International Conference on Human Side of Service Engineering (HSSE2012), pp.6632-6641 (2012)

CHAPTER XX

Introduction of Computer Supported Quality Control Circle in a Japanese Cuisine Restaurant

Ryoko Ueoka, Takeshi Shinmura* **, Ryuhei Tenmoku*, Takashi Okuma*, Takeshi Kurata**

*National Institute of Advanced Industrial Science and Technology
Tsukuba Japan
**Ganko Food Co. Ltd.
Osaka, Japan

ABSTRACT

The activity of quality control circle (QCC) has been conducted in restaurant business to improve service productivity. However, it was difficult to show the evidence of improvement objectively. For the purpose of developing the new QCC method specified in service industry, we propose Computer Supported Quality Control Circle (CSQCC). In this study, as a first step of CSQCC we carried out a pilot study in a Japanese cuisine restaurant and evaluated potential capabilities of CSQCC with which we can not only measure behaviors of workers over a month but also show statistical data combining workers' trajectories with point-of-sale (POS) accounting data in a 3D manner. As members of the QCC shared waitresses' behaviors, they could effectively find some patterns of traffic in working area correlating to productivity, which shows potential of CSQCC as a new method of service observation.

Keywords: Quality Control Circle (QCC), Service Engineering, Visualization, Human Behavior Sensing

1 INTRODUCTION

QCC is defined as a small group of employees who come together to discuss with the management issues related to either quality control or improvement in production methods. These employees usually work in the same areas, and voluntarily meet on a regular basis to identify, analyze and solve their problems (Watanabe, 1991, EZINE, 2008). QCC was first introduced in manufacture such as automobile industry (Monden, 2000). In this industry, observational techniques such as measuring behavior of workers at a fixed place were fairly effective in identifying problem and adopting techniques such as the *kaizen* method for improving work efficiency (Imai, 1986). However in service industry, collecting objective data is not easy due to the cost and technology for dealing with relatively-large indoor fields. Therefore most of reasonable data being used for conventional QCC is questionnaire to employees or customers, amount of daily sales and so on. So for the purpose of developing the new QCC method to observe both productivity and subjective values specified in service industry, we propose Computer Supported Quality Control Circle (CSQCC) (Figure 1).

In this study, as a first step of CSQCC we carried out a pilot study in a Japanese cuisine restaurant and evaluated the potential of CSQCC for observing service productivity. This was done by using measurement devices, including Pedestrian Dead Reckoning sensors (PDR), RFID (Radio Frequency IDentification) tags (Ishikawa, Kourogi, Okuma and Kurata, 2009, Kourogi, Ishikawa and Kurata, 2010) , to measure the behaviors of workers for a month. Also by using 3D visualization tool showing 3D visualization and statistical data which combines workers' trajectories with point-of-sale (POS) accounting data during a phase of pilot discussion of QCC, members of the circle shared waitresses' traffics which helped to find some patterns of traffic in working area which relate to productivity. It shows CSQCC helps to identify and analyze problems of interfering productivity.

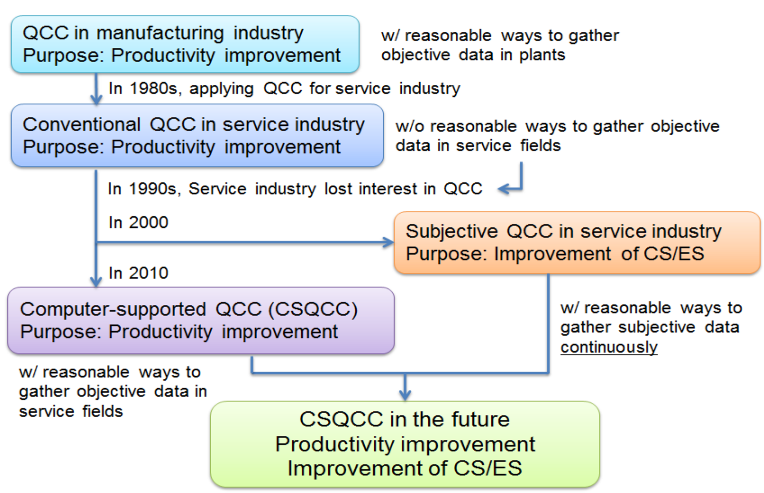


Figure 1 History of QCC in the Service Industry in Japan and CSQCC.

2 RELATED RESEARCHES

A range of devices including wearable sensors and mobile phones have been used to measure human behavior, and a variety of analytical methods have been proposed including organizational analysis and the generation and analysis of interpersonal topological network diagrams. For example, the SocioMeter designed at MIT Media Lab (Choudhury and Pentland ,2003) and Hitachi's Business Microscope (Hitachi Cooperation, 2011) employ IR transmitters as sensors to measure face-to-face communication between office workers, and this data is then used to analyze personal interaction in organizations and topological behavior between groups. The SocioMeter analyzes connectivity between people and how long they converse using sensor data, while the Business Microscope provides visualization of organizations as an index of office work value creation through face-to-face communication. When measuring face-to-face communication with sensors, the point of contact with the other person is the critical point that is sensed, and fine-grained positional accuracy is much less important. In reality, office work is generally categorized by area in the office—meeting room, showroom, section room, and so on—and more detailed information about specific work within an area is typically measured using PC logs or some similar mechanism. In the service industry that is the focus of this study, there is relatively little work involving face-to-face communication with other employees. Rather, the work primarily involves work in different areas and communication with customers. Thus, differences in types of food depending on place, differences in customers depending on service location, and other considerations regarding position and paths in areas are significant factors for work in the service industry. While detailed movement data within an area is required, the accounting data such as POS can be used to replace communication history with customers. Because the types of sites we are interested in differ from those addressed in previous studies, this means that we are looking for different types of data.

Reality mining permits us to visualize social structures around human connectivity (Eagle and Pentland, 2009, Eagle, Pentland and Lazer, 2009). The purpose of this research is to build generative models that can be used to predict what a single user will do next as well as model behavior of large organizations using log data collected from mobile phones. Here they have analyzed the interpersonal behavior of individuals around connectivity with others in society, and attempted to model the social activity of individuals based on their mobile phone usage history. Since modeling service providers and customers in the service industry field differs in terms of social scale and members, the type of sensors used, the type of data collected, and the model assumptions used in this study all differ.

A number of studies measuring human behavior in the service industry have been conducted including an analysis of changes in the selection of shopping centers based on the type of customer at a shopping mall (Dennis, Marsland, Cockett and Hlupic, 2009) and a shopping promotion study that seeks to induce purchasing using an experiment environment that simulates store shelves (Sae-Ueng, Pinyapong, Ogino and Kato, 2007). However, the focus of these studies of purchasing behavior is on the customer, whereas our study focuses on the behavior of the service providers.

Naya *et al*. proposed using sensors and a behavior recognition algorithm to detect the behavior of nurses as they go about their work at a health-care facility (Naya, Ohmura, Yakayangi and Noma, 2006). The authors employ the similer method we use in our study of attaching sensors to the clothing of the subjects to measure their behavior, but Naya *et al*. are primarily interested in the structuring of nursing work. The purpose of our study is fundamentally different. Rather than structuring the work of individual workers, in our study we integrate the measured behavior data with POS accounting data with the goal of discovering work objectively linked to service value and elevating service quality.

3 HUMAN BEHAVIOR SENSING AND VISUALIZATION TOOL

For this study, we continually monitored the behavior of about 20 workers in a two-story Japanese cuisine restaurant over a one-month period. Staff can be divided into three main job categories: kitchen staff, waitresses, and assistant waitresses who convey food and dishes from the kitchen to the pantry, prepare drinks, and do other miscellaneous tasks. On any given day there are at least 30 employees working in the restaurant, but we had limited experimental device so we selected 20 workers to participate in the study.

Measurements were recorded using PDR sensors attached at the waists of the subjects that measured their walking paths. And we compiled electronically recorded POS data including what was ordered in the restaurant, the number of customers and orders, when the orders occurred, where in the restaurant the orders occurs, the times that customers paid their bills, the names of waitresses associated with each order, etc.

Figure 2 illustrates how the sensors were attached to the subjects. Because the study was conducted over a one-month period at the restaurant, the sensor system was implemented in such a way that it would not interfere with work and could be easily removed by the subjects themselves. The waitresses wear kimonos when they are on duty, and the sensors were incorporated into accessories that are attached to the sash (*obi*) that goes around her waist.

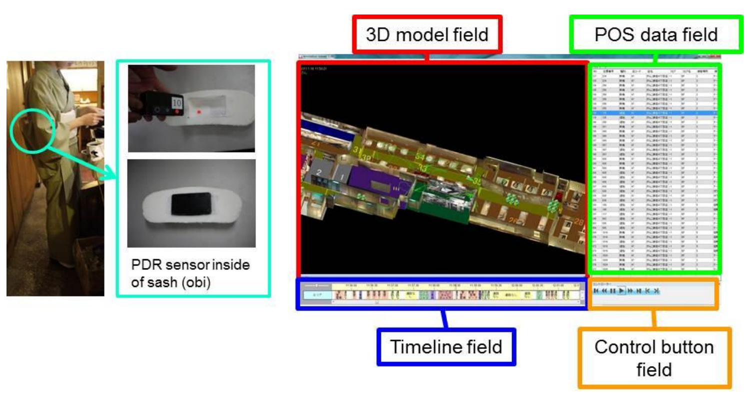
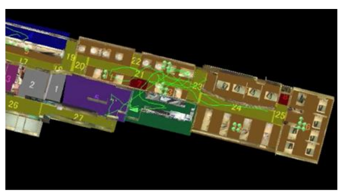


Figure 2 Human behavior sensing image (left) and developed 3D visualization tool (right)

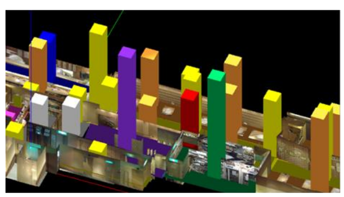
Also we developed a visualization tool that permits synchronized playback of all the measured behavioral data (estimated walking path results for each employee, speech data, VAD (Voice Activity Detection) results, POS and other work-related data). One can see in Figure 2 that the visualization tool consists of the following components:

- 3D model field: Displays a 3D model of the experimental environment, including walking paths and indicators of the subjects' positions as well as customer icons showing the location and the number of customers in the time period. (Figure 3 (a),(b)).
- Timeline field: Shows where the subject is in the environment and voice activity on the time line.
- POS data field: Displays POS log data in a spreadsheet.
- Control button field: Displays buttons to control playback, fast forward, and rewind of data shown in each field.



(a) Personal trajectory

(b) Customer numbers in each table



(c) Time spent in each area

(d) Earnings of each table

Figure 3 Example of visualized analysis

In addition to synchronized playback, the tool has a number of other important capabilities: you can input queries then search for places in the measurement data corresponding to the queries, and the tool calculates and displays various statistical values such as number of items ordered per customer, the proportion of time employees spend in different areas of the restaurant during working hours, etc. Regarding statistics of measured data, there are person, time, and area axes as multi-dimensional data, so by inputting queries, we are able to compare measured data for each person, each unit of time, and each area. Some of the statistical values that can be compared include amount of movement, number of times waitresses pass through an area, number of orders, sales, and face-time with customers. Comparing these statistics for each area, we can generate graphic representations superimposed on a 3D model as illustrated in Figures 3(c) and (d).

4 PILOT STUDY OF CSQCC

4.1 Discussion Phase

In order to assess how CSQCC works in actual service fields, we conducted a pilot study to evaluate the ability of the restaurant staff to identify problems, suggest improvements, and actually implement the proposals at the restaurant through CSQCC. In this pilot study, we first used the 3D visualization tool to show the behavior measurement data in the first week such as the movements of the waitresses, the amount of time they spent in the dining area, and so on. Then, once the staff had a good objective understanding of the situation based on the visualization results, they sorted out the problem areas and proposed improvements. In the fourth week of the behavior measurement study, the staff actually implemented their suggestions for improvement. And we compared staff behavior before and after the improvements were implemented to see if there were any discernible changes.

Details of the QC circle activity are summarized as follows:

- Date: February 1, 2011
- Participants: Three executive team managers, and three local staff members.
- Data used for visualization: Seven waitresses for four or more days during the first week of the behavior measurement study. (January 12-18, 2011).

During the QC circle activities, the participants discussed problems and issues on productivity and quality control while seeing data replayed in real time, and also while seeing graphs and tables showing one week's data that had been statistically processed in advance using the visualization tool.

As an example of traffic patterns of peak time, Figure 4 shows the movements of waitresses over one hour period from noon to 1:00 PM on two floors of the Japanese restaurant (floors B1 and B2). Note that peak time is a particularly busy time during the lunch hour rush, and we were able to verify the extent that waitresses stayed in service area based on actual data. By playing back the traffic data, we could see that the waitresses frequently shuttled back and forth to the back office on floor B1 even though this was the busy lunch hour. (Figure 5) Feedback from the manager revealed that when a waitress in the service area takes a call with her cell phone from a customer who wants to make a reservation, she has to make a trip to the backyard to check the reservation ledger. This finding led to a future agenda to introduce computerized reservation ledges for improving efficiency of the work not directly linked to serving customers.

These findings motivated participants to discuss whether the waitresses actually focus on customers in the service area.

As one can see in Figure 6 (left), the first week measurement results revealed that the average ratio of time stayed in service area per hour is 40%, which was not enough proportion as a waitress. It was thought that this is because the waitresses also work as assistant waitresses conveying the food before it reaches the dining area, and as one can see in Figure 6 (right), they move around other areas doing work other than serving customers in the service area.

While no major changes were made in terms of shifts or system modifications as a result of the QC circle pilot study in a short time, an improvement plan was nevertheless implemented in the fourth week of the study with the goal of increasing time staying in service area by having the waitresses consciously increase the time spent for interacting with customers. The plan was implemented on floor B1 where many walk-in customers were coming without reservations during the time frame from 2:00 to 4:00 PM when there are relatively few customers. Because the restaurant is not busy during those hours, this made it easier for the waitresses to take care of customers and increase face-time with them by encouraging them to have a low-cost dessert or coffee after their meal, or by chatting with them. As one can see in Figure 6 (left), the first week measurement results revealed that the average ratio of time stayed in service area per hour fell from 40% throughout the day on average to 37% around the off-peak hours of the targeted time frame. Although time stayed in service area is reduced simply because there are fewer customers during these hours, it was decided based on the QC circle activities to improve services by increasing the time stayed in service area per customer during this time frame.

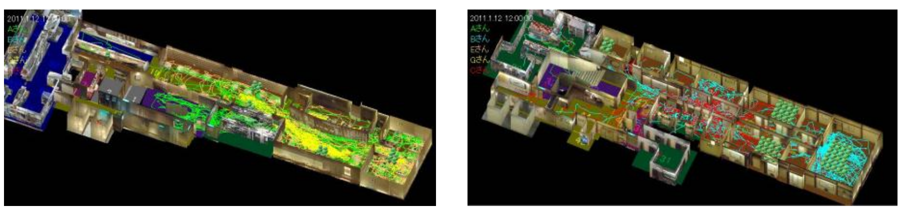


Figure 4 Example of peak time traffic of waitresses on two floors

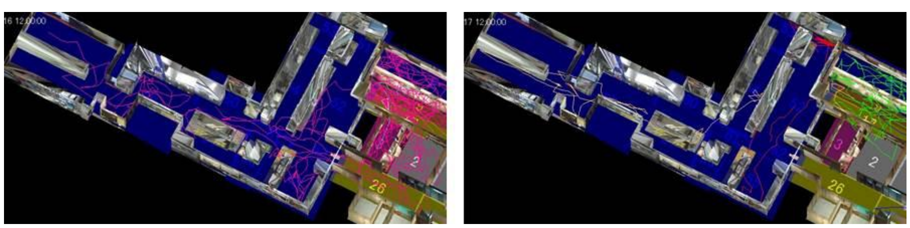


Figure 5 Example of traffic to and from the backyard during peak time on Jan 16 and 17,2011

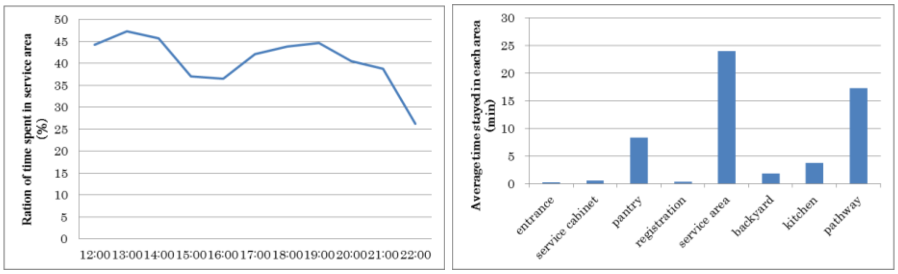


Figure 6 Ratio of time stayed in service area of each time frame (left) and time stayed in each area (right)

4.2 Comparison of Before and After CSQCC

As a pilot study for evaluating the effects of this service improvement, we first compared time spent in service area during the first week (before improvement) and the fourth week (after improvement) of the experiment.

Figure 7 shows the box plot of the ratios of time spent in service area from 14:00 to 16:00 during the first week and the fourth week. Being compared to the median time ratio of 22% in the first week, the ratio increased by 1% to 23% in the 4th week. No big change has been found but variance of time decreased in the 4th week, which may say that service quality became stable in the fourth week.

Figure 8 shows that the total time spent in the service area per customer had increased from 2.4 minutes in the first week to 2.6 minutes in the fourth week. This too reflects a gradual increase of improvement in the latter week.

In a follow-up with the managers, we confirmed that these results were actually reflected in changes at the restaurant since during the fourth week, a manager tried to tell to the waitresses to spend more time in the dining area and to communicate with the customers more.

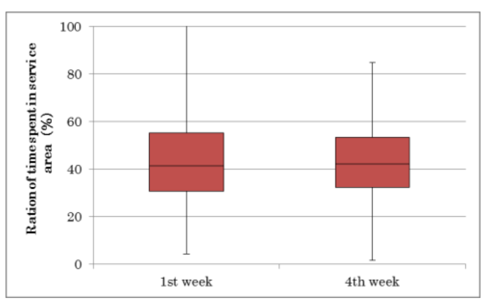


Figure 7 Boxplot of the ratio of time stayed in service area in 1st week and 4th week

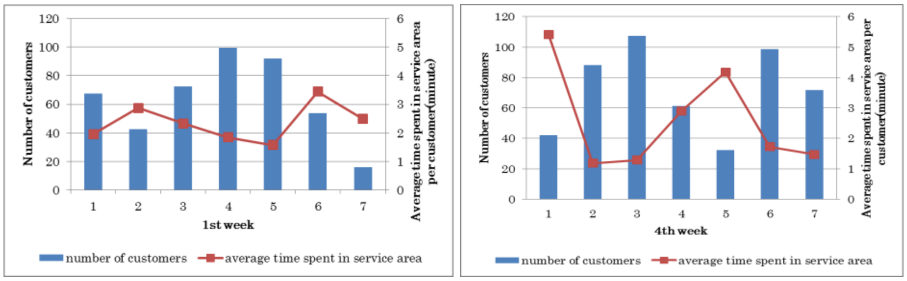


Figure 8 Number of customers and average time stayed in service area per customer (min)

5 CONCLUSIONS

As a first step of CSQCC we carried out a pilot study in the Japanese cuisine restaurant and evaluated the potential of CSQCC. By using measurement devices to measure the behaviors of workers for a month, we proved our proposing system was able to measure employees' behavior in service industry over a long period of time.

Also by using 3D visualization tool, members of the circle shared waitresses' traffics which helped to find notable patterns of traffic in working area which relate to productivity during a phase of pilot discussion of QCC.

It shows CSQCC has the potential capabilities to help to identify and analyze problems of interfering productivity. In the end, based on the discussions in the circle, they tried to increase waitresses' staying time in service area as a pilot study of quality control. And we evaluated before and after the activity out of workers' measuring data objectively. It succeeds to show potential of CSQCC as a new method of service observation.

Usually, it is said to take a few weeks to understand the current situations before identifying the problem with traditional QCC. In the future study we would like to compare the effectiveness of traditional QCC and CSQCC by seeing how long it takes to identify problems and issues with each methodology.

Also for further understanding of correlation between workers' behavior and productivity, we are currently working on developing the algorithm to estimate the types of service operation from sensor data in order to break down service operation as a context (Tenmoku, Ueoka, Makita, Shinmura, Takehara, Tamura, Hayamizu and Kurata, 2011). By adapting this method, it is expected to understand the relationship quantitatively between each service operation and productivity.

Moreover, by combining behavioral data and feedbacks from customers, we can link workers' behavior and customers' satisfaction, which will make it possible to interactively analyze the relation between productivity and subjective values for improving service quality in future.

ACKNOWLEDGMENTS

This research was entrusted by the Ministry of Economy, Trade and Industry (METI). We thank all the staffs in Ganko Food Restaurant at Ginza 4-chome for cooperating with our experiment. We also thank Mr. Ogawa and Mr. Tsunemori of executive managers in Ganko Food Restaurant Tokyo branch office for cooperation of our research.

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