RESEARCH ON CONSUMER PORTRAITS OF OFFLINE FAST FASHION SHOE STORES BASED ON IOT SMART HARDWARE

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There is a close relationship between consumer's portrait and product's attributes. Consumer portraits are usually obtained from information provided by consumers or by using data analysis of computer vision technology when they were in store. However, there was few concerns on the product's attribute which was a critical factor affecting consumer portrait establishment. Therefore, the purpose of this study was to establish IoT based product attributes' data collection system then to use this system to portrait consumers behaviors. Firstly, we used our own developed smart hardware to collect consumers' attention data on products of fast fashion shoe stores. Then the product attention index was obtained by combining sales data, and the quantitative attributes of the products with the highest attention index were analyzed, including the age, style and price. At last, improved the TOFA model to make it suitable for the conversion analysis of product attributes to consumer portraits. The results showed that there were core hedonic middle-aged consumer groups and potential thrifty youth consumer groups in the store, and the styles of shoes tend to be fashionable and casual. The conclusion was that the new model can effectively analyze the core consumer portraits of shoe stores and provide strategies for shoe store positioning and supply.

Keywords: IoT (The Internet of Things), Fast fashion shoe store, Consumer portrait

INTRODUCTION

As we all know, fast fashion imitates the current fashion trends of luxury brands and keeps up with fashion trends with the advantages of low prices and rapid design (Joy *et al.*, 2012), production, and launch (Tokatli, 2008). From the relevant research reports of fast fashion, we found that fast fashion brands can respond to supply and demand matching through rapid production, reducing the risk of slow sales or shortages (Cachon and Swinney, 2011). By proposing the complexity of the fast fashion supply chain concept, it could quickly respond to the existing supply chain management model (Barnes and Lea-Greenwood, 2006). Through forward-looking pricing, discount strategies could be selected in advance to adjust seasonal inventory balance and increase potential profits (Aviv and Pazgal, 2008). Through inventory forecasting, the inventory allocation problem of all stores in the retail network could be solved (Caro and Gallien, 2010). Therefore, fast fashion is fast, flexible, forward-looking and strategic. It is important to study fast fashion products, achieve rapid response to demand, and reduce the information asymmetry of supply and demand.

Nicosia (Nicosia, 1966) proposed that the consumer behavior pattern consists of four aspects: the generation of consumer attitudes, the investigation and evaluation of products by consumers, the effective decision-making behavior of consumers, and the formation of consumer experience. Consumer behavior firstly originated from the first acquaintance (Hsieh *et al.*, 2010, Di Sorrentino *et al.*, 2016), and then the customer's cognitive process was triggered by interest, which ultimately lead to the solidification of

decision-making and experience. We summarize the process by which consumers are interested in products as attention behavior. Generosi *et al.* (2018) adopted face recognition technology and introduced an expression tracking system to collect consumer attention emotions. Liu *et al.* (2015) developed a system that captures the characteristics of the customer's arm to track consumer attention behavior. There was also research to establish regional product attribute data (Yoshida and Koiso, 2010), and used RFID and infrared equipment to collect the attention-to-hand rate of a single shelf area (Chen, 2014). Due to the short product life cycle in fast fashion store (Hou *et al.*, 2019) and high cost, these results were limited to discussion.

Research on consumer portraits can accurately tailor information for consumers (Palmer, 2010), and the research on consumer portraits was mainly carried out on three indicators: age (Hervé and Mullet, 2009), consumer values (Kahle *et al.*, 1986), and consumer preferences (Choi *et al.*, 2010). Consumer portraits can change with market changes. It was important to grasp the core age groups in the market and made marketing strategies for them (Dychtwald and Gable, 1990). The consumer values and consumer preferences would be diversified due to individual differences in consumers. We can use the attributes of the shoe product (Wang, 2014) to quantify the consumer values of the consumers who bought it (the price reflected the frugal or hedonistic) and consumer preference (product style). The TOFA (Traditionalism, Optimism, Financing and Advance) model proposed by Kahle *et al.* (1992) introduced the fashion index style (S) to measure the consumer preference between fashion and tradition; and the cost index risk (R) was introduced to measure the consumer values between thrift and hedonic. The current studies have not considered age, consumer preferences and consumer values together into the evaluation of consumer portraits. Thus, this paper improved the TOFA model and considered the age of consumers in the parameters describing consumer portraits.

The purpose of this study was to obtain the core consumer profile by analyzing the attributes of the core product. We mainly developed a set of intelligent hardware that used RFID technology to collect the number of times each product in the store has been visited. The system constructed offline store consumer behavior detection and consumer portrait analysis models. Through analyzing product attributes, we can construct consumer portraits by product preferences. Thereby, the characteristics of the core customer group of the store were determined. Therefore, the store can achieve precise marketing in the short product cycle and increase profits.

METHOD

Intelligent Hardware Design

The basic principle of attention data collection: we installed product heat sensors on footwear products, when customers pick up the shoes, the sensor emits vibration frequency to collect data. Through the analysis of specific RFID algorithms, the number of concerns of the product was obtained.

The wireless acquisition device used in this study was characterized by its miniaturization (2 cm×3 cm×0.4 cm) and convenient use. As shown in Figure 1, the data collection of the product was received wirelessly. The pairing devices used to directly hung on the corresponding shoes, and recorded the number of attentions by

shock sensing, which optimized the defect that the receipt cannot be accurately collected due to the limited distance of RFID.

Figure 1. Equipment installation and data collection process

Data Collection

Firstly, we selected a flagship store of a shoe brand in China, set up smart store system hardware for the target store, and built a data collection platform. Then, the brand branch company gave a list of products for the season, which included attribute information such as shoe model number (SKU), style, price, product age, etc. And we entered the product information into the data platform. Finally, we collected the attention and sales data of shoes in the spring and summer (from March 2019 to August 2019) of the store.

Model Building

This study proposed to apply the product age (A) factor to the traditional TOFA model (Kahle *et al.*, 1992), so that the improved model can also be used to describe the age positioning of store consumers (as shown in Figure 2-a).

To fill in the product's style, age, and price into the three-dimensional coordinate system, it was necessary to deal with the three in quantitative rules. The style (6 types of styles were shown in Figure 2-b) denoted as $S \in \{-3, -2, -1, 1, 2, 3\}$; As for ages, 20 represented under 20 years old, 30 represented 21 to 30 years old and so on, which denoted as $A \in \{20, 30, 40, 50, 60\}$; The zero point of the price was the average price of all products in the store, and the corresponding value was the sample product price minus the average price, denoted as $R \in (-\infty, +\infty)$.

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Figure 2. Improved model of relationship between product attributes and consumer profile

Data Processing

The store's core products can reflect the shopping preferences of the store's core consumer groups. In this study, we selected the core products through the ranking of the comprehensive index of product attention and sales.

Firstly, we separately standardized the collected product attention numbers and sales numbers. Assuming that the number of attention were $x_1, x_2, \dots, x_n$, the number of sales were $y_1, y_2, \dots, y_n$. The formulas for obtaining attention index (X) and sales index (Y) were as follows:

$$X = \frac{x_i - \min_{1 \leq j \leq n} \{x_j\}}{\max_{1 \leq j \leq n} \{x_j\} - \min_{1 \leq j \leq n} \{x_j\}} \quad (1)$$

$$Y = \frac{y_i - \min_{1 \leq j \leq n} \{y_j\}}{\max_{1 \leq j \leq n} \{y_j\} - \min_{1 \leq j \leq n} \{y_j\}} \quad (2)$$

Then, the comprehensive index (C) of the core product was obtained by the attention index (X) and the sales index (Y):

$$C = 0.5 \times (X + Y) \quad (3)$$

Finally, the top 50 products with the highest comprehensive index were selected as the main research samples. We filled in the applicable age, price and style of the core products into the three-dimensional coordinate system to make a scatter diagram. Through the distribution of scattered points, the characteristics of consumers' age, consumption level and preferences are obtained. The portrait of the store's core consumer groups was also obtained through the pairwise comparison between the three factors.

RESULTS

Figure 3. Scatter plot results of core products and consumer portraits

From the basic distribution of the scatter diagram in the Figure3-a, 3-b, 3-c, it can be seen intuitively that the core product style of the store was fashionable and casual, and the age of the products was mainly concentrated in the 31-40 years old. More than half of the product prices were about 100 yuan (about 375.32 yuan) higher than the average store price. From the improved TOFA three-dimensional model (as shown in Figure 3-d), the shoes with high attention index (the higher the index, the larger the shape) were mainly concentrated in the 21-30 years old. The price were slightly lower than the average price, and the style of shoes were also fashionable and casual.

We can further analyze the consumer portrait. The core consumer group in the store was mainly middle-aged, whose consumption level was higher than the average price of the products in the store. They preferred fashionable and casual style shoes, and thier consumption values were biased towards hedonic. There were potential thrifty young consumers whose consumption level was close to the average price of products in stores, and their also preferred fashionable and casual shoes.

DISCUSSION

This study designed a set of consumer attention data collection system to collect shoe products data for a Chinese brand's fast fashion offline store. We used the improved TOFA model to analyze the attributes (style, price, and applicable age) of the store's core products, and converted the results into a description of the store's core consumer profile, including consumer age, consumption level and preferences.

From the results of consumer portraits, we obtained the actual core consumer group portraits and potential consumer group portraits in the store. Both of them prefer fashionable and casual style shoes, but there were certain differences in age and consumer values. The age of potential consumers was lower than the age of actual core consumers. We suggested that the shoes production can be younger in product transformation. Potential consumers tended to be diligent and thrifty in their consumption values, which can indicate that the main factor for potential consumers not

to buy products was that the price was higher than expected. Stores can appropriately lower the price of products for this group of people to promote sales.

The advantage of the attention behavior collection system was that it can track the attention degree of a single product. Compared with computer vision technology to collect behavioral data from a consumer's perspective (Rosa, 2015), this system simplified the analysis process and reduces equipment costs. Chen et al. (Chen, 2014) used RFID and infrared equipment to analyze the number of concerns of the entire shelf or store area. Our advantage was that we can collect the attention data of specific products without being affected by display adjustments. So as to achieve rapid response, precise marketing, and meet the needs of fast fashion product data conversion.

This study also has certain limitations. In terms of equipment wear and tear, because the pairing device used disposable button batteries, the batteries need to be replaced regularly (about half a year). In terms of model analysis, due to the limited number of shoes in stores, the number of core product samples is relatively small. In future research, we plan to apply this technology to different formats stores to compare the differences in core consumer's portrait in stores.

CONCLUSION

The consumer attention data collection system can effectively collect attention data of specific individual products. The improved new model can effectively analyze the core consumer profile of shoe stores, and provide strategies for shoe store customer positioning and supply.

REFERENCES

- Aviv, Y. and Pazgal, A. (2008), "Optimal pricing of seasonal products in the presence of forward-looking consumers", *Manufacturing & Service Operations Management*, 10(3), 339-359, <https://doi.org/10.1287/msom.1070.0183>.
- Barnes, L. and Lea-Greenwood, G. (2006), "Fast fashioning the supply chain: shaping the research agenda", *Journal of Fashion Marketing and Management: An International Journal*, 10(3), 259-271, <https://doi.org/10.1108/13612020610679259>.
- Cachon, G.P. and Swinney, R. (2011), "The value of fast fashion: Quick response, enhanced design, and strategic consumer behavior", *Management Science*, 57(4), 778-795, <https://doi.org/10.1287/mnsc.1100.1303>.
- Caro, F. and Gallien, J. (2010), "Inventory management of a fast-fashion retail network" *Operations Research*, 58(2), 257-273, <https://doi.org/10.1287/opre.1090.0698>.
- Chen, C.-C. (2014), "RFID-based intelligent shopping environment: a comprehensive evaluation framework with neural computing approach", *Neural Computing and Applications*, 25(7-8), <https://doi.org/10.1007/s00521-014-1652-7>.
- Choi, T.-M., Liu, N., Liu, S.-C., Mak, J. and To, Y.-T. (2010), "Fast fashion brand extensions: An empirical study of consumer preferences", *Journal of Brand Management*, 17(7), 472-487, <https://doi.org/10.1057/bm.2010.8>.
- Di Sorrentino, E.P., Woelbert, E. and Sala, S. (2016), "Consumers and their behavior: state of the art in behavioral science supporting use phase modeling in LCA and eco-design", *The International Journal of Life Cycle Assessment*, 21(2), 237-251, <https://doi.org/10.1007/s11367-015-1016-2>.
- Dychtwald, K. and Gable, G. (1990), "Portrait of a changing consumer", *Business Horizons*, 33(1), 62-74, [https://doi.org/10.1016/0007-6813\(90\)90073-K](https://doi.org/10.1016/0007-6813(90)90073-K).
- Generosi, A., Ceccacci, S. and Mengoni, M. (2018), "A deep learning-based system to track and analyze customer behavior in retail store", Paper presented at the 2018 IEEE 8th International Conference on Consumer Electronics-Berlin (ICCE-Berlin), <https://doi.org/10.1109/ICCE-Berlin.2018.8576169>.
- Hervé, C. and Mullet, E. (2009), "Age and factors influencing consumer behavior", *International Journal of Consumer Studies*, 33(3), 302-308, <https://doi.org/10.1111/j.1470-6431.2009.00743.x>.

<https://doi.org/10.24264/icams-2020.III.9>

- Hou, K., He, J., Liang, L., Li, J. and Zhou, J. (2019), "Bass-modeling for fast fashion lady's shoes based on consumer behavior". *Leather and Footwear Journal*, 3, 167-176, <https://doi.org/10.24264/lfj.19.3.1>.
- Hsieh, L.-W., Yang, S.-C., Chen, M.-Y. and Tung, I.-W. (2010), "Multiple Groups Confirmatory Factor Analysis of Exploratory Consumer Buying Behavior in Athletic Footwear Inventory", *Asian Sports Management Review*, 4(1), 44-64.
- Jackson, V., Stoel, L. and Brantley, A. (2010), "Mall attributes and shopping value: Differences by gender and generational cohort", *Journal of Retailing and Consumer Services*, 18(1), <https://doi.org/10.1016/j.jretconser.2010.08.002>.
- Joy, A., Sherry, J.F., Venkatesh, A., Wang, J. and Chan, R. (2012), "Fast Fashion, Sustainability, and the Ethical Appeal of Luxury Brands", *Fashion Theory*, 16(3), 273-295, [Dhttps://doi.org/10.2752/175174112X13340749707123](https://doi.org/10.2752/175174112X13340749707123).
- Kahle, L.R., Beatty, S.E. and Homer, P. (1986), "Alternative measurement approaches to consumer values: the list of values (LOV) and values and life style (VALS)", *Journal of consumer research*, 13(3), 405-409, <https://doi.org/10.1086/209079>.
- Kahle, L.R., Liu, R. and Watkins, H. (1992), "Psychographic variation across United States geographic regions", *ACR North American Advances*.
- Liu, J., Gu, Y., & Kamijo, S. (2015), "Customer behavior recognition in retail store from surveillance camera", Paper presented at the 2015 IEEE International Symposium on Multimedia (ISM), <https://doi.org/10.1109/ISM.2015.52>.
- Nicosia, F.M. (1966), "Consumer decision processes; marketing and advertising implications", *Journal of Marketing Research*, 5(3), 334, <https://doi.org/10.2307/3150361>.
- Palmer, E.L. (2010), "Consumer Research". *The Corsini Encyclopedia of Psychology*, 1-2, <https://doi.org/10.1002/9780470479216.corpsy0224>.
- Rosa, P. (2015), "What do your eyes say? Bridging eye movements to consumer behavior", *International Journal of Psychological Research*, 8(2), 90-103, <https://doi.org/10.21500/20112084.1513>.
- Tokatli, N. (2008), "Global sourcing: insights from the global clothing industry—the case of Zara, a fast fashion retailer", *Journal of economic Geography*, 8(1), 21-38, <https://doi.org/10.1093/jeg/lbm035>.
- Wang, Y. (2014), "Consumers' purchase intentions of shoes: theory of planned behavior and desired attributes", *International Journal of Marketing Studies*, 6(4), 50, <https://doi.org/10.5539/ijms.v6n4p50>.
- Yoshida, T. and Koiso, T. (2010), "System and method for customer behavior movement frequency prediction in a store", in: Google Patents.

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