DEVELOPMENT OF BUSINESS INTELLIGENCE SYSTEM FOR TRAFFIC MANAGEMENT DURING FESTIVAL

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ABSTRACT

Abstract—Festival causes the traffic volume significantly that usually results in traffic congestion as well as traffic accident. Thus, effective traffic management during festival is more than important for traffic operator and festival-goers as well. Despite of such importance, very little study on traffic management during festival has been made. Business Intelligence (BI) system is the data analysis system useful for effective data management and extraction. In this study, Business Intelligence (BI) system for traffic management during festival was developed and is expected to make commitment to relieving traffic congestion as well as reducing traffic accident during festival.

Keywords— festival, business intelligence system, traffic management, intelligent transportation systems (ITS)

INTRODUCTION

Nowadays, more and more people throughout the world visit the festival to enjoy the leisure and cultural activities by seeing and eating. The festival plays important role to enhance the image of the regional society and revitalize the community (Getz, 1997) For such reason, municipal governments attracts the tourists by offering a variety of regional festivals. However crowded tourists during festivals cause traffic congestion. During Mid-Autumn festival in China, not surprisingly, it took 20 minutes to move a few hundred meters (Mingxin, 2013) And terrible traffic jam was caused by popular rock festival in UK (Elks, 2011) According to investigation, a number of visitors during festivals have increased by 14,000 on average in Korea too (Jang, 2013) Furthermore, death toll during festivals rose to 50 persons or more (Indo-asian new service (2011; Sokhean, 2014) As data shows, traffic management during festival is extremely important but in fact the study on traffic management during festival has yet to be put on track. Traffic management operator or visitors could make effective plan, taking into account of traffic congestion time or route.

But road user or traffic management operator has difficulties in collecting and analyzing the traffic data with regard to festivals by themselves. Business Intelligence (BI) system offers the function to collect and analyze various traffic data and provide them with summarized information they require in a timely manner. Among the systems that provide compiled traffic data is Performance measurement system (PeMS) in California, which however offers real- time traffic information or the data in past without the information regarding festivals (Indo-asian new service, 2011) Hence, it's necessary to develop the system that is used for efficient traffic management during festivals.

This study is intended to develop Business Intelligence (BI) focusing on national highway in Korea, thereby making commitment to accomplishing efficient traffic management during festivals. In Section II, review of preceding research is made and in Section III, data collection and traffic characteristics of the region for study are described. In Section IV, BI system development approach is mentioned and in Section V, system development outcome and In Section VI, conclusion of the study is introduced.

LITERATURE REVIEW

Federal Highway Administration in USA has implemented Archived Data User Service (ADUS) since 1999 which provides the users with history data such as ITS in a bid to improve traffic management and use. Archived data management system (ADMS) is the part of the concept which ADUS contains. ADMS collects, processes and stores ITS data in real time to provide analyzed information for the users (Turner, 2001) Includes in ADMS are PeMS and Minnesota's traffic management center(TMC), Kentucky's advanced regional traffic interactive management and information system(ARTIMIS) and Louisville-Southern Indiana Traffic Information (TRIMARC)

PeMS provides basic traffic index, travel time by destination and traffic congestion section in the form of map or table (FHWA, 2005) TMC displays traffic status on map through loop detector or CCTV by classifying them into non-congested, delay and congested and emergency situation by weekday and weekend (Turner, 2001) It also has the function to automatically check the quality of data and notify the operator of any abnormality (Turner, 2001) ARTIMIS and TRIMAR provide traffic data from detection points in the form of GIS-based map in real time (Varaiya, 2002) Korea Expressway Corporation has the operations analysis and supportive information system(OASIS), the traffic history management system, that functions to analyze and extract weather data in addition to traffic data (Jung, 2009)

As seen above, existing systems mostly provide real time traffic data only and has difficulty in identifying the relations with other factors. Even the historic data has the limit in time and space and the users have to do processing to obtain the required information.

DATA COLLECTION

3.1. The site for study and data collection

The festival which is the subject of this study was Boryeong Mud Festival which has been designated as Good Festival by Korean government for 3 years in a row and was the Korea Festival Contents Awards-winner (Lee, 2009; Choi, 2015) For such reason, this festival is selected for the study. Surrounding routes of Boryeong Mud Festival are national highway route 21 running south to north and route 36 and 40 running east to west. Traffic detection spot was within the festival site. Fig 1 shows the parts of traffic pattern analysis points.

Traffic data used for the study is permanent traffic counts(PTCs) from national highway agencies. To identify the effect of the festival on traffic before developing BI system, part of the spots is used for 3 years from 2010 till 2012. Analysis of traffic volume variation by time and vehicle type during usual days and festival is made by integrating traffic data and festival data.

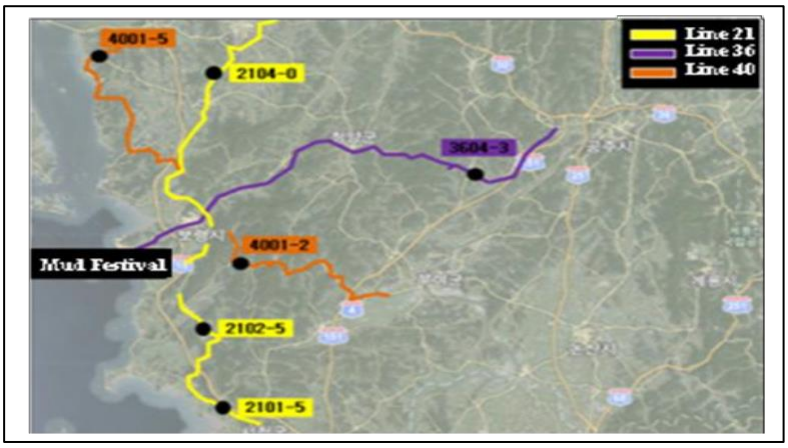


Figure 1 Parts of the spot

3.2. Analysis of traffic pattern by time

The spots for analysis before developing BI system are 6 as shown in Fig 1 which are 3 on route 21 and 1 on route 36 and 2 on route 40. To compare the traffic between festival days and usual days, traffic data immediately before festival is used as the data for usual days.

Comparison of traffic volume for 24 hours is made to identify the peak time by spot, traffic volume variation and distribution. Analysis result is represented in graphic in Fig 2 that explains well the result. Traffic volume is increased during 08:00 till 19:00 than usual days in 2010 and 2011, but the traffic volume during festival appears to be similar with or partly reduced than usual days in 2012.

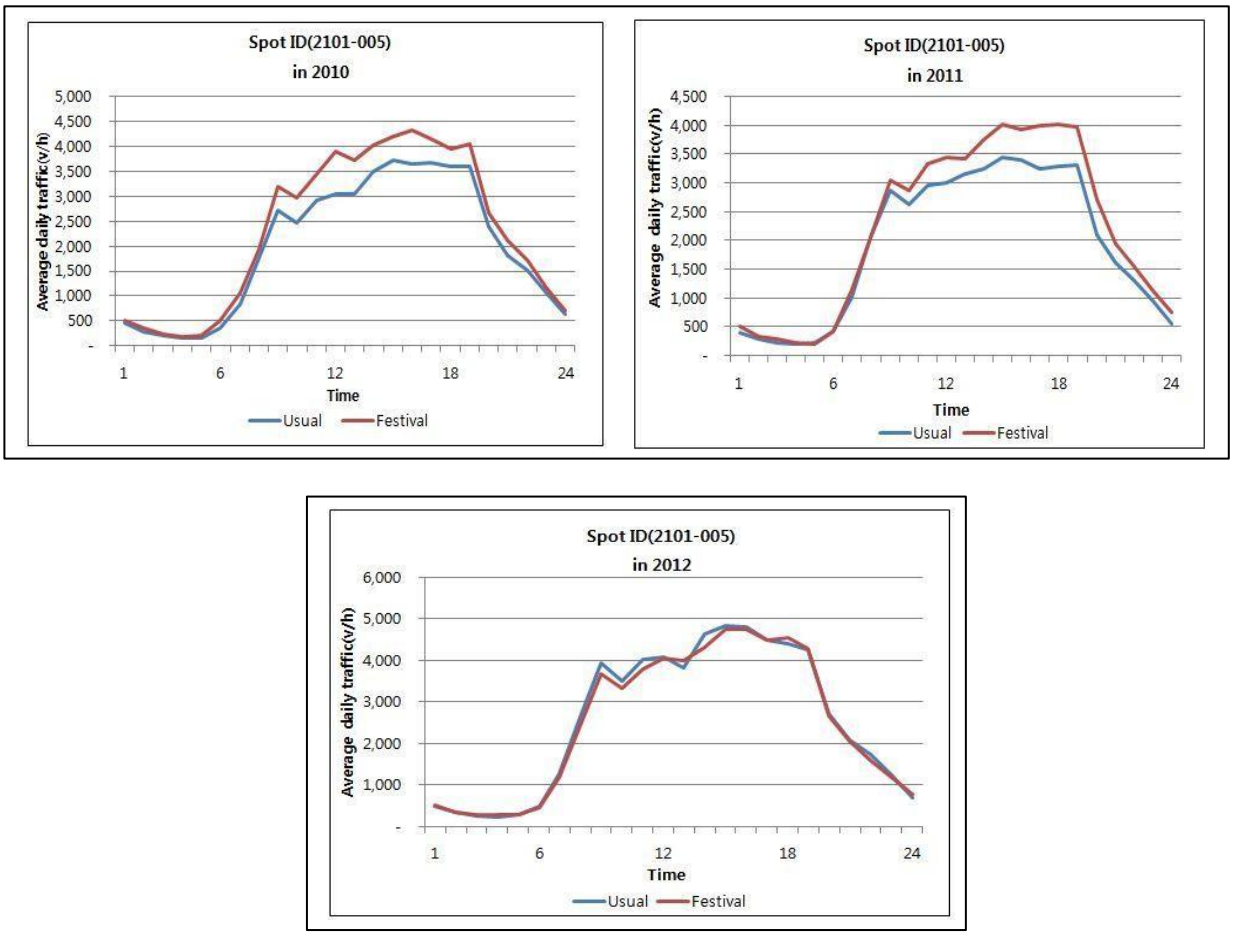


Figure 2 Parts of the Spot

3.3. Analysis of traffic pattern by vehicle type

Analysis of traffic pattern by type of vehicle is made to identify the distribution of vehicle by type and by spot. Type of vehicle is defined based on 12 types used for the traffic volume on national highway with automatic traffic recorders (ATRs). To help better understand the analysis result, the trucks categorized into Class 3 ~ 12, except Class

1 passenger car and Class 2 bus, are classified into cargo vehicle in analyzing variation in traffic volume.

Table 1 shows numerical variation during usual days and festival at spot 4001-002 where variation in traffic volume by type of vehicle is significant. As a result of analysis, passenger cars were increased during festival for all 3 years which indicated increase in festival-goers using passenger cars. When it comes to bus and truck, decrease in traffic was also monitored in certain year but decrease was insignificant.

Table 1 *Traffic at 4001-002 by type of vehicle (2010-2012)*

Type / Year	Passenger car (vehicles/day)		
	Usual	***Festival***	***Rate (%)***
2010	3,424	3,714	8.47
2011	4,071	5,157	26.69
2012	3,813	4,089	7.26

Type / Year	Bus (vehicles/day)		
	Usual	***Festival***	***Rate (%)***
2010	176	198	13.04
2011	161	150	-7.10
2012	144	162	12.47

Type / Year	Truck (vehicles/day)		
	Usual	***Festival***	***Rate (%)***
2010	228	252	10.65
2011	74	81	9.03
2012	132	125	-4.84

BI SYSTEM DEVELOPMENT

As a result of comparing traffic volume variation by time and type of vehicle, festival proved to have caused increase of traffic volume but it's difficult to identify the relations with the festivals by using current traffic systems. Moreover, policy-makers and drivers prefer to get the information more quickly and in easy way, instead of handling the data by themselves. BI system provides the users with the data after collecting, integrating, processing and analyzing them in visible form for better understanding which is a great help for policy-makers, planners and drivers in making a decision (Olszak & Ziemba (2006; Dayal, Castellanos, Simitsis, & Wilkinson, 2009) As shown in Fig 3, BI system is not an independent system but is in need of data warehouse, extraction transformation load(ETL) system and online analytical processing(OLAP) development technologies (Jung, 2009; Jang, 2013) BI system provides new information in easy and familiar form using the data accumulated at relevant organizations so as to help the users better understand the information. Thus, BI system is developed in a bid to analyze characteristic information during festivals in accurate and a timely manner by traffic management operator
for efficient traffic management support.

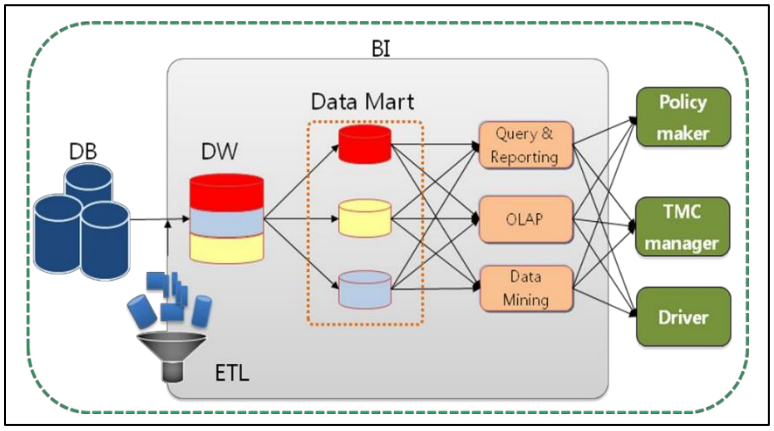


Figure 3 System conceptual diagram

4.1. Configuration of Data warehouse

Data warehouse is the data space which is rearranged to the structure to provide the logical information in required form by collecting the data physically scattered at numerous locations. DW has such characteristics as subject orientation that requires a certain configuration by subject, integration that incorporates different data in consistent form, time-variance that stores the data over time variance and non-volatile characteristic that the data, once stored, is not modified or deleted. The space storing the data after classifying is called data mart (DM) (Lee, 2006)

To analyze the traffic pattern more accurately before development of the system, data accumulated for 5 years during 2009 ~ 2013 is collected. Data integration with traffic data and festival data is made using route number and spot id on festival-related roads. And Data Mart (DM) is developed to search the summary from stored data in a timely manner. Table 1 shows DW of traffic data and festival data and list of DM.

Data integration methods are outlined below.

- Designation of analysis time
- Selection of national highway route around festival
- Extraction of spot numbers available in the region
- Calculation of variation in traffic volume during usual and festival

Table 2
Data warehouse and data mart list

Category	**Traffic data**	**Festival data**	
		Festival-related road data	***Festival history data***
List	Loute number	Loute number	Festival start date
	Spot ID	Spot ID	Festival end date
	By time / type of vehicle	Province	Venue
	Direction	City	-

4.2. Implementation of ETL system

ETL system is needed to collect the data scattered at relevant organizations as part of work to structure DW. ETL system extracts the data to integrate traffic data and festival data into DW and as extracted data is still complex and not standardized, code conversion to integrate them is needed and data alignment process is also required as well. That is, ETL system is the process of storing data which is converted to the form which the user requires.

For automatic data collection, minimum connection information shall be provided from raw data-supply organizations. Unless such information is provided, manual data input is inevitable. In case of Boryeong Mud Festival for which data collection system was not provided, information on festival start and end date, festival history information such as festival location and other festival information including the route and spot number shall be input to collect the necessary data.

4.2. Development of online analytic processing(OLAP)

OLAP is used to provide the information after refining and summarizing the large data at DW, which is in contrast to online transaction processing (OLTP) representing existing transaction-focused operation system. While OLTP is data renewal-centered system, OLAP is data search-centered system.

That is, OLAP provides the users with direct access to required information without through mediator such as data processing department. Furthermore, it analyzes the information from various viewpoints and keep analyzing in conversational way till obtaining required analysis outcome.

This study is intended to develop visualization reporting screen using open source, Spago BI to provide the users with summary information on relations between traffic volume and festivals. Spago BI provide the function for users to share on the internet without extra process after installing the system.

A filter function is designed for users to analyze the data such as festival duration and traffic pattern by route and spot. The list includes in order of festival name, year, route number, spot number, up and down, and type of vehicle. And for displaying on screen, traffic variation before and after festival in graphic is displayed to provide traffic pattern information for better understanding. Moreover, table showing the variation in traffic volume on the screen was developed. Traffic volume displayed on the screen is the average of total traffic.

RESULT

Development of BI system enables the users to easily and quickly analyze variation of traffic volume during the festival at certain period. It reduces the time in collecting and processing traffic data and festival data and provides the data in easy and understandable form. A result analyzed variation in traffic volume could be checked by arranging the data through filtering function, Fig. 4 shows the screen displaying using BI system daily average traffic variation of all types of vehicles on all festival-influenced roads. Traffic during usual days and festival was distinguishable in different colors.

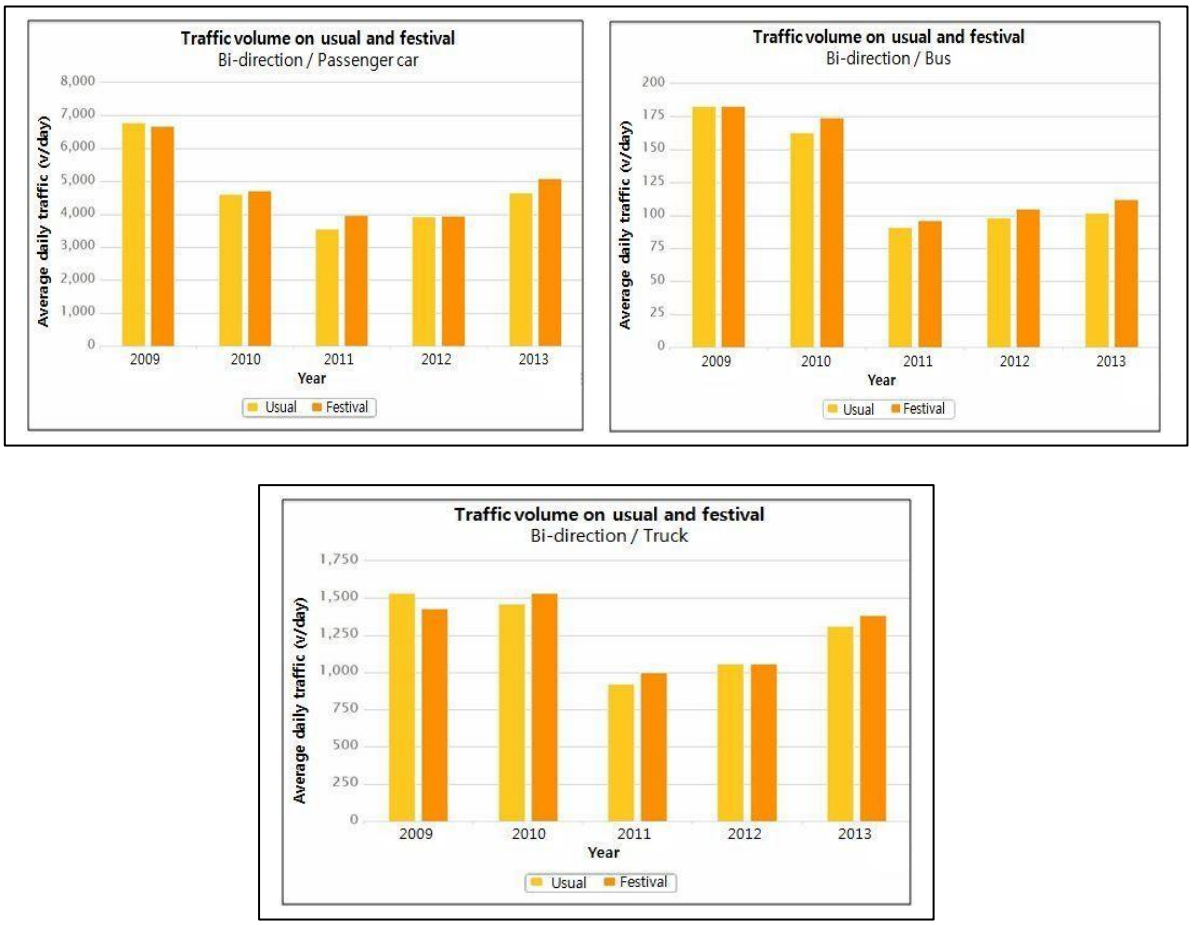
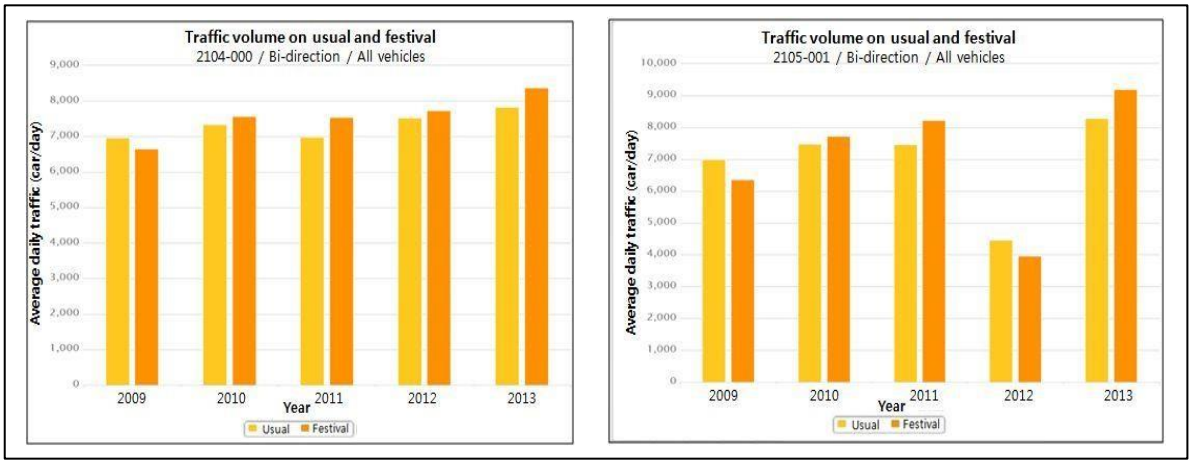


Figure 4 Screen displaying total traffic at festival spots



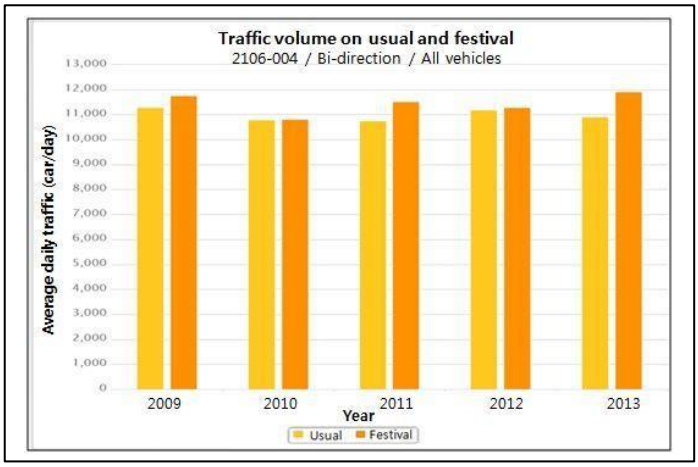


Figure 5 Screen displaying traffic volume in route 21

In addition, traffic volume by route and spot for analysis was displayed. Fig 5 shows variation in traffic volume at certain spots on route 21, indicating different pattern with Fig 4, despite of same festival, which indicated the information from ordinary traffic information system and the information on road which the users require may be different. Thus this system is expected to analyze and provide variation in traffic volume information on road which the users require more quickly and accurately.

CONCLUSION AND RECOMMENDATIONS

In this study, a large scale festival proved to be the factor that causes the increase in traffic volume and traffic congestion on neighboring roads during festival and the difficulties in controlling the traffic flow were recognized. To deal with such challenge, BI system that will provide accurate information in timely manner was developed.

It's intended to develop BI system to provide the traffic management operators or drivers with easy, quick and refined information. Road users including drivers would be able to make a driving plan avoiding congested section and time, taking into account of the information on route and spot which the drivers want to use, type of vehicle, variation in traffic volume on down & up line displayed in graphic and the traffic management operator would be able to develop the policy for bypass to ease the traffic congestion.

This study, however, focuses on traffic volume data only excluding speed without considering meteorological factors. Hence, should the further study continue by incorporating meteorological factors, this system is expected to provide the users with more accurate information when applying to the festivals such as Boryeong Mud Festival.

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