Face Recognition and Smart People-Counting System: Cases of Asian Trade Shows

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Abstract

Exhibitors are highly interested in visitors' visitation, ordering, and buying behaviors in business-to-business (B2B) and business-to-consumer (B2C) trade shows. Previous studies on business trade shows have focused on various aspects, such as trade show selection, motivation, and performance and benefits. However, only a few empirical studies have examined the experiences of exhibitors in their participation in face recognition systems in trade shows. In the current study, face recognition software combined with a server linking the Internet of Things concepts was adopted. People flow tally and data collection were carried out in six in empirical cases of Asian trade shows. These cases include three B2B cases and three B2C cases in three Asian countries, namely Taiwan, China, and Japan, through experimentation and observation, coupled with video and scanning system set up at site exits and entrances. Results show that the face recognition system can precisely and timely provide distribution data on the number of people at an exhibition site, as well as their age, gender, and time of stay. The exhibitors can use data tally and information on the peak and off-peak hours of people flow or the cold and hot areas of the exhibition site to timely and dynamically adjust marketing activities.

Keywords: Internet of Things, Big data, Face recognition system, Cloud computing, Smart people-counting system

1 Introduction

In various studies, business trade shows have been referred to using different names, such as exhibitions, fairs, and trade fairs [1]. In [2], the authors defined trade shows as a "facilitating marketing event in the form of an exposition, fair, exhibition or mart, which takes place at periodically recurring intervals to reach a large number of potential customers face-to-face at a lower cost than that of sales people calls." Holding a trade show is a complex task. Targets of the exhibition industry include exhibition organizers, exhibitors, and visitors. The exhibition industry has an extensive scope, covering public relations marketing, advertising media, video, exhibition site design and renovation, stage layout, audio engineering, lighting equipment, and various businesses.

As the exhibition industry is a pollution-free industry that combines trade, services, and international economy, it possesses features such as high growth potential, added value, innovation, and benefits. Research has shown that this green-inspired industry brings significant economic benefits to a country and promotes international exchanges and cooperation [3-4]. According to the 2008 data of the International Congress and Convention Association, 400,000 meetings and exhibitions were held worldwide, with a total expenditure amounting to US$280 billion. Union des Foires Internationales (UFI) also stated that the annual output of the exhibition industry reached US$1 trillion and 160 billion dollars, thereby bringing considerable economic benefits to host countries and cities [5].

Exhibitions often present the future development potential of an industry and enable companies to display new products, technologies, and services. Simultaneously, exhibitions attract a large number of target customers, which include existing customers, potential customers, and experts and scholars. Therefore, monitoring the characteristics of potential customers at exhibitions, closing deals, and engaging in collaboration are matters of significant concern to exhibitors. According to the 2015 exhibition benefit research report of the Center for Exhibition Industry Research, business owners join exhibitions to strengthen their corporate and product brand image, improve sales performance, seek orders from existing and new customers, collect information of customers and competitors, manage customer relations, maintain existing customers, contact new customers, and establish a network with interested parties.

With the extensive application of technologies imported into exhibitions, such as the Internet and the Internet of Things (IoT), big data, business intelligence (BI), face recognition system, and cloud computing, the variety of information available facilitates the

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timely and continuous interaction of exhibitors, visitors, and industry organizations, thus improving the efficiency of exhibition operations and increasing the demand for and importance of smart applications displayed in exhibitions.

The IoT refers to interconnecting internal smart sensors, smart facilities, video surveillance systems, and externally enabled terminal devices and facilities through a wireless, wired, long-distance, or short-distance communication network. In the intranet, extranet, and Internet environments, the adoption of a suitable mechanism for information security protection and the timely provision of online surveillance, cloud storage, statistical reporting, and decision-making support are regarded as new business opportunities that follow in the footsteps of smart phones. A breakthrough is expected to take place from 2017 to 2020, with an estimated 26 billion network devices worldwide, which is a 30-fold growth rate compared to that in 2009. The marginal earnings of the entire industry reach US$309 billion, thereby bringing US$1.9 trillion worth of added value [6].

With global digitalization, network broadband, diversified IoT applications, and growing cumulative data, an increasing number of organizations have discovered that the use of numerous data analyses in trade shows to explore new business opportunities and new markets, evaluate new channel partners, carry out market research, enhance the sales efforts of a company [7-8], and strengthen customer service is the future mainstream in business models. In [7], the authors considered trade shows as an important and effective means to enhance the marketing efforts of an organization. Previous studies have addressed trade show selection, motivation, effectiveness, virtual communication technologies, and visitor buying behavior [7, 9-10]. However, one area that has been neglected in the literature is the role of face recognition technologies in trade shows.

From the perspective of exhibitors, "how to keep up with the times and establish all the elements, such as a strong brand, the buyer and supplier's huge database, and the accumulation of industrial professional knowledge contributing to the holding of a successful trade shows exhibition through face recognition system, the use of big data and business smart technology" remains an extremely important management issue [11-13].

For exhibitors, the quick access to potential buyers is the main participation motivation [14]. However, traditional trade exhibitions often resort to exchange of business cards, individual customer information login, and interpersonal and interactive interpretations. Trade exhibition sales representatives are unable to timely track the interests and purchase intention of visitors. Therefore, utilizing the face recognition system technology; tracking and observing browsing routes, interests, preferences, and dynamic behaviors of visitors; collecting purchase behavior performance, shopping experience, and other information of visitors to improve the corporate brand image; and using data analysis to gain insight into the purchase trend of visiting customers are interdisciplinary research issues that combine IoT, big data, BI, cloud computing, and corporate marketing research [15-16]. Table 1 summarizes the general conceptual finding of the research in the exhibition industry.

Although face recognition is a well-researched field with a history that can be viewed as a strategic marketing tool for exhibitors, limited research exists on company participation as exhibitors in face recognition technology. The current study aims to answer the following questions: "How should exhibitors use the people flow information report in the face recognition system to effectively obtain gender and age distribution information of visitors?" and "How should the distribution of the number of visitors at different exhibition times be analyzed?" Meanwhile, according to the information report on people flow in the face recognition system, determining the cold and hot areas of an exhibition site based on stationary route locations of visitors and other quantitative prediction and assessment operations was deduced to assist exhibitors in effectively monitoring the overall marketing benefit factors.

In the era of popular technological applications, such as IoT, big data, BI, and cloud computing, the current study is expected to comprehensively explore the applications of the face recognition system at exhibition sites. The goals of this research are as follows: first, determine and understand the influence of face recognition system in a particular context on trade shows; second, obtain quantitative results, which may provide the business community an insight into the contents of exhibition management and decision-making references, to promote monitoring of trade show benefits.

2 Literature Review

2.1 Characteristics of the Exhibition Industry

The exhibition industry is service-based; it aims to boost the satellite industry system and achieve seven to ten dollars of peripheral economic benefits. The development of the exhibition industry is generally considered to be an important indicator for evaluating the prosperity of a region and the degree of internationalization. Thus, many governments attach considerable importance to this industry, and many cities regard the development of the international exhibition industry as "a new era of urban development strategy" [17]. The UFI defines "exhibition" as "a temporary market, through organized planning, it is an exhibition marketing activity that enables sellers and buyers to complete sample checking, inquiries, and

Table 1. General conceptual finding in the exhibition industry

Years	Scholars	Factors	Research findings
2008	International Congress & Convention Association	Perspective	400,000 meetings and exhibitions were held worldwide, with a total expenditure amounting to US$280 billion.
2004 & 2011	Hansen [3]; Hsu et al. [4]		The exhibition industry is a pollution-free industry. This industry high growth potential and is inspired by green industry, which brings significant economic benefits to a country and further promotes international exchanges and cooperation.
2016	Ministry of Economic Affairs, R.O.C. [5]		UFI stated that the annual output of the exhibition industry reached US$1 trillion and 160 billion dollars.
2016	Gartner [6]		Abreakthrough is expected to take place from 2017 to 2020, with an estimated 26 billion network devices worldwide, which is a 30-fold growth rate compared to that in 2009. The marginal earnings of the industry reaches US$309 billion, thereby bringing US$1.9 trillion worth of added value.
2011	Whitfield & Webber [14]	People flow	For exhibitors, quick access to potential buyers is the main motivation for their participation.
2008 & 2011 & 2012	Sato & Kuriya [11]; Lucke & von der Malsburg [12]; Wolfrum & Wolff [13]	Face recognition system, Big data	In organizing a successful trade show exhibition through face recognition system, the use of big data and business smart technology remains an extremely important management issue.
2014 & 2015	Kellezi [1]; Sarmento, Simões & Farhangmehr [2]		Business trade shows have been referred to using different names, such as exhibitions, fairs, and trade fairs..
2015	Center for Exhibition Industry Research	Industry	Business owners join exhibitions to strengthen their corporate and product brand image, improve sales performance, manage customer relations, and collect the information of customers and competitors.
2010 & 2017	Gottlieb & Bianchi [7]; Kirchgeorg, Springer, & Kastner [8]		Trade shows are conducted to explore new business opportunities and markets, evaluate new channel partners, carry out market research, and enhance the sales efforts of a company.
2017	Gottlieb & Bianchi [7]		Trade shows are important and effective means to enhance an organization's marketing efforts
2016 & 2017	Wertime & Fenwick [15]; Plume, Dwivedi, & Slade [16]	Big data, BI, Cloud computing	Data analysis can be used to gain insight into the purchase trend of visiting customers. Interdisciplinary research issues that combine IoT, big data, BI, cloud computing, and other technologies, and corporate marketing research.
2012 & 2017	Gottlieb & Bianchi [7]; Gopalakrishna & Lilien [9]; Rittichainuwat & Mair [10]	Virtual communication technologie	Previous research has addressed trade show selection, motivation, effectiveness, virtual communication technologies, and buying behavior of visitors.

purchase order placement at the site." In other words, an exhibition provides manufacturers, existing customers, and potential customers with an opportunity to make inquiries and engage in face-to-face dealings; it is a platform that facilitates contact between the buyer and the seller [18]. That is, "exhibition marketing" refers to the participation of manufacturers in exhibitions to display their products or services. Exhibition marketing is an approach to boost customer demand, discover potential customers, strengthen customer relations, enhance business management performance, and shape business image.

An exhibition is the main marketing promotion tool for manufacturers, which allows exhibitors to effectively collect business information from domestic and international markets, including competitor assessment, buyer assessment, and technical assessment. In other words, exhibitors can seize opportunities to immediately reply to customers through interactive situations at the exhibition site, thereby enabling them to better contact customers who are interested in their products with less interference from other factors. One-on-one interpretation opportunities also arise, and customers are provided with the "hands-on product experience" [19].

Previous research has shown that the main motives of exhibitors for participating in exhibitions include the following: (1) Meet existing customers, promote existing products, receive inquiries, and accept orders to complete transactions [20]; (2) Search for and contact potential new customers and track these customers to make them new customers after the exhibition [21]; (3) Launch new products or products with updated features [22]; (4) Establish the company

image or maintain company visibility and exposure [23-24]; (5) Conduct a market trend survey to collect business information and dynamic information of competitors [25]. For visitors, the main motivation of their visit is to obtain the latest market information and make inquiries regarding product features and prices of exhibitors [26]. Table 2 presents detailed information on the findings of related studies on exhibition marketing.

Table 2. Motivations of trade shows participation for exhibitors

Years	Scholars	Expound
1987	Kerin & Cron [21]	Search for and contact potential customers and track them to gain new customers after the exhibition.
1992	Sashi & Perretty [22]	Launch new products or products with updated features.
2002	Blythe [20]	Meet existing customers, promote existing products, receive inquiries, and accept orders to complete transactions.
2006	Wen [25]	Conduct a market trend survey to collect business information and dynamic information of competitors
2007	Du [19]	One-on-one interpretation of opportunities arises, and customers are provided with the "hands-on product experience."
2008	Ministry of Economic Affairs, R.O.C. [17]	Many governments attach considerable importance to the development of the exhibition industry, and many cities regard the development of the international exhibition industry as "a new era of urban development strategy."
2002 & 2010	Camarero, Garrido, & Vicente [23]; Tanner [24]	Establish the company image or maintain company visibility and exposure
2012	Zhao [18]	Potential customers provide an opportunity to make inquiries and engage in face-to-face dealings; A platform that facilitates contacts between the buyer and the seller.
2013	Chiang [27]	Defined the application scope of IoT, comprehensively described the relationship between people and objects and between processes and data, and analyzed the information exchange behaviors between P2P, P2M, and M2M.
2002 & 2017	Tanner [24]; Ebert & Griffin [26]	The main visiting motivation of visitors is to obtain the latest market information and make inquiries regarding product features and prices of exhibitors

Take a B2C exhibition for example. When many visitors simultaneously enter the exhibition site, immediately collecting characteristic information of visitors becomes difficult for exhibitors. However, through the face recognition system, the number of visitors, gender, age, and other information can be tallied using the smart people-counting system. Then, through statistical data and analysis provided by backend computing, the display route, products, and other components of the exhibition can be adjusted. Alternatively, based on the grouping setup of the face recognition system host, the grouping advertising media can be played to achieve human-computer interaction, thereby effectively enhancing and attracting customers' desire to stay and make a purchase. The backend computing cloud server carries out related information collection and constructs a big data storage platform through data return using wireless transmission on equipment. Exhibitors can fully monitor the age, gender, purchase preferences, time of stay, and other data information of visitors through the statistical analysis. Advertisements can also be timely updated depending on the preferences of customers, which will ensure precise playing of advertising content and effective advertisement operation management. In addition, marketing managers at the exhibition site can call the attention of target customers to stop, stay, and shop at any time depending on the site situation, thus achieving the most flexible human-computer interaction.

2.2 IoT and Big Data

IoT is a technology that can be used to connect machines, objects, and people with electronic devices; IoT services are increasingly provided in the form of Web services [27]. Cisco Internet Business Solutions Group once defined the application scope of IoT, comprehensively described the relationship between people and objects and between processes and data, and analyzed the information exchange behaviors between people to people (P2P), people to material (P2M), and material to material (M2M). Additionally, through the big data stored in databases, websites, or servers, the IoT information applications are converted into new values to create new business opportunities. Examples of IoT applications are as follows. GE invested in Internet-related technologies applied in internal combustion engines, engines, wind power, and other new energy technologies. Tencent (QQ.com), Baidu, and Alibaba's opening up of hardware to

engage in IoT layout; MiGlobal's application of smart phones in smart homes, healthcare, and other applications; Taiwan Media Tek's design and development of the LinkLt platform, TSMC, and the development of other major semiconductor plants of low-power technology platforms. All of these applications contribute to the vigorous development of IoT. The era of IoT will comprehensively affect various industries and people's way of life.

Big data, which is a term for a collection of data sets, is usually used to describe a massive volume of different types and structures of data that is extremely large and complex [28]. Big data is not a completely new thing. Google's search service is a typical application of big data. According to the keyword needs of people, the most likely answers are timely and quickly found from the stored global mass information, which is a typical big data service. Single datum has no value and lacks data integration and mining to present values. However, as data accumulates, the quantitative change of data will lead to qualitative change. Therefore, the generation, acquisition, mining, and integration of massive data will produce significant commercial value, which is the primary purpose of big data. With the current popularity of the Internet, the development of big data is an inevitable extension and application. In view of M2M development, Vodafone Group predicted that the analysis and use of massive data will lead to intelligent business activities and accelerate the development of the new Industry 4.0. [29]. Therefore, in the current study, we adopt the idea of IoT and big data as factors of face recognition and smart people-counting system, respectively.

2.3 Face Recognition System and Business Intelligence (BI)

The principle of face recognition system is to capture face images through a camera. Based on the facial features of the customer, the contour of the face, gender characteristics, skin tone, and other characteristics can be determined. Through the face recognition algorithm at the system end [30], the age and gender of a customer can be quickly identified, thereby achieving the following smart selling actions in practical applications.

(1) Apply the face recognition technology to construct a smart selling system to provide automated advertisement play through central management and cloud advertising and achieve maximized benefits.

(2) Apply the face recognition system to collect and determine gender and age information of customers and automatically play corresponding advertisements, thereby achieving the purpose of advertising precision and marketing benefits.

(3) Through a digital synergy display and camera, capture the number of consumers, their gender, age, and other information from the played content, which shall serve as actual performance data for advertising carriers when analyzing purchase behaviors of consumers, appropriately adjusting sales approaches, calculating people flow quantity according to time, and compiling analyses and report outputs, thereby effectively monitoring business information analysis management.

In view of the above discussions, the face recognition system applications bring out the functions of BI, which are provided to exhibitors through a number of database system analysis, mathematical algorithms, statistics, artificial intelligence, data mining, and online instant analysis system. The exhibitors need to be provided with timely information for business decision-making, marketing analysis, customer demands, and product preferences at the exhibition site to carry out the automatic decision-making analysis mechanism. Additionally, the customer attributes and demand efficiency must be grasped within the shortest possible time. Through the most flexible human-computer interactions, visitors must be immediately provided with product information and guided through instant consumption orshopping completion.

3 Research Method

In the study period of 2016/09/06 to 2017/01/20, the experimental environment of six exhibitions was designed in Taipei and Kaohsiung, Taiwan; Beijing, China; and Tokyo, Japan, including three B2B cases and three B2C cases of trade shows. Figure 1 shows the photos of the six experimental simulation environments in this study.

The network cameras and servers were installed at the entrance of the exhibition to facilitate face recognition and storage track record. Our smart people-counting system in Figure 1 was tested in the range of exhibition visitors and network cameras within a distance of 3 meters. In this setup, participants can move around and change positions. In addition, network cameras can intercept collected records of moving images of an exhibition.

Table 3 presents the list of equipment for face recognition and smart people-counting system. This system is equipped with a 1.3 megapixel CMOS sensor configuration 720P HD resolution and USB 2.0 UVC video output format camera, smart gateway CPU ARM Cortex A9 Quad Core, Android 4.4.2 operating system, 2 GB system memory, and 8 GB system storage spaceOverall, our system can be used to track visiting customers and field properties to record the characteristics of customers according to the data recorded by the cloud servers.

The framework of face recognition system and the people flow operating procedure in the current study are presented in Figure 2. The features of a web camera combined with face recognition technology in tracking and recording the characteristics of visiting customers at the exhibition venue. The face recognition system

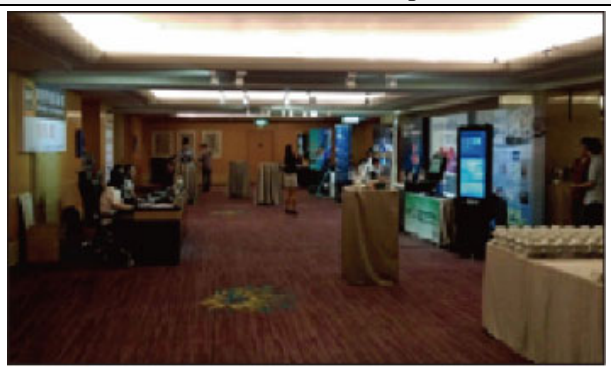
CASE	
Case-1 Smart Retail Forum Taipei of 2016	**Case-4 2016 EMBA forum & EMBA Enterprise Fair**
	
Case-2 Security China 2016	**Case-5 World of IoT Japan 2016**
	
Case-3 2016 TFVS	**Case-6 "SEMICON Japan 2016" in Tokyo**
	

Figure 1. Six experimental simulation environments in this study

determines the face contour, gender characteristics, facial lines, and skin tone of people based on the customer face images extracted from the web camera and through the face recognition software function. The algorithm of face recognition at the system end is used to quickly identify age and gender. Records of people flow at the exhibition boots were tallied, and the gender and age ratios of people who stopped over at the booths were recorded and presented in a report to enable managers to conduct peak analysis of people flow and facilitate relevant promotional activity planning. There by producing data statistics, analysis reports, and graphics that represent data recorded by the cloud server. Such information was stored in the backend server management system. Then, the information was analyzed to become reports with a reference value and supplied to exhibitors to carry out relevant information statistics and increase exhibition benefits.

4 Empirical Results

4.1 An Nalysis Results of the Six Empirical Cases

Exhibitors consider trade shows as regularly scheduled events, where numerous companies present their new products and sell them to customers [8]. Trade shows play an important role in marketing [20]. In many cases, exhibitors view trade shows as an opportunity to develop customer relationships, thus offering possibilities for sales and sales promotion [1]. The analysis results of the six empirical cases are shown in Table 4.

Table 3. List of equipment for face recognition and smart people-counting system

A. System Host	
Unit element	Function and specification
CPU	ARM Cortex A9 Quad Core
Memory	2 GB
Storage	Internal 8 GB and external USB storage connect
O.S	Android 4.4.2
Resolution	HDMI: 2160P/1080P/1080i/720P/576P/480P
Lane	Wire 10/100M/1000M, Wi-Fi 801.11b/g/n
Power	/2A
B. USB Camera	
Interface	USB UVC/UAC
Resolution	Support 1080P, 720P (Pre-store)
Identification specification	Best distance of identification: Under 3M to catch clear facial features for face recognition Number of identification instances: To simultaneously identify 8 to 10 persons Identification rate of gender: Around 97%, Identification rate of age: Around 70%
C. Cloud server	
CPU	Intel Core i3 3 GHz
Memory	8 GB
OS	Windows 7/8/10 Professional

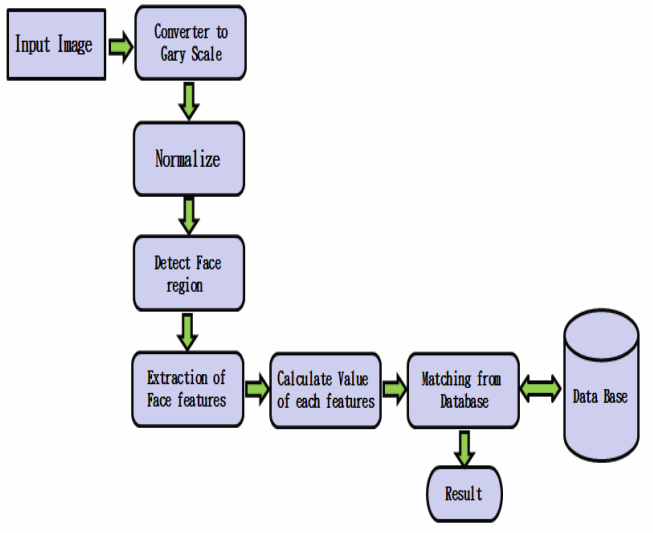


Figure 2. Face recognition system architecture and pedestrian survey process overview

4.2 Findings

As shown in Table 4 and Table 5, Cases 1 to 6 are empirical quantitative experiments, which were conducted in Taiwan, China, and Japan. Regarding commercial property variables, Cases 2, 5, and 6 show B2B models, while Cases 1, 3, and 4 show B2C models. Fairgrounds experiments were conducted in different regions and environments with different properties. This study used face recognition and smart people-counting system to record the daily pass and stop flow by transferring data to the management server system in real time, analyzing data, and reporting reference requirements.

Summary descriptions of the quantitative experimental results for Cases 1 to 6 are as follows.

(1) According to the entrance booth

distribution of the vaild visitor's number analyzed by the smart people-counting system in B2B models (Cases 2, 5, and 6) of exhibition, the effective number of visitors that entered a booth was approximately 30%-35%, and the male-female ratio is approximately 9:1. Male visitors of the 40-49 age group accounted for more than 50%, thereby representing middle-aged men who are social elites. These men have specific visit objectives and decision-making power.

(2) The enter booth distribution of vaild visitor's number was approximately 20%-25% in the B2C models (Cases 1, 3, and 4) of exhibition, which is lower than that of the B2B model. The male-female ratio is approximately 7:3. Majority of the visitors were males aged 40-49 and females aged 30-49. This information represents male and female visitors, which all have participation and decision-making power in the B2C exhibition.

(3) According to the period distribution of the number of visitors analyzed by the smart people-counting system, relatively few people visited in the early and late period

Therefore, the empirical findings of this research show that exhibitors can maneuver the arrangement of staff in accordance with different periods to control the cost of human resources. Simultaneously, exhibitors can also decide the adjustment of product display in real time based on the change in the number of visitors, the cold or hot areas, or the appropriateness of the product display to achieve the benefits of the exhibition.

5 Conclusions

5.1 Theoretical Implications

The aims of this research are as follows:

(1) To understand how exhibitors install network cameras at an exhibition site, images of visitors are extracted and supplied to the system host to carry out face recognition and utilize the face recognition system analysis report to monitor gender, age distribution, and other statistical data of exhibition visitors. This information will provide insight into the utilization of smart Internet technology to plan manpower configuration, promotion time, play advertising marketing information, product display, and other marketing activity strategies and suggestions for exhibitions.

Table 4. Analysis results of six empirical cases in Asian trade shows

Case 1 "2016 Intelligent Retail Forum" in Taipei

Date - 2016.09.06

Visitors observed data and share rate			Sample of validity	Visitor number, gender distribution and proportion			Visitors age distribution and proportion							
							30-39		40-49		50-59		Others	
							People	%	People	%	People	%	People	%
Passer	1351	63%	810	Male	742	92%	320	43	333	45	51	7	38	5
Visitors	810	37%		Female	68	8%	31	46	13	19	1	1	23	34
Total	2161	100%		Total	810	100%	351	43	346	43	52	6	61	8

We developed a smart people-counting system for pedestrian survey and analysis from 9:00 to 17:00. A total of 2,161 images of people was retrieved by cameras, the relevant information of active influence in Case 1 was as follows:
Action and passed by: 1,351 (63%) passed by and 810 people (37%) watched and asked questions.
Gender distribution: 742 people (92%) were male and 68 people (8%) were female.
Gender * Age distribution: Male age distribution 40-49 years old up to 45%, followed by 30-39 years old 43%, 50-59 years old and other accounted for 12%; Female age distribution 30-39 years old up to 46%, followed by 40-49 years old 19%, 50-59 years old and other accounted for 35%.
Time distribution: Most males visited at 10:00-12:00 (54%) and 13:00-15:00 (31%), while most females visited at 10:00-11:00 (46%) and 14:00-15:00 (38%).

Case 2 "2016 Security Expo" in Beijing

Date - 2016.10.25 ~ 2016.10.27

Visitors observed data and share rate			Sample of validity	Visitor number, gender distribution and proportion			Visitors age distribution and proportion							
							30-39		40-49		50-59		Others	
							People	%	People	%	People	%	People	%
Passer	6811	65%	3691	Male	3447	93%	512	15	1992	58	822	24	121	3
Visitors	3691	35%		Female	244	7%	131	54	75	31	10	4	28	11
Total	10502	100%		Total	3691	100%	643	17	2067	56	832	23	149	4

The pedestrian survey data for Case 2 were collected from the "2016 Security Expo" in Beijing for three days on October 25-27, 2016, from 10:00 to 17:00. A total of 10,502 images of people was retrieved by cameras, the relevant information of active influence in Case 2 was as follows:
Action and passed by: 6,811 people (65%) passed by and 3,691 people (35%) watched and asked questions.
Gender distribution: 3447 images of people (93%) were male, and 244 people (7%) were female.
Gender * Age distribution: Male age distribution 40-49 years old up to 58%, followed by 50-59 years old 24%, 30-39 years old and other accounted for 18%; Female age distribution 30-39 years old up to 54%, followed by 40-49 years old 31%, 50-59 years old and other accounted for 15%.
Time distribution: Most males visited at 13:00-15:00 (53%) and 10:00-12:00 (38%), while most females visited at 13:00-15:00 (47%) and 10:00-12:00 (43%).

Case 3 "2016 Taiwan International Fruit and Vegetables Fair" in Kaohsiung

Date - 2016.10.25 ~ 2016.10.27

Visitors observed data and share rate			Sample of validity	Visitor number, gender distribution and proportion			Visitors age distribution and proportion							
							30-39		40-49		50-59		Others	
							People	%	People	%	People	%	People	%
Passer	9110	78%	2643	Male	2092	79%	522	25	1094	52	380	18	96	5
Visitors	2643	22%		Female	551	21%	296	54	110	20	14	3	131	23
Total	11753	100%		Total	2643	100%	818	31	1204	46	394	15	227	8

The pedestrian survey data for Case 3 were collected on November 10-12, 2016 from 10:00 to 17:00. A total of 11,753 images of people was retrieved by cameras, the relevant information of active influence in Case 3 was as follows:
Action and passed by: 9,110 people (77%) passed by and 2,643 people (23%) watched and asked questions.
Gender distribution: 2092 images of people (79%) were male, and 551 people (21%) were female.
Gender * Age distribution: Male age distribution 40-49 years old up to 52%, followed by 50-59 years old 25%, 30-39 years old and other accounted for 23%; Female age distribution 30-39 years old up to 54%, followed by 40-49 years old 20%, 50-59 years old and other accounted for 26%.
Time distribution: Most males visited at 13:00-15:00 (45%) and 10:00-12:00 (41%), while most females visited at 13:00-15:00 (49%) and 10:00-12:00 (41%).

Table 4. Analysis results of six empirical cases in Asian trade shows (continue)

Case 4 "2016 EMBA Forum and Business Fair" in Taipei

Date - 2016.11.27

Visitors observed data and share rate			Sample of validity	Visitor number, gender distribution and proportion			Visitors age distribution and proportion							
							30-39		40-49		50-59		Others	
							People	%	People	%	People	%	People	%
Passer	1725	72%	684	Male	501	73%	97	19	263	52	108	22	33	7
Visitors	684	28%		Female	183	27%	96	52	45	25	4	2	38	21
Total	2409	100%		Total	684	100%	193	28	308	45	112	16	71	10

The pedestrian survey data for Case 4 were collected on November 27, 2016, from 10:00 to 17:00. A total of 2,409 images of people was retrieved by cameras, the relevant information of active influence in Case 4 was as follows:
Action and passed by: 1,725 people (72%) passed by and 684 people (28%) watched and asked questions.
Gender distribution: 501 images of people (73%) were male, and 183 people (27%) were female.
Gender * Age distribution: Male age distribution 40-49 years old up to 52%, followed by 50-59 years old 22%, 30-39 years old and other accounted for 26%; Female age distribution 30-39 years old up to 52%, followed by 40-49 years old 25%, 50-59 years old and other accounted for 23%.
Time distribution: Most males visited at 10:00-12:00 (45%) and 13:00-15:00 (40%), while most females visited at 13:00-15:00 (39%) and 10:00-12:00 (37%).

Case 5 "World of IoT Japan 2016" in Tokyo

Date - 2016.12.14 ~ 2016.12.16

Visitors observed data and share rate			Sample of validity	Visitor number, gender distribution and proportion			Visitors age distribution and proportion							
							30-39		40-49		50-59		Others	
							People	%	People	%	People	%	People	%
Passer	7455	74%	2595	Male	2338	90%	787	34	1072	46	305	13	174	7
Visitors	2595	26%		Female	257	10%	143	56	34	13	2	1	78	30
Total	10050	100%		Total	2595	100%	930	36	1106	43	307	12	252	10

The pedestrian survey data for Case 5 were collected on December 14-16, 2016, from 10:00 to 17:00. A total of 10,050 images of people was retrieved by cameras, the relevant information of active influence in Case 5 was as follows:
Action and passed by: 7,455 people (74%) passed by and 2,595 people (26%) watched and asked questions.
Gender distribution: 2,338 images of people (90%) were male, and 257 people (10%) were female.
Gender * Age distribution: Male age distribution 40-49 years old up to 46%, followed by 30-39 years old 34%, 50-59 years old and other accounted for 20%; Female age distribution 30-39 years old up to 56%, followed by 40-49 years old 13%, 50-59 years old and other accounted for 31%.
Time distribution: Most males visited at 13:00-15:00 (54%) and 10:00-12:00 (37%), while most females visited at 13:00-15:00 (50%) and 10:00-12:00 (43%).

Case 6 "SEMICON Japan 2016" in Tokyo

Date - 2017.01.18 ~ 2017.01.20

Visitors observed data and share rate			Sample of validity	Visitor number, gender distribution and proportion			Visitors age distribution and proportion							
							30-39		40-49		50-59		Others	
							People	%	People	%	People	%	People	%
Passer	12462	72%	4877	Male	4335	89%	916	21	2345	54	884	20	190	4
Visitors	4877	28%		Female	542	11%	298	55	152	28	30	6	62	11
Total	17339	100%		Total	4877	100%	1214	25	2497	51	914	19	252	5

We set up a smart people-counting system for pedestrian survey and analysis
from 10:00 to 17:00, which is the end of the exhibition every day. A total of 17,339 images of people was retrieved by cameras, the relevant information of active influence in Case 6 was as follows:
Action and passed by: 12,462 people (72%) passed by and 4,877 people (28%) watched and asked questions.
Gender distribution: 4,335 images of people (89%) were male, and 542 people (11%) were female.
Gender * Age distribution: Male age distribution 40-49 years old up to 54%, followed by 30-39 years old 21%, 50-59 years old and other accounted for 25%; Female age distribution 30-39 years old up to 55%, followed by 40-49 years old 28%, 50-59 years old and other accounted for 17%.
Time distribution: Most males visited at 10:00-12:00 (40%) and 13:00-15:00 (35%), while most females visited at 10:00-12:00 (44%) and 13:00-15:00 (34%).

Table 5. The summarizes of analysis results for six empirical cases in Asian trade shows

Case	Visitors Observed No	Gender	Age distribution of visitors				Active influence of face recognition system	
			30-39	40-49	50-59	Others	Commonality	Difference
Case 1 "2016 Intelligent Retail Forum" in Taipei (B2C)	810	M	320	333	51	38	1. Relatively few people visited in the early and late period. Therefore, the empirical findings of this research show that exhibitors can maneuver the arrangement of staff in accordance with different periods to control the cost of human resources. 2. Exhibitors can also decide the adjustment of product display in real time based on the change in the number of visitors, the cold or hot areas, or the appropriateness of the product display to achieve the benefits of the exhibition	1. B2B models (Cases 2, 5, and 6) of exhibition, the effective number of visitors that entered a booth was approximately 30%-35%, and the male-female ratio is approximately 9:1. Male visitors of the 40-49 age group accounted for more than 50%, thereby representing middle-aged men who are social elites. These men have specific visit objectives and decision-making power. 2. B2C models (Cases 1, 3, and 4) of exhibition, which is lower than that of the B2B model. The male-female ratio is approximately 7:3. Majority of the visitors were males aged 40-49 and females aged 30-49. This information represents male and female visitors, which all have participation and decision-making power in the B2C exhibition.
		F	31	13	1	23		
Case 2 "2016 Security Expo" in Beijing (B2B)	3,691	M	512	1,992	822	121		
		F	131	75	10	28		
Case 3 "2016 Taiwan International Fruit and Vegetables Fair" (B2C)	2,643	M	522	1,094	380	96		
		F	296	110	14	131		
Case 4 "2016 EMBA Forum and Business Fair" in Taipei (B2C)	684	M	97	263	110	31		
		F	95	46	5	37		
Case5 "World of IoT Japan 2016" in Tokyo (B2B)	2,595	M	787	1,072	305	174		
		F	143	34	2	78		
Case 6 "SEMICON Japan 2016" in Tokyo (B2B)	4,877	M	916	2,345	884	190		
		F	298	152	30	63		

(2) To obtain quantitative results and provide the business community with a face recognition system, the "customer data," including the number of people, their gender, age, time of stay, and other information are monitored. The customer data output and actual sales data are conjunctively analyzed for BI and enable exhibitors to better understand the characteristics of purchase groups, thereby serving as a reference for planning marketing strategies.

Table 6 shows the differential analysis of the behavioral benefits of traditional exhibitions and the smart people-counting system. In the past, traditional exhibitions often resorted to manual counting or scanning of admission tickets claimed upon reporting to tally the number of visitors. Obtaining information on gender, time of stay, exhibition route, and exhibition area of interest of visitors was not possible. However, in today's era of big data, this study analyzed the use of face recognition system to carry out smart people flow counting to effectively evaluate characteristics of visitors and timely monitor marketing and subsequent tracking and improvement practices, all of which are the main theoretical contributions of this paper.

5.2 Suggestions for Future Study

Based on the experimental content of the six empirical cases at the exhibition sites, the smart people-counting data shown in Table 2 can help exhibitors build a big data storage platform. In addition, age, gender, purchase preference, time of stay, and other data information of visitors can be monitored through statistical analysis operations. Based on the customer group characteristics, the marketing management benefits of the smart people flow counting system in Table 3 can be implemented. However, the research direction still has room for improvement. In future studies, improvements targeting the following recommendations can be made:

(1) Venues for installing the face recognition system in this study are mainly exhibition sites. The exhibition types use B2B and B2C models. Future research may further conduct data collection and tally targeting for other commercial activities, such as mall sales or vending machine venues, to compare and verify the different environments and the differential analysis of

application results.

(2) The face recognition targets in this study are focused on the Asian race with similar skin tone. Future research should include a system set up for Western countries, including European countries and the United States, to compare the differences in target recognition from the West and the East with different skin tones.

(3) Regarding the face recognition system application in this study, apart from people flow counting, future research is suggested to target retail logistics malls or vending machines, where the face recognition system and advertising digital synergy are integrated to experiment and observe the relationship between advertisement contents played and consumer behaviors. In addition to serving as actual performance data for advertising carriers, retail logistics of malls and vending machines can be given the role of a "big data collection center," thereby quickly analyzing consumer behaviors and instantly providing manufacturers with sales adjustment approaches.

Table 6. Differential analysis of traditional manual counting and smart people-counting system

Variables	Traditional manual counting	Smart people counting
Behavior	• tain information using manual counting at the entrance. • Scan admission tickets claimed upon reporting.	• Unmanned, multi-point camera installation, monitoring of people flow route in the exhibition site. • The data information enables managers to analyze the people flow route, monitor the length of visitors' time of stay, quickly provide visitation route, modify relevant product displays, plan promotional activities, effectively recognize the identity of passing visitors' information, and timely display the most appropriate marketing information, thereby attracting visitors.
Benefits	• Properly monitor the number of visitors. • Unable to determine hobbies to timely carry out marketing, tracking, and improvement operations.	• Timely collection, tally, and analysis of the number of exhibition visitors, groupings, time, and routes. • Based on group distribution and hobbies, monitor and adjust product display locations. • Monitor promotional time based on the hot area, cold area, popular time, unpopular time, and other quantitative data, thereby enhancing the overall benefits of the exhibition site. • Link advertising machines to play corresponding advertisements, strengthen exhibition results, and effectively promote smart Internet establishment of exhibito

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