Review Article

Methodology for the Design and Implementation of Smart Billboards in Pakistan: (Case Study)

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Abstract: Billboard's advertisement is an effective way to communicate with the audience by influencing the user mind and motivate them to purchase the respective items. Attention-Interest-Desire-Action (AIDA) model was initiated to target the audience through traditional advertisement (physical billboards) and the viewer's become willing to purchase the product or to avail the service. In result, the companies can earn more profits, but for these advertisements they have to pay a significant amount to the advertisement companies, which may be affordable for big brands but not by the small-scale companies. Moreover, they are placed for some fixed days even at those times when their audience are not frequent on the road, for example Candies (Sweets and Chocolate) advertisement can be best suited when the students are on road, Restaurant advertisement can be best suited after the office timing and family products advertisement can be best suited in evening. This highlights the main issue of observing the target audience with respect to their age groups and gender, and accordingly the registered companies can see the crowd behavior. The focus of this research is to automatically identify the audience and provide a platform to the registered users to bid for their advertisement on the specific time slots (the slots are hourly classified and a bid is for one week) by occupying the entire billboard or the segment of it. This may be useful for both advertising agencies and companies to promote their products in a sensible way. A questionnaire survey has been conducted on mall shopkeepers and customers to know their willingness for smart billboard that is justified by significant empirical results of this survey.

Keywords: Smart Billboards; Digital Billboards; Advertisement; Ambient Intelligence;

1. Introduction

Advertisement is an effective way of influencing the audience by keeping them aware, and retain, about the products, services or ideas. Billboards are a traditional way of advertisement; whose target audience is general public. Its appealing graphics work on the phenomena of Attention-Interest-Desire-Action (AIDA) model which motivate the viewers for the purchasing of product or availing the service. In result, companies increase their sales and earn more profits. Typically, billboard is an expensive way of advertisement, but due to its attention gaining advantage over other traditional methods e.g., television, mobile SMS, emails, or brochures, — as they can be easily avoided — the billboard advertisement is mostly adopted by big

brands. The local and small industries/companies — which are further refer as "Clients Billboard" (CB) in this research– are often working in tightrope of challenges and are not able to bear their expense, that's way they are unable to avail the benefits of billboard advertisement and interact new customers. Which not only effect their sales/profit but also have an impact on country economy, as the growth of any country economy is depend on the productivity of their local industry. Thanks to the advancement in the area of Ambient Intelligence, image processing and smart technologies by which the billboard advertisement can be affordable to CB. The research in the area of technologically embedded billboard can also be referred as Billboard Digitalization or Smart Billboard (SB). To expedite the review and typesetting process, authors must follow the Microsoft Word template   provided for preparing their manuscripts. This template must be strictly adhered to when formatting the manuscript for submission.

1.1. Research Gap and Contribution of Study

A surge of literature has paid attention to digital billboard advertisement for big or international brands but no study has focused to develop digital billboards for local manufacturers that operate at small scale. This study contributes to the literature by developing cost effective advertisement pattern of smart billboard that is suitable for local manufacturers because these manufacturers operate at small scale and are not well established so they cannot pay a handsome amount from their meagre profits for marketing of their products for a long period of time.

Although substantial literature has focused on billboard advertisement but no study has analyzed from the consumer perspective. This study also contributes to the literature by analyzing the feasibility of smart billboard advertisement pattern from consumer's perspective after taking their opinion through statistical analysis of fata from field survey and considering human psychology. It is because traditional billboards become less attractive and thus affects human psychology severely as constantly watching the same advertisement molds consumer's mind and makes them more loyal and attached to that specific product by ignoring other brands and they remain unaware of new products arrival.

1.2. Objective of the Study

The main objective of this research is to facilitate the local and small industries/companies by providing cost effective way of advertisement. For this, time and frame based slicing approach is adopting. Instead of full board advertisement, it can be displayed at some portion/slice of the SB and instead of full day display it can be displayed for some certain time. The motivation behind time slicing is that the Target Customers (TC) are not always frequent on the road. For the identification of TC image processing technique is used by which the age and gender of the pedestrians can be known. The occurrence frequencies of TC help the CB for the selection of appropriate time at which their advertisement can display, for example candies (Sweets and Chocolate) advertisement can be best suited when the students are on road, restaurant advertisement can be best suited after the office timing and family products advertisement can be best suited in evening.

2. Review of Related Work

Chen and Lin (2009) have presented an approach for the counting system of viewers. At first step they count the number of people by using face detection technique, then they filter the faces on the basis of those faces whose are watching towards the advertisement. Due to the low resolution of surveillance videos, sometimes, the identification of face portion is not practicable therefore they use extracted features from the torso region for the compensation of deficiency.

Shlomot and Beach (2013) have presented a methodology of displaying the advertisement on billboards according to user interest. For this, firstly they identify the passing cars, passengers in cars and items in car and then – by viewing/knowing the characteristics of these from their repository – the selected advertisement is displayed on the electronic billboards.

According to Khalil et al. (2023) all facets of advertising are undergoing a revolution due to technological advancements in recent decades, including Internet of Things (IoT) and Internet of Behavior (IoB) technologies. Out-of-home (OOH) advertising is no exception. The fact that OOH is currently unable to precisely target consumers based on their tastes and behaviors is one of its biggest issues. The research's objective is to examine how IoT and IoB might enhance OOH targeting capabilities before putting out a case study for potential future opportunities.

S.Sümer et al. (2022) have observed a fierce rivalry between the businesses along with the changes in customer preferences in recent years. The companies' decision-makers have begun designing new marketing strategies based on the requirements and expectations of their target markets. Businesses have begun to design their advertising strategies with a concentration on value. At this point, customized advertising is one of the most powerful means of developing the customer interest. To put it another way, customized marketing is the simplest approach to target particular audiences and markets. As a result, it grabs the interest of numerous companies. This indicates that, in comparison, targeted marketing initiatives attract greater customer attention. It is also true that it may positively affect the company's sales.

Naleer (2020) has developed software for productivity based advertising. For this purpose a camera's vision is utilized to recognize faces, gender, and age using artificial intelligence. (Processing Images). This study employs artificial intelligence to recognize faces, gender, and age through camera vision. Additionally, this research offers a technique that can determine an individual's gender, age range, and what shows are most likely to draw different people's attention to commercials. Robust Algorithm was utilized by the researcher to detect faces in color footage. In color photos, there is a robust algorithm for frontal face detection.

Pourhossein and Mahmoudabadi (2019) developed a smart urban street advertising pattern that will provide a meaningful link between the "planned messages" that smart billboards display and the "parameters received from the environment." The primary concept of the suggested pattern is to use a billboard equipped with magnetic, thermal, optical, and environmental sensors to sense various aspects. A questionnaire has been designed and is being used to gather audience opinions for the purpose of picking ads based on the parameters felt by smart billboards, with the aim of investigating the relationships that currently exist between the advertisement patterns. The acquired data has been evaluated using a sample size of 107 in order to assess the general idea of selecting adverts based on quantifiable factors. The study findings indicate a noteworthy correlation between environmental and traffic characteristics and the advertising contexts recommended by intelligent billboards. Thus, suggesting smart billboards that can identify traffic and environmental factors can enhance the effectiveness of advertisements to draw in viewers.

Shan and Roh (2018) have presented an analytical model in this research to describe the intricate correlations that exist between the discovery time and other BLE operational factors, including the number of advertisements, advertiser interval, scan interval, and so forth. We have also suggested a very efficient way to find the ideal advertisement interval to reduce the discovery time using the analytical model. It has been demonstrated that a significant reduction in the discovery time is possible with the suggested strategy.

Haval A. (2016) have reviewed the existing literature on "Face Behavior Recognition using Support Vector Machines". They have suggested new method for extracting the facial feature point extraction methodology and using it to recognize facial expressions from still images of two distinct sets of facial expressions. The five primary phases of this face behavior recognition system are as follows: pre-processing, feature extraction, feature selection, and classification.

Yang et al. (2016) have presented WIDER FACE (a sizable face detection dataset) by putting out a two-stage, multi-scale cascade framework that employs a divide and conquer tactic to address large-scale variances, they provide WIDER FACE. In this approach, a collection of convolutional networks with different input sizes are trained to handle a given range of scale faces.

Liu et al. (2004) have enhance the functionalities of SB by using wireless technologies. When a person see advertisement on SB, its identification by using data processing system (profile based) is made and

accordingly persons' interested products advertisement is played on the its mobile devices, PDAs or cell phones.

A parametric review of the above found literature is also presented in Table 1. All the parameters are self-explanatory and their values show the consideration of that activity in the work or not.

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Table 1: Parametric Analysis of the Found Literature.

Parameters	Shlomot and Beach (2013)	Haritaoglu and Flickers (2002)	Nigam et al. (2016)	Smart Billboard
Use of sensors	✓	✓	✓	✓
Digital / Electronic Billboards	✓	✓	✓	✓
Customer satisfaction	×	✓	×	✓
Targeted individual/ crowd of customers	Individual	Crowd of customers	Crowd of customers	✓
Changing Advertisement	✓	✓	✓	✓
Check effectiveness of companies Advertisement	×	✓	×	✓
Technique use	Camera and control unit to extract information	Silhouette based algorithm	Data mining and RFID tags	Face++ API
Customer Relationship Management	×	✓	×	✓
Cost effective	×	×	×	✓
Customer Behavior (based on gender)	×	×	×	✓
Gender and Age Detection				✓
Attractiveness	×	×	×	✓

3. Methodology

This section is further divided in two subsections. In the first section a survey about the feasibility of research is conducted from various stakeholders and in section 2 pattern of smart billboard has been designed.

3.1. Empirical Research Findings:

A survey is conducted for knowing the applicability constructing hypotheses to judge the interaction and interest in smart billboard of its stakeholders particularly shopkeepers and customers.

Considering the studies carried out in this area, several parameters are considered such as Customer Acceptance, Shopkeeper Acceptance, Customer Attractiveness, Shopkeeper Attractiveness, Smart Billboard, Traditional Billboard, Print Media, and Broadcast. Data is collected from shopkeepers and customers through questionnaire survey. A sample of size 100 in considered in case of shopkeepers and 150 in the case of customers. Responses have been collected through a five-score Likert scale (strongly agree, agree, no opinion, disagree, strongly disagree) is used for selecting advertising context in different areas and conditions. Consequently, a variety of hypotheses are tested to study the relationship between the above-mentioned parameters of this study.

Premises 1 concludes about the shopkeepers' response to SB, premise 2 concludes about customers' interest and preference of SB, whereas premises 3 shows the acceptance of SB over traditional billboards. These premises are analyzed using correlation coefficient (R), ANOVA table and regression techniques. These techniques incorporate statistical tests of significance for example F-test, t-test and coefficient of determination (R^2) to accept or reject the null and alternative hypotheses. Moreover, the Variables used in premises are abbreviated as SAtt (shopkeepers' attractiveness), SAcc (shopkeepers' acceptance), Cust_Att (customers' attractiveness), Cust_Acc (customers' acceptance) and AD (Advertisement Method).

- **Premise 1:** The use of smart technologies in advertisement is attractive for shopkeeper.

Table 1.1 exhibits correlation coefficient (R) and coefficient of determination (R^2). R exhibits 55% of linear association between these variables. R^2 explains that 30.5% of variations in SAcc is caused by customization. Both indicators provide evidence that this model is valid.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error if the Estimate
1	.552[a]	.305	.298	.58613

a. Predictors: (Constant), Cust_M

Source: Author's estimates using SPSS 21

Ho: Billboard attractiveness does not affect the shopkeeper acceptance.

H1: Billboard attractiveness affects the shopkeeper acceptance.

Table 3: ANOVA Table

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	14.767	1	14.767	42.983	.000[c]
Residual	33.668	98	.344		
Total	48.435	99			

a. Dependent Variable: SAcc_M
b. Predictors: (Constant), SAtt_M
c. Significance level(a) = 5%
Source Author's estimates using SPSS21

Table 3 represents ANOVA analysis that incorporates F-test to check the overall significance of regression model. The probability value of F-test is 0.000 that is signifying the relationship between SAtt and SAcc.

Table 4: Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficient	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.401	.345		4.061	.000[b]
SAtt_M	.557	.085	.552	6.556	.000[a]

a. Dependent Variable: SAcc_M
b. Significance level(a) = 5%
Source Author's estimates using SPSS21

Table 4 represents the coefficients obtained in regression model. Beta means that when shopkeepers are attracted from SB then they adopt SB technology 0.557 times on average. This coefficient is also significant as verified by its t-statistical probability.

- **Premise 2:** The attractiveness of smart technologies in advertisement is acceptable for customers.

Table 5: Model Summary

Model	R	R Square	Adjusted R square	Std. Error of the Estimate
1	.169[a]	.029	.022	.73015

a. Predictors: (Constant),Cust_Att_M
Source: Author's estimates using SPSS21

R signifies the 17% linear association between Cust_Acc and Cust_Att.

Null (Ho) and Alternative (H1) hypothesis in case premise 2 are following:

- H0: Billboard attractiveness does not determine the customers' acceptance.
- H1: Billboard attractiveness determines the customers' acceptance.

Table 6: ANOVA[a] Table

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2.331	1	2.331	4.373	.038[c]
Residual	78.902	148	.533		
Total	81.233	149			

a. Dependent Variable: Cust_Acc_M
b. Predicators (Constant), Cust_Att_M
c. Significance level (α) = 5%

The significance of attractiveness of SB on customer's intention to adopt SB technology is analyzed by ANOVA table 6. The probability value of F-test is 0.038 that is less than 5% level of significance. So, it signifies the relationship between Cust_Att and Cust_Acc

Table 7: Regression Coefficient

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. error	beta		
Constant	3.024	.174	.533	17.344	.000[b]
Cust_Att_M	.091	.043	.169	2.091	.038[b]

    a.   Dependent Variable: Cust_Acc_M
    b.   Significance level (α) = 5%
   Source : Author Estimate using SPSS21

Beta coefficient depicts that in response to one unit change in attractiveness customers adopt it 0.091 times. This relation is supported with t-statistic that is significant at 5% level of significance.

- **Premise 3:** The comparison between smart billboard traditional billboards.

Customer table 3 exhibits the frequency and percent distribute on of 4 modes of advertisement. The most preferred mode of advertisement is SB (57%) while print media is the least preferred mode (9%). Traditional billboard is preferred by 24% and broadcast mode of advertisement by 10% people.

Table 8: Advertisement Method

		Frequency	Percent	Valid Percent	Cumulative Percentage
Valid	Traditional Billboards	24	24.0	24.0	24.0
	Smart Billboards	57	57.0	57.0	81.0
	Print Media	9	9.0	9.0	90.0
	Broadcast	10	10.0	10.0	100.0
	Total	100	100.0	100.0	

Source: Authors Calculation using SSP21

Following Pie chart portrays the comparative preference of different modes of Advertisement by shopkeepers. SB has occupied the greatest slice of this pie as 57% people prefer it while print media has occupied the smallest slice 9%. The remaining area is distributed between traditional billboard (24%) and broadcast (10%).
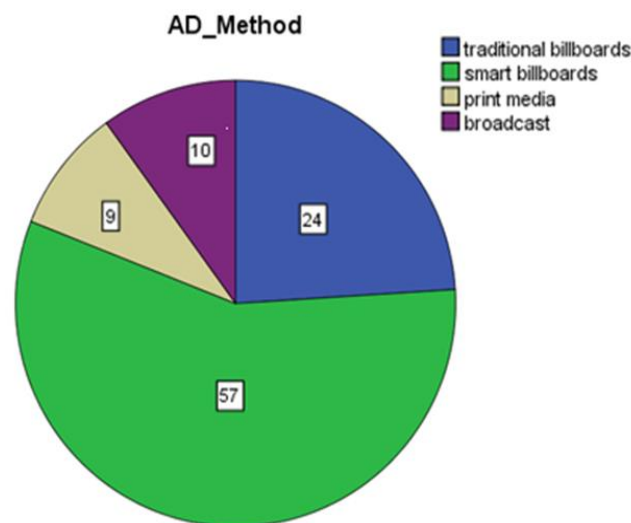
Figure 1: Pie Chart (Preferential distribution of Advertisement Method)

3.2. Designing the Pattern of Smart Billboard

The framework of our proposed research is shown in fig 3. In this system camera captures images that are stored in a storage file upon which face detection and feature analyzer API is applied. The results of this API are stored in database. After these results are fetched from database that can be viewed by stakeholders CB's and AC. Observing this CB's can give request for booking a time slot according to their

customer ratio related to their product. After processing the advertisement booking the advertisement will be shown on billboard.
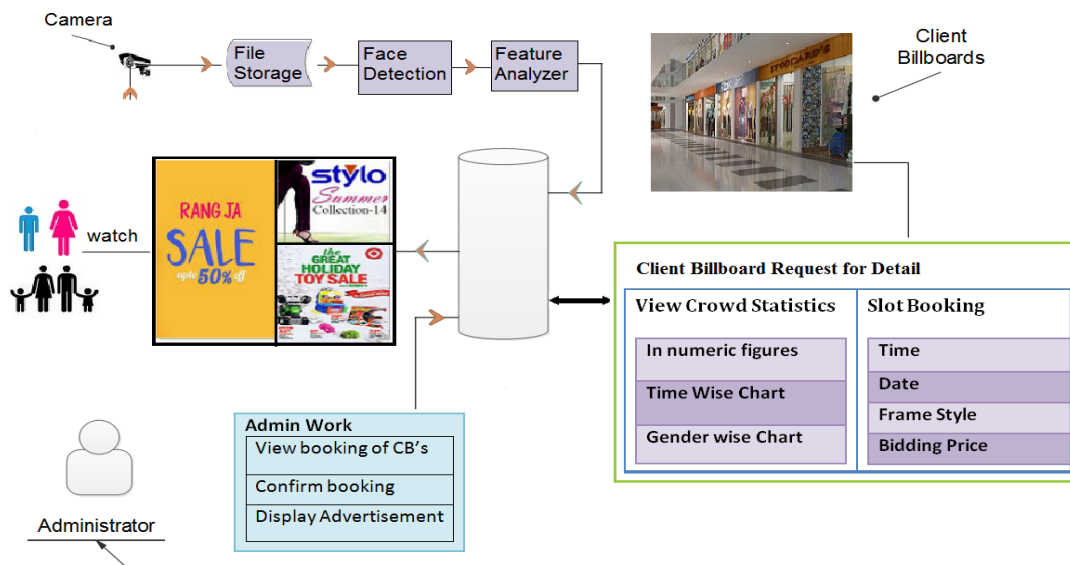

Figure 2: Framework of Smart Billboard

Figure 1 displays the general view of this research. Smart billboard runs advertisement for a specific limited time regarding customer behavior. In front an LCD has been displayed at mall entrance to run advertisement based on specific gender and age group of customers. The left side of this figure is portraying the control system where data about customers has been saved that is used by CB or AC for organizing advertisements.

Figure 3: Outlook of Research

3.2.1. Camera

There are (Closed Circuit Television) cameras in every shopping mall for security purpose. This system can use these existing CCTV cameras for face detection. This camera is capable of capturing video surveillance footage. This camera has IR facility of capturing video in low light and no light areas.

3.2.2. File Storage and Face Detection

This camera is attached with a personal computer. So that all captured images are stored in a storage file. After this apply face detection technique. For this purpose, use a Microsoft Azure face API. This estimates the number of persons and detects their faces in a crowd.
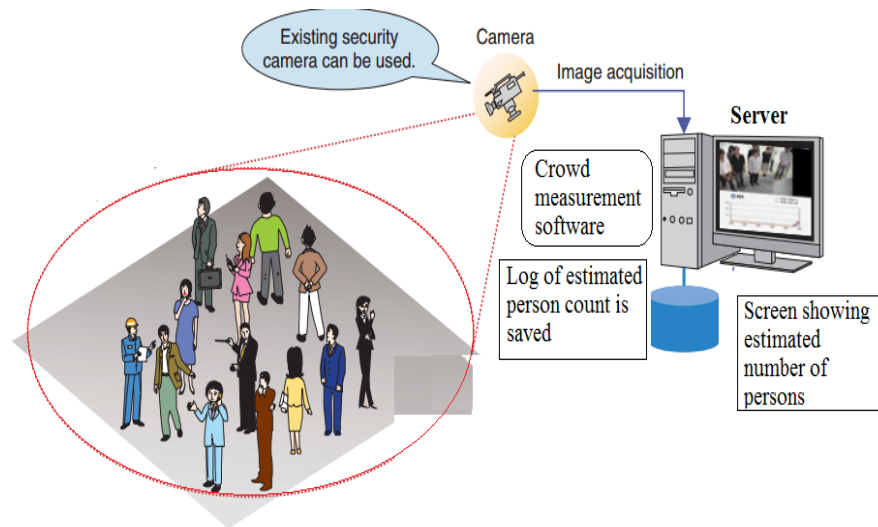
Figure 4: Crowd Measurement Technique

Figure 4 shows the procedure crowd measurement technique. In this technique the CCTV camera is capturing the images of incoming people to the mall and storing in personal computer storage file. API processes on the stored images and at the end the screen image of estimated results is shown.

3.2.3. Feature Analyzer:

The used API is capable of analyzing features of detected faces. This provides the facility to know the face attributes. The face attribute features available are: Age, Gender, Glasses and Smile.

Figure 5 shows the working of this feature analyzer component. API is processing on the images from file storage to scrutinize the feature based on age and gender and other attributes. At the end screen image of computer is displaying the estimated results of feature analyzer.
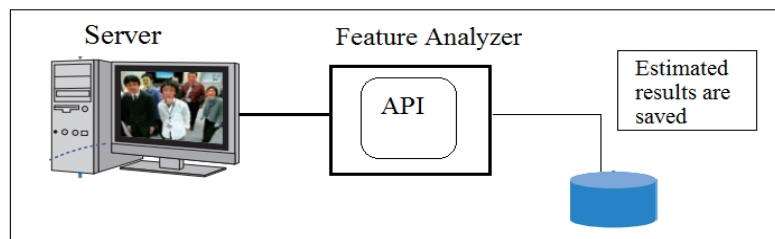
Figure 5: Face Identification

3.2.4. Database:

The processed data of API is saved in database. In this system database name is face_detection.db that has table titled as tbl_data. This table has columns that are ID, Image, ImagePath, ImageDate, ImageTime, Age, gender, Smile, glasses, Created_at, Updated_at. Image column is used to save images in BLOB (A Binary Large OBject) data type that is a collection of binary data stored as a single entity in a database management system. Blobs are typically images, audio or other multimedia objects, though sometimes binary executable code is stored as a BLOB.ImagePath column saves the storage information of image. ImageDate column stores the date at which a particular image was captured and stored in storage file. ImageTime stores the information of timing of images when it was captured form camera. Age column saves the age attribute of detected face (image) that is captured and shows its detail. Gender column saves the detail of gender attribute of captured images.

Figure 4 shows the view of table in which all detail of captured image is saved.

When run this task it will take automatically the images from this stored storage file and after applying the face detection and finding the feature attributes all data are saved in database

Figure 6: Overview of Database

- Website Visits:

The CBs (client billboards) visits the website to see detail about customers such as timing and other attributes of people along with gender and age. This system analyzes and shows the report in digits and chart form. This required information is fetched using SQL queries so that relevant data are accessed from database and CBs be able to watch the detail. So, they use this information to take decision regarding customer behavior based on gender and age groups. Figure 7 shows the detail of in which a website is maintain in ASP.NET
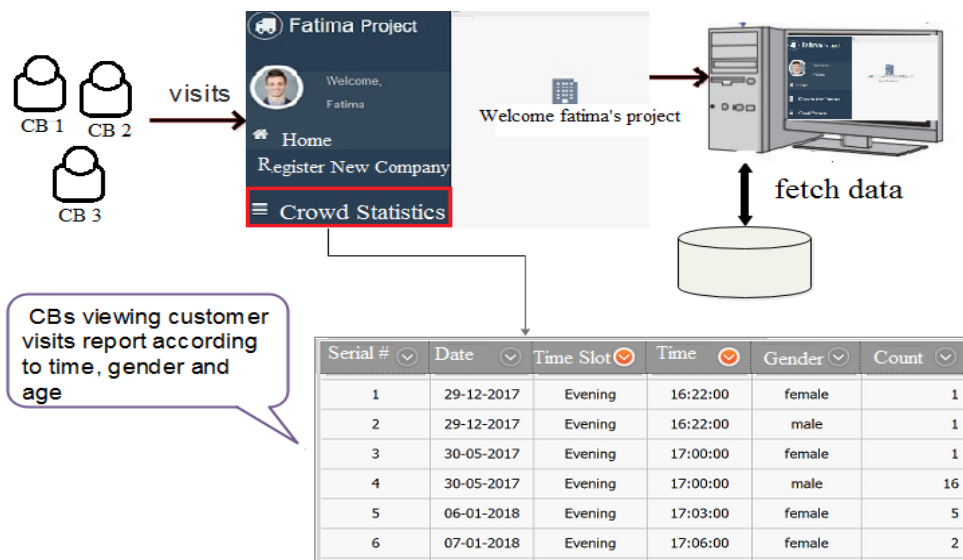

Figure 7: Website visit

3.2.5. Advertisement Booking

Figure 8 shows the Advertisement booking process. In this CBs visit the website and then according to detail of customer arrival (timing, gender and age information) they check the available slot. Then they select the required slot according to their product type. After this a new web page is available on which

they will enter their information and also their bid price for time slot. They also decide about the screen option either they want full or partial screen to run their advertisements and request for booking of that slot for their advertisement. Then our system checks the detail of all CBs and confirmation of booking is done of that CB (or CBs in case of partial screen selection by more than one CB) whose bid price is high. This system will be a facilitator study for customers, CBs and advertising agencies who will implement this system in malls.

Figure 8: Overview of booking time slot

3.2.6. Confirmation of Booking and display Advertisement

Figure 9 shows that this system checks the detail of all CBs and administrator confirm the booking of that CB (or CBs in case of partial screen selection by more than one CB) whose bid price is high. This system will be a facilitator study for customers, CBs and advertising agencies who will implement this system in malls.
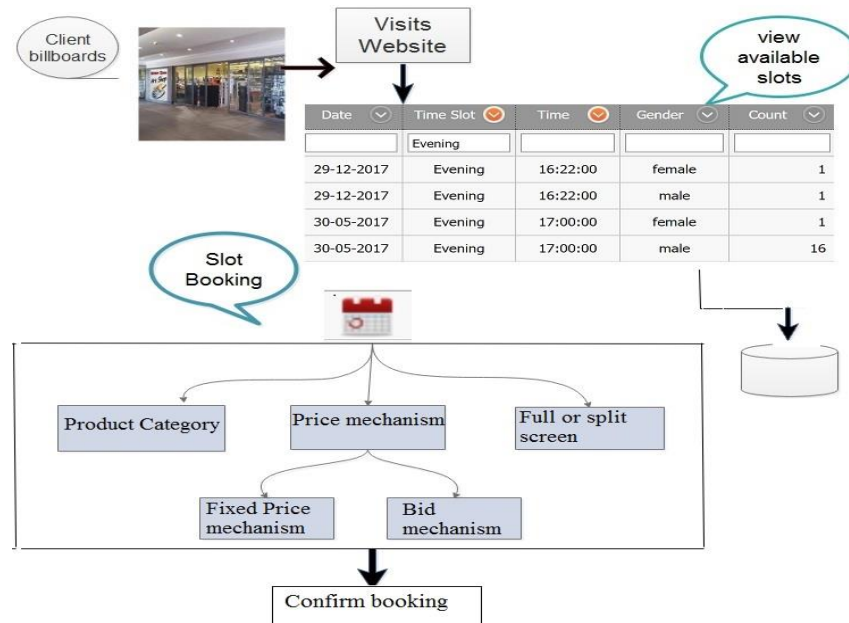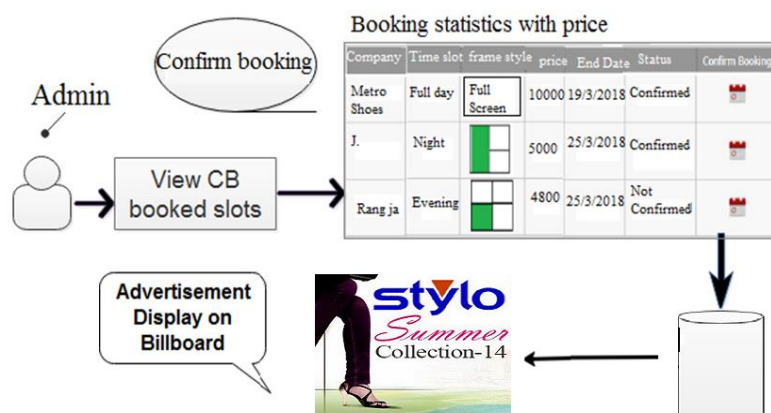

Figure 9: Booking Confirmation and Display of Advertisement

4. Conclusion:

This research proposes an advanced technology of billboard advertisement. A preliminary survey is conducted over a finite sample to come to know either proposed system is required or not. The proposed

system observes the customer behavior based on their gender and age group coming to mall and shows these results to CB's in statistical and charts form to enable them to decide to advertise their products according to customer behavior on SB.

Declaration of Interest Statement: It is declared that authors have no potential conflict of interest.

References

[1] Chen, Duan-Yu, and Kuan-Yi Lin. "A novel viewer counter for digital billboards." In *2009 Fifth International Conference on Intelligent Information Hiding and Multimedia Signal Processing*, pp. 653-656. IEEE, 2009.

[2] Khalil, Gehan Abdelalim, Maysoon Mohamed Qutp, and Mai Ali Nada. "Intelligent Billboards Targeted Advertising Systems." *Journal of Art, Design and Music* 2, no. 2 (2023): 5.

[3] Sümer, Selay Ilgaz, Çağatay Berke Erdaş, Emre Sümer, and Ahmet Paker. "A New Tool for Personalized Advertising in Shopping Malls: A Smart Billboard System." *Archives of Current Research International* 22, no. 8 (2022): 46-59.

[4] Mohamed Naleer, Haju Mohamed. "Human face recognition to target commercial on digital display via gender." (2020).

[5] Shan, Gaoyang, and Byeong-Hee Roh. "Advertisement interval to minimize discovery time of whole BLE advertisers." *IEEE Access* 6 (2018): 17817-17825.

[6] Pourhossein, Fatemeh, and Abbas Mahmoudabadi. "Original Paper Smart Urban Street Advertising Pattern Using Internet of Things Based on Environmental and Traffic Conditions."

[7] Yang, Shuo, Ping Luo, Chen-Change Loy, and Xiaoou Tang. "Wider face: A face detection benchmark." In *Proceedings of the IEEE conference on computer vision and pattern recognition*, pp. 5525-5533. 2016.

[8] Ahmed, Haval A., Tarik A. Rashid, and Ahmed T. Sadiq. "Face behavior recognition through support vector machines." *International Journal of Advanced Computer Science and Applications* 7, no. 1 (2016).

[9] Liu, Te-Kai, Yun-Wu Huang, and Jen-Yao Chung. "Interactive wireless electronic billboard." In *IEEE International Conference on Networking, Sensing and Control, 2004*, vol. 1, pp. 553-558. IEEE, 2004.

[10] Nigam, Saral, Shikha Asthana, and Punit Gupta. "IoT based intelligent billboard using data mining." In *2016 international conference on innovation and challenges in cyber security (ICICCS-INBUSH)*, pp. 107-110. IEEE, 2016.

[11] Kinebuchi, Tetsuya, Hiroyuki Arai, Isao Miyagawa, Shingo Ando, Kaori Kataoka, and Hideki Koike. "Image processing techniques for measuring advertising effectiveness of digital signage." *R&D on Digital Signage as an Advertising Medium* (2010).

[12] Shlomot, Eyal. "Smart Electronic Roadside Billboard." U.S. Patent Application 13/586,016, filed March 7, 2013.

[13] Azure AI Vision, Discover computer vision insights from image and video analysis with OCR and AI. *https://azure.microsoft.com/en-us/services/cognitive-services/face/*

[14] Cook, Diane J., Juan C. Augusto, and Vikramaditya R. Jakkula. "Ambient intelligence: Technologies, applications, and opportunities." *Pervasive and mobile computing* 5, no. 4 (2009): 277-298