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AnalyzingIn-store Shopping Paths from Indirect Observation with RFIDTags Communication Data

Takao Terano
Tokyo Institute of Technology
Address: 2-12-1 Ookayama, Meguro-ku Tokyo 152-8550 JAPAN
E-mail: terano @dis.titech.ac.jp

Masaki Kitazawa
Tokyo Institute of Technology
E-mail: m.kitazawa@trn.dis.titech.ac.jp

Takashi Yamada
Tokyo Institute of Technology
E-mail: tyamada@trn.dis.titech.ac.jp

Masakazu Takahashi
Yamaguchi University
E-mail: masakazu@yamaguchi-u.ac.jp

Gaku Yamamoto
Tokyo Institute of Technology
E-mail: yamamoto@jp.ibm.com

Atsushi Yoshikawa
Tokyo Institute of Technology
E-mail: at_sushi_bar @dis.titech.ac.jp

Toshiki Fujino
Tokyo Institute of Technology
E-mail: t.fujino @trn.dis.titech.ac.jp

Abstract: This paper presents in-store customer behavioral model gathered from RFID (Radio Frequency Identification) tags communication data. Although this kind of research has been made by various methods such as interviewing or tracking behind customers, Conventional research methods are made by with the existence of customer tracking research, so far. For collection of natural customer behavior, we made a customer in-store behavior research with RFID tags in a real retail store. In a conventional store design theory, it has been thought that increasing the length of staying time can raise the amount of money per person. Therefore, the store has been designed in the form that goes inside of a shop around. The experimental results suggest that there is a correlation between the spent of time and the length of customer walking path.

Keywords: Shopping Path, Customer Behaviors, Point of Sales (POS) data, Radio Frequency Identification (RFID), Retail Store, Services Sciences and Management and Engineering

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INTRODUCTION

In Japan, deflation overlaps with a long-term slump in consumer money spends and the regulatory policies for the retail businesses have occurred in the competitive market. Some leading companies utilizing the benefits of business scale fierce price competition to the mid and small companies and make engaging in price competition among the market area. Price competition is a capital oriented method, and it is necessary to compete for the small and medium-sized retail store in another way with the major ones. Therefore, it becomes important for efficient store management to do following activities; Research of customers' Purchase items to prevent from both of the stock out and the surplus of the items and arrange the layout that customers easily find and buy. Service management of retail business in a super-market requires investigations for store operations including the shop layout, sales promotion, and control of customer flows. So far, such investigations have cost very much to examine in real situations. Inthis study, we propose a handy method for gathering customer walking paths with theRFID tag, and it reports on the result of the experiment in the retail supermarket. We carry out a data gathering experiment for the purpose of the customer-walking path in the store through the RFID tags. The rest of the paper is organized as follows: Section 2 discusses the background of the research and related work; Section 3 briefly explains the field study of the target supermarket; Section 4 describes the basic principles presents experimental results; and Section 5 gives some concluding remarks and future work.

BACKGROUNDS AND RELATED WORK

A retail store performs many sales promotions in order to make sales increase. One of the conventional methods of the evaluation is with ID (Identification)-POS (Point Of Sales) data analysis[1].There have been many researches concerning to consumer behaviors and their decision analysis systems in marketing science literature [2], [3]. They are both based on statistical analysis of Purchasing items and attributes of consumers. On the other hand, several data mining techniques have been used for the analysis [4], [5]. They have been also utilized customers' movement data in a real shop using technologies of RFID (Radio Frequency Identification) tags and video camera tracking [6]-[9].

In our country, in addition to competing intensification by the regulation, the declining birth rate and the growing proportion of elderly people is advancing at the speed at which the example is not seen in the history. The competition in the domestic market intensifies more along with this population decrease. The method of sales promotion that uses the Reward Card is in common in the Japanese retail business. For instance, it aims to enclose the customers and gathering customers excluding price attractiveness to double the point of a Reward Card to Purchase more items as usual. Moreover, the store layout has been regularly changed for the sales promotion. So far, the layout change had been understood to affect customers' flow in the store in the rule of thumb up to now. Therefore, the most efficient method of understanding the customers' flow in the store is required.

We are conducting a research project to develop a decision support system to increase the service productivity on retail store management including ordinary supermarkets [10]-[14]. In the current situation, however, to measure the individual customers' behaviors in real time is very difficult because of the measurement costs and decision algorisms of customer behavior. This is a

part of the research report.

EXPERIMENTAL SETUP IN THE TARGET STORE

This section explains the setups and results of field study with RFID tags in the target store. The condition of target store and setups of field study is shown in Table 1.

RFID is one of the individual recognition technologies using a radio antenna and an IC tag. This device is mainly used for logistics inventory so far, and an indoor location estimation method is focused with RFID, recently [15], [16].Since RFID is comparatively small, its influence that it has on a customer is small under the research. Figure 1. indicates the RFID antenna location and layout of the store, Figure 2(a). indicates the RFID tag position attached a shopping cart, and Figure 2(b). indicates the RFID tags mounted on a fixture, respectively.

Table 1. Condition of Target Store and Setups of Field Study

Store Location	Shimane Prefecture, Japan
Operating Hour	9:00 – 21:00
Daily Average of Customers	2,000
Experimental Period	March 3 – March 5,2011
RFID Antennas	10 on display fixture, 6 on each register
RFID Tags	53 on shopping cart(Half of shopping cart)

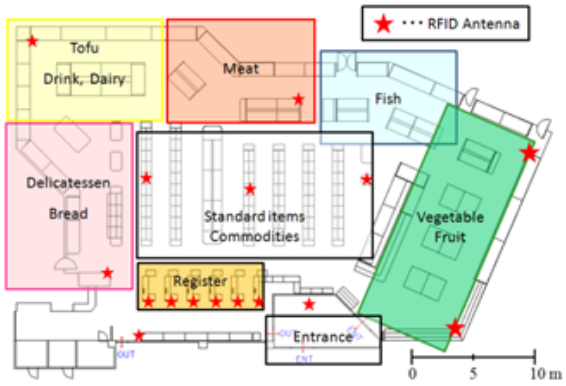

Figure1. Store Layout and RFID Antennas Position

Figure2(a). RFIDset on a Shopping Cart

Figure2(b). RFIDset on a Display Fixtur

As for the shopping path, we assume the shopping path from the entrance to the register. We consider the path as an edge and the fork as a node to estimate the customer shopping pass. Figure 3 indicates nodes and edges in the target store. Since we can trace the position of fixture from POS data, we assume that the customer passed through the path in front of the fixture of Purchase items.

As for the staying time, we assume the staying time as between from the time received radio wave from the antenna tags in the vegetable section to the time received the radio waves in the cash register.

If we synchronize POS data with RFID tag set on a shopping cart or a shopping cage, we can estimate both the staying time and the position of passed fixture for shopping path calculation. Figure 4.indicates the communication range of antenna. The communication ranges of RFID tag set on fixture indicate surrounded by blue respectively. From the preliminary experimental results of RFID communication range, it is determined whether passed through the path in which signal strength and antenna tag number of the communication destination.

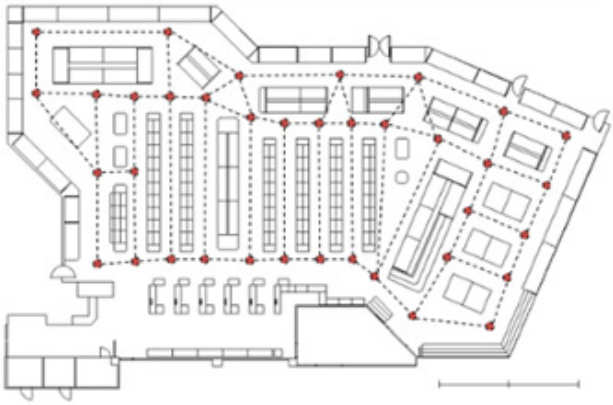

Figure3. Nodes and Edges in the Target Store

Figure4. Communication Range of the Antennas

ANALYTICAL RESULTS FROM GATHERING DATA

The shopping paths from POS data and RFID communication data with fifty transactions issued on March 4, 2011 are analyzed. Table 2. Indicates the result of the statistical results. Table 3. Indicates the relation of shopping path, staying time, number of Purchase items, Purchas evolume. As for the shopping path, it turned out to be less relation with number of Purchase items or Purchase volume.

Table 2. Results of Gathering Data

	Walking Path (m)	Staying Time	Number of Items
Average	174.07	14':45"	12.38
Std Dev.	83.28	11':06"	8.04
Median	157.44	10':26"	10.00
Min.	42.55	03':44"	2.00
Max	425.11	47':51"	39.00

Table 3. Relation of Gathering Data

Elements	Correlation
Shopping Path – Staying Time	0.8284
Shopping Path – Number of Purchase Items	0.4341
Staying Time – Number of Purchase Items	0.2598
Number of Purchase Items – Purchase Volume	0.8921
Shopping Path – Purchase Volume	0.4346
Staying Time –Purchase Volume	0.2894

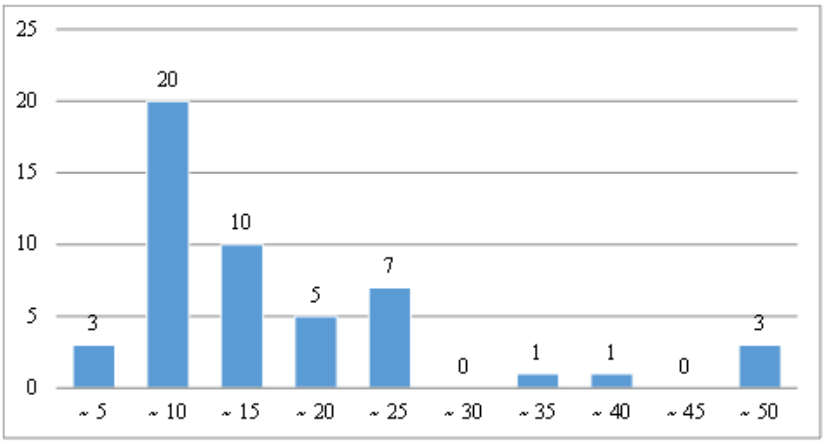

Figure5. Histogram of Staying Time (Method: Sturges)

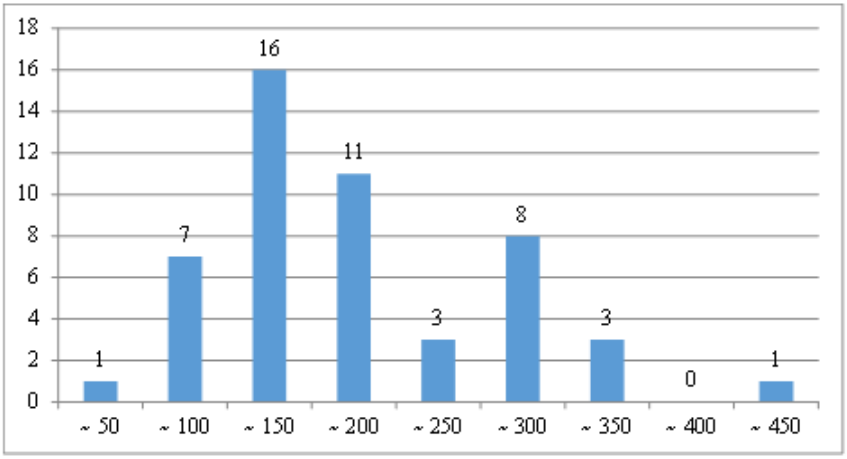

Figure6. Histogram of Shopping Path (Method: Sturges)

Figure 5. indicates histogram of staying time. The horizontal axis in figure 5 shows staying time with 5 minutes interval. Figure 6. indicates histogram of shopping path. The horizontal axis in figure 6 shows shopping path with 50 meters interval.

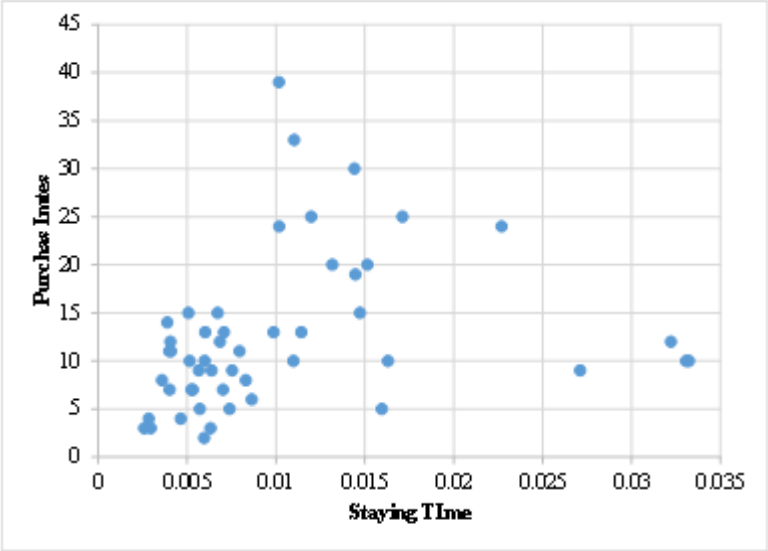

Figure7. Staying Time and Number of Purchase Items

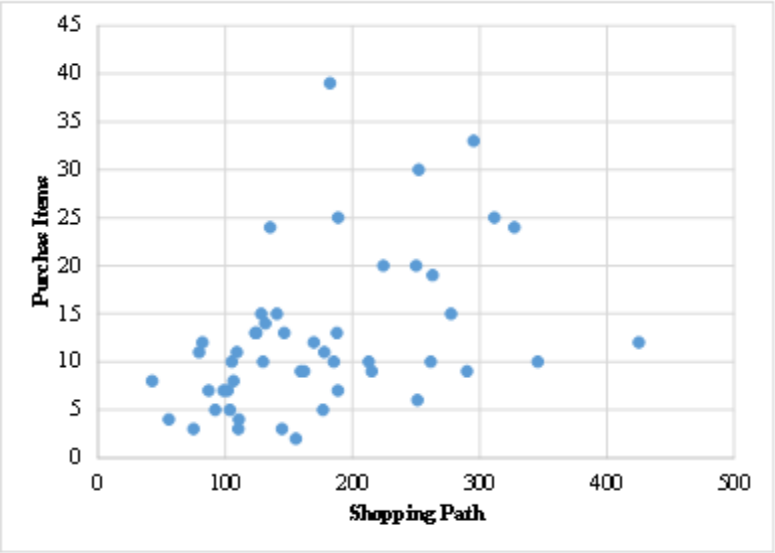

Figure8. Shopping Path and Number of Purchase Items

Figure7. indicates the relation of staying time and number of purchaseitems. Figure 8. also indicates the relation of shopping path and number of purchase items, respectively. From the analysis, the staying time extends, the shopping path get longer.Even if the shopping path or staying time gets longer, the number of Purchase items does not increase.

Figure 9. indicates example of short shopping path with large purchase items.This customer took items with same category intensively and might be seen well understand the item position in the store for shopping around efficiently. Figure 10. indicates example of long shopping path with small purchase items, respectively.The blue line shows first round in the store and the dot line in red shows second round in the store, respectively. This customer made two rounds in the store and went back and force in the same place. It is impossible to figure out which round might be put in the basket from this result. According to the real observation in the target store, Most of the customers look around in the store in the first round for the preliminary research and take target items in the second round.

Figure9. Example of Short Shopping Path with Large Purchase Items

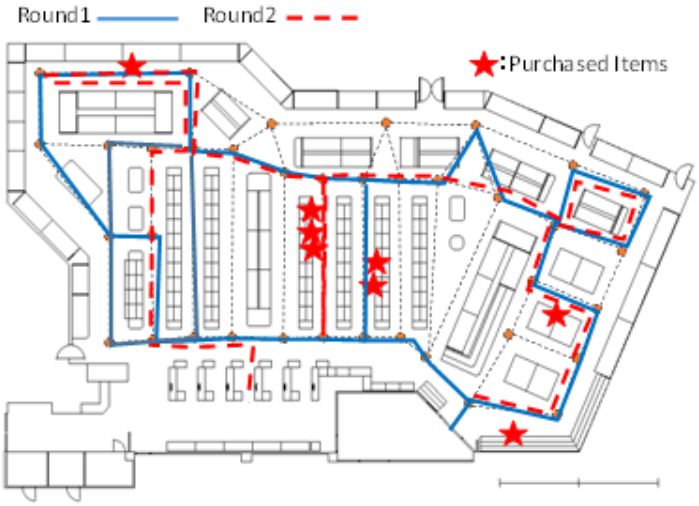

Figure10. Example of Long Shopping Path with Small Purchase Items

CONCLUDING REMARKS AND FUTURE WORK

This paper has presented investigating for analyzing customer shopping path in a supermarket which aims at developing a marketing decisionsupport system for retail management. We have described theresearch background, research setup, and experimental resultsof fieldstudy. Before executing studies, we have carried out intensive field survey and POS data analysis to uncover the current situations of the targeted super-market.The experimentalresults have suggested that the staying time in the store extends, the shopping path get longer. And even if the shopping path or staying time gets longer, the number of purchase items does not increase. Our future work includes1) analysisregarding customer information base on a reward card and product categories, 2) analysis of customers' branching probability in a real store to ground walkingflow,3), and 4) mounting the results of customer behavior data with thesimulation. These work will require practicalexperiments and further survey studies.We wish to express our gratitude of the cooperation to our experiment.

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