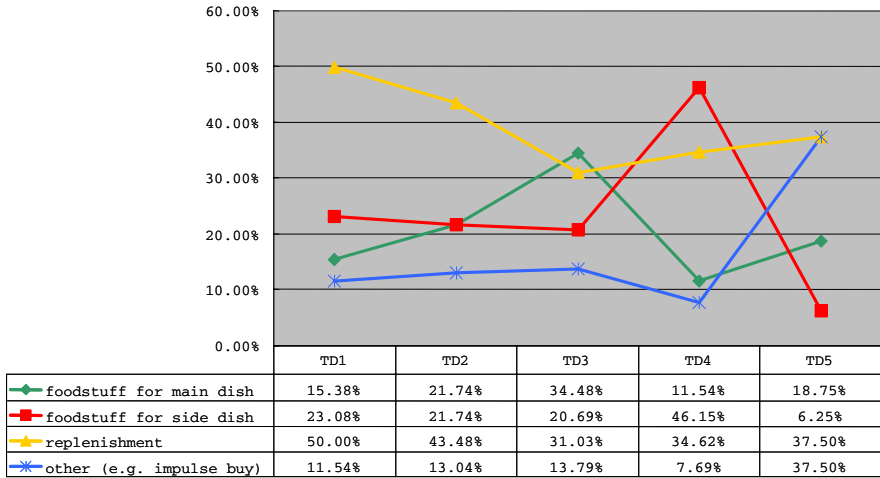
- After declaring that they finished their shopping on the day, some observees still continued to look around their pathway and found what they would like to buy.
- (An utterance from an observee) “I’m always feeling that I might forget to buy what I have to buy today, so I usually scour for something tell me so in the closing stage of my shopping” (a homemaker in her 30s)

There seemed to exist the wrapping-up phase before terminating her shopping. In this phase, she tended to buy items which were not necessarily to have on the day. She was also willing to take new articles and reduced items to try them out. In other words, this phase acutely triggered her impulse buying. We could see she was relaxed and feeling fun during this phase since, we speculated, she was freed from the mission of the shopping on the day.

### 2.3 Findings from the Video Ethnography

We did moment-to-moment analyses of the video data of the seven observees (One is omitted due to lack of her video data). We normalized their shopping durations because they differed from each other, split them into five divisions, and plotted the items chose according to the applications in each division (Fig. 3.). As the result, “replenishment” got the highest rate in the first and the second division, “foodstuff for main dish” was the highest in the third division, “foodstuff for side dish” was the highest in the fourth division, and “replenishment” again and “others” including pure impulse buy (without any assumptions of use) were the highest in the final division. To compare this result with the result in the previous section, we could understand that the first and the second division roughly corresponded to the first phase, the third and the fourth division to the second phase, and the final division to the third phase, due to the similarities of the observed behaviors.

Consequently, we defined the three-phase model, or TPM (Fig. 4.): From the first to the second phase, it was divided in the wake of starting to buy a foodstuff for a shopper’s main dish, and, from the second to the third phase, it was divided in the wake of finishing to buy what a shopper have to buy on the day.



**Fig. 3.** The rate change according to the applications of items which were added to the observees' shopping carts in five time-divisions respectively

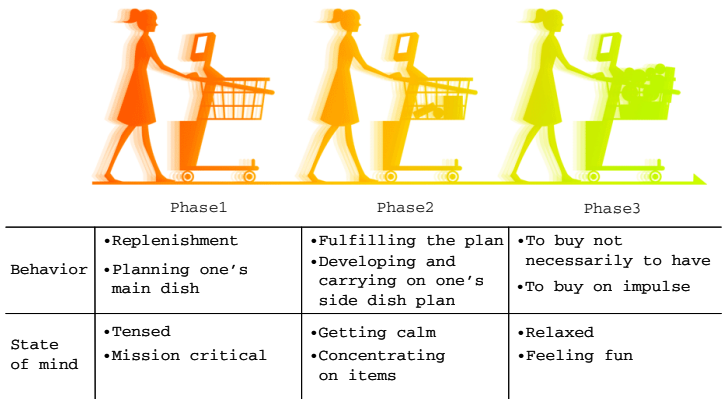
### 3 Design Implications

As premises for TPM, what services are the best for each phase? Given that we would develop a mobile kiosk terminal embedded with a shopping cart which would be feasible to operate in a supermarket at that time, we described an experience scenario corresponding to each phase referring to the findings in the previous section.

#### 3.1 Experience Scenarios

**Experiences in the First Phase.** I come to the supermarket with the thought that a meat dish is better for today's dinner menu because I cooked fish yesterday. I rent out a mobile kiosk terminal embedded with a shopping cart, turn on the system, and check today's fresh recommendations on the screen. I discover that every pack of pork is twenty percent reduced, so that I move to recipe recommendations on the screen and retrieve recipes of pork dishes. There are plenty of appealing pork dishes varying by parts and seasonings. Since I would like to have a hefty dish today, I choose "pork spareribs grilled with barbecue sauce" from them. I bookmark the recipe and head down to the meat floor to see pork spareribs. I pick up a carton of milk and a pack of sausages, which I have already planned to buy, on the way. While I'm passing over the egg section, I happen to remember that there are just three eggs left in the refrigerator at home, and I, therefore, take a pack of eggs which is also recommended on the screen.

**Experiences in the Second Phase.** I arrive at the meat floor and notice that there are two types of pork spareribs. I scan a bar-code attached to one of pricier type by using bar-code reader which is embedded to the system. There emerges a description



**Fig. 4.** The three-phase model: consecutive changes of a shopper’s behaviors and his/her states of mind

regarding the article on the screen. I come to know that the type of pork has been fed on organic foods, so that it seems healthier than the other one. I decide to buy the pricier one and take a pack with adequate amounts.

Because I remember barbecue source is now out of stock at home which is necessary to cook the menu, I head down to the grocery floor. I notice that recommendations on the screen have changed from fresh foods to packaged foods. I see through them all and notice a brand of barbecue source is included. It is not the one I usually use, therefore I switch to the description of the article and know that it is totally made with organic ingredients. Although it is at a cut-rate price for this week but still a little pricier than the usual one, I decide to buy it in a sense of a tryout. While taking a bottle, I notice that three new recommendations are flashed in rotation at the corner of the screen. One of them is a jar of mustard. I think up mixing mustard with barbecue source sounds good. I remember that there remains enough amount of mustard at home, so that I don’t have to buy it on this occasion.

Then I head for the greengrocery floor. I feel anything plain will be better for a side dish because the pork spareribs are somewhat greasy. I look into the screen and find that there are many recipes using in-season vegetables ready, which suit for my thought. I prefer “tomato salad with boiled spinach”, so that I display the ingredients by touching the particular icon. I confirm that all the ingredients, except spinach, are stocked at home. I directly access the spinach shelf, and select a lively-leafed bunch. I also bookmark this recipe for remembrance' sake.

**Experiences in the Third Phase.** I have gathered most for today’s dinner menu, so that I settle on the idea that I will stroll down the aisles to see what I had better buy. I again notice that instances on the screen transformed. There are new articles of the week now. I check them one by one, find a brand of low-calorie ice cream, and get happy to know my favorite mango taste is lined up. I go straight down to the ice cream freezer and two cups of mango and chocolate taste respectively for everybody in my family for after-dinner dessert.

On the way for checkout, I stop by at the tofu section and notice that there are sales rankings of the section for the last week displayed on the screen. I realize that I have not tried out the most popular one. I hesitate but bring it forward, although it seems attractive really. Then I go straight to the checkout counter.

At the checkout counter, the two recipes bookmarked are automatically printed out and I can obtain them for later use.

Looking back on the entire journey, I should say what an attractive supermarket it is!

### 3.1 Allocation and Configuration of Services

We identified five service types included in the scenarios. Corresponding to a shopper's dynamic process, the situation when a particular service exerts never uniform, but dynamically shifts as well. We speculated the best allocation and configuration of the service types by examining when and how the each service type would become activated.

**Recipe Recommendations.** As recipes are effective information to a shopper's comprehensive planning, they will tend to be used in early part of the process. Since we could know a shopper usually plans his/her main dish in the first phase and side dish in the second phase, an appropriate series of contents should be provided at each phase respectively.

**Product Recommendations.** Although product information seems valuable throughout the process, each phase will favor different kind of information. In the first phase, information regarding a sale on fresh food may help a shopper to develop his/her plan for a main dish. In the second phase, information which will enable a shopper to compare prices, qualities, and features of an array of choices may help a shopper to fulfill his/her plan for a main dish as well as for a side dish. In the third phase, information regarding new and luxury articles may help a shopper to suffice his/her curiosity about grocery items.

**Location and Preference Based Recommendations.** While the previous two service types aim at communicating from the retailer, information taking account of a shopper's unique context, including where he/she is and what he/she prefers, may contribute to provide more appropriate information to a shopper him/herself. This service type will be expected to exhibit the multiplier effect by linking up with the previous two service types.

**Bookmark Functions.** This service type will complement the previous three service types. Since it aims at helping a shopper return to the information which he/she saw earlier in the process whenever he/she likes, it have to be accessible at any time.

**Scan-to-deliver Information.** This service type will make an article itself as a trigger to retrieve its detailed description. It may be especially useful from the second phase onward because it will provide a shopper information which enables him/her to choose and to evaluate articles.



## 4 Subsequent Study

We developed a mobile kiosk terminal embedded with a shopping cart, named SmartCart, as the core of the prototype system. We also conducted an operation test at the project site for about two weeks in September 2006. About fifty customers used the system during their shopping trips, and about twenty among them cooperated with our participatory observations. We will introduce the details of the system as well as the evaluation of it based on the operation test in the near future.

## 5 Conclusion

In this paper, we reported our human-centered approach for the purpose of developing a ubiquitous computing system aiming at providing better experiences for shoppers at a supermarket.

We focused on shopping processes by using ethnographic research techniques, understood the process with details, and constructed TPM which classifies a shopper's behaviors and states of mind change into three phases. We also described our concept design of service types for a prototype system and dealt with allocation and configuration of the service types corresponding to TPM.

Although we didn't give details, we had already developed the prototype system based on the design implications stated in the previous sections and conducted an operation test at the project site. We are now investigating in the data which were acquired from the test. In the near future, we will introduce the details of the system as well as the evaluation of the system from the view of how the system had an effect on shoppers' behaviors and their states of mind.

We believe that understanding people's cognitive process, like TPM, will hugely contribute to practical applications of ubiquitous computing technologies. As Abowd and Mynatt stated, one of the most major motivations for ubiquitous computing is to support the informal and unstructured activities typical of much of our everyday lives [9]. Through the researches in applications at real retail outlets, we hope we will be able to contribute to solve such the difficult problems.

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