MAKING ACCIDENT DATA COMPATIBLE with ITS-BASED TRAFFIC MANAGEMENT: TURKISH CASE

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ABSTRACT

One of the most important reasons of the high rate of accidents would largely lend itself to ineffective data collection and evaluation process since the necessary information cannot be obtained effectively from the traffic accidents reports (TAR). The discord and dealing with non-relevant data may appear at four levels: (1) Country and Cultural, (2) Institutional and organizational, (3) Data collection, (4) Data analysis and Evaluation. The case findings are consistent with this knowledge put forward in the literature; there is a transparency problem in coordination between the institutions as well as the inefficient TAR data, which is open to manipulation; the problem of under-reporting and inappropriate data storage prevails before the false statistical evaluation methods. The old-fashioned data management structure causes incompatibility with the novel technologies, avoiding timely interventions in reducing accidents and alleviating the fatalities. Transmission of the data to the interest agencies for evaluation and effective operation of the ITS-based systems should be considered. The problem areas were explored through diagnoses at institutional, data collection, and evaluation steps and the solutions were determined accordingly for the case city of Izmir.

INTRODUCTION and PROBLEM DEFINITION

Approximately 500,000 people are killed, and about 15 million people are injured in the developing countries on roads in the world every year (Ghosh and Lee 2005, Garrison and Ward 2000, Gwilliam 2002). In developing countries including Turkey, the high rate of accidents is more devastating due to the ineffective safety management, which largely results from likely ineffective data collection, storage and evaluation.

Intelligent Transportation Systems (ITS) have an important role in the organization of reliable and effective data, and its management. Yet, ironically mismanagement in traffic safety defers the deployment of ITS. Data derived from the traffic accident reports need to be integrated to new technologies for effective traffic management and evaluation of the results. However, there are problems with the data gathering and statistical evaluation. Data are processed manually because it is believed to be faster, which may lead to human error during the incidence configuration, and data transferring. It is vital to reach data gathering standards including a standardized accident reporting system which is also suitable with the international conventions. Technologies that record in-vehicle or on-road data can ease court proceedings following accidents (White Paper 2001). But, this very role has been tampered by the inertia in the current management practices. As explained in Fig.1, pervasiveness of ITS will break existing clumsiness in data gathering to resolve in time.

This paper aims, first, to address especially ITS-compatible solutions for current data inefficiencies in order to remedy the underlying data collection, storage and evaluation inefficiencies about the traffic accidents, particularly in the Turkish case. Especially, such difficulties pertaining to ineffective data management caused by the institutional inertia and indifference in taking initiatives are of prime interest. Some ITS-based proposals can propose a solution for such disintegration. The increasing demand for the ITS requirements necessitates that the data collection be modernized along with the other technological developments occurring.

This study hypothesizes that inefficient data handling could be the major source of the current severity levels of accidents in Turkey, since it makes retardation effect over the traffic management and safety, as delays in police operation at right time and place. Such inefficiencies may be contributing factor to increased fatalities due to the misled interpretation of data for necessary interventions either at operational level (police counter–measures) or scientific investigations (as crash prediction models). Verifying the literature, the data from the case town will be used to cross-verify that fact at four analysis levels, as discussed in Method Section.

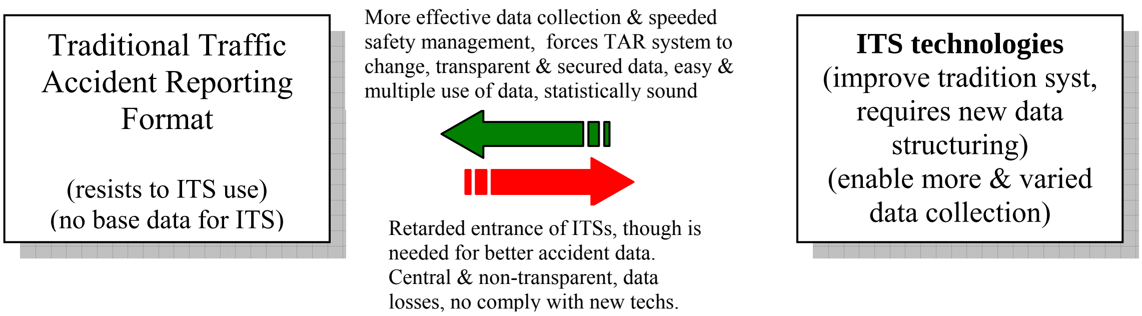


Fig.1. Dichotomy between traditional TAR data collection and the ITS use

BACKGROUND

Traffic safety management has close connection with the ITS modeling. Lately, EU has put an emphasis to deploy Europe-wide ITS to improve the safety levels (White Paper 2001). Below, Table 1 gives a summary of the literature for the four problem levels described.

Traffic safety should be a high-priority issue among the priorities of the state. The risk or safety is matter of cultural perception; when countries pay attention to the value of life, then attaining preventive policies could be at agenda (Jarvis et al. 2009, Gwilliam 2002, Griffin 1968). Cultural differences actually start from safety and risk perception in general (Nordbakke 2009).

Problem Analysis Levels	Basic Inefficiencies	Literature Sources	Novel or Technol. App's	Expected Consequences
country, legal & cultural	. no consensus among states . negligence & less attention . legal inadequacies . differences in judicial structures	Erdogan et al., 2008, Jarvis et al, 2009 Gwilliam 2002, Griffin, 1968 Nordbakke 2009 White Paper 2001	the independent investigation	Finding out clear culpability & liabilities
institutional & organizational	. non-transparency . autonomy . non-ideal inspect. methods and form quality . no harmony, & stdrdzed process . no accountability	ERSO, 2005 Williams and Poulovassilis, 2008 Grabowski et al 2009, Bliss 2004	. on-line data-sharing (internet) . electr. Forms . Electr. driving license	.rapid & more reliable data gath. . data exch. with no bureaucr.
data collection & transmission	. ineffic training of staff . under-reporting . costly & time consuming . misallocat. of data entries . missing inform.	Tiglaco, 1988 Yumrukcali, 1998 Duvarci et al, 2005	. video detection & IP algorithms . real-time data entering on acc site . data-sharing softwares	. reliable & icreased range of factors . speed & less cost
data analysis, evaluation & dissemination.	. non-ideal data storage . non-ideal use of statis'al analysis . ineffective data sharing . data is erroneous . inadequate spatial analys	Erdogan et al., 2008 Miaou et al 1992 Kweon and Kockelman, 2004	. data mining tools . factor analysis & classification tools	. more reliable info. for timely & approp. policy & appl's . geo-referen'g. . land-use integration

Table 1. Inefficiencies in Traffic Safety Issues and Relevant Literature Studied

Police are responsible for reducing the accident levels through effective policy and measures, which depends on the effective monitoring of the performance. But, this monitoring requires collection of healthy data about the past accidents. Efficient data evaluation can wind up with efficient accident prediction models and spatial decision support systems (as GIS) both of which finally serve to deployment of set of policies in preventing accidents. Besides the active ones, the infrastructure and environmental precautions are operational in reducing the accidents. However, there is still ambiguity about what real factors cause accidents and which measures, particular technologies may be competent (Rygh 2005).

There is almost no standard process of road accident investigation throughout Europe (Elliman et al. 2007). For example, some local authorities in England did not even record damage-only accidents (Hasseea 2003). Independent inspection system in EU is not mature, yet. Comparable data systems are aimed as in CADaS Project (Yannis et al. 2009) utilizing advanced technologies and communication platforms.

In order to maintain a Europe-wide harmonization in safety, major projects that deal with large databases of Europe are as follows:

- SafetyNET is a European Commision project (started in 2004): To build a new framework, focusing on new data items and data collection techniques. The consortium made up of 22 partner organizations, including various data bases throughout 17 European countries; CARE data is the largest pan-european database (15 national statistics)

- ERSO (European Road Safety Informatıın System): An effort to assemble wide range of information through internet). It is also a pan-European transparency of data, and data sharing (called PENDANT).
- CONCERTO, developed by the Ministry of Transports in France, is a media for connecting various GIS programs. It allows many interfaces of data into GIS and GIS-based analyses with the communication softwares.
- CADaS Common framework for accident data collection (Yannis et al. 2009)

In other countries, different techniques are used for traffic accident reports (TAR). For example in Texas, the reporting is done on the basis of persons who are involved in the crash (Hasseea 2003), and, in Korea, the reports (TAR) are processed into secondary Traffic Accidents Statistics Forms (TASF), after the accident, which have two parts of main and supplementary forms. Main form is for the first and second persons involved in the accident and the minor one for the third party who are involved in the accident, where first 50 columns are about accident characteristics, other columns for fatality or highway type accidents, etc.. TAR data are aggregated into annual Traffic Accidents Statistics Form (TASF) in police station jurisdictions. Categorical variables are used with levels. The important part is that, while it has parts for the basic characteristics of the accidents, the other columns are for explaining the injury level and fatality (Shon and Shin, 2001). In the UK, accidents are reported using a format known as STATS-20 in which, a record exists for each accident, following by one or more records for the people and the vehicles involved in the accident. However, there are still queries that cannot be answered via this schema alone (Williams and Poulovassilis 2008). Similarly EU's Major Accident Reporting System (MARS), with 48 variables recorder for each accident, has also data documentation limitations (ERSO 2005). There is no consensus among states which are necessary items to be recorded in accident reports (Erdogan et al. 2008). Khan et al. (2004) examined the accident report forms used by the Police in various countries and they found that these report forms yield up to 99 different pieces of information related to accident environment (Erdogan et al. 2008).

For the Middle East region, including Turkey, the accident figures increase approximately by 65% (Bliss 2004). Current consensus is on developing more scientific approaches to traffic accident investigations, which include collecting data not only for judiciary issues, but also statistical and research issues (DfT 2005). Following sample categorization of traffic accident data includes over 400 variables for the purpose of in-depth accident causation analysis (ERSO 2005): (a) general variables at the levels of accident type, road, vehicle, road-user, pedestrian, other critical events, (b) user related contributing factors, (c) vehicle related factors, and, (d) infrastructure related factors. In contrast, Traffic Inspection Department of Turkey collects accident data for about 40 parameters which are not sufficient for effective analysis, which makes it difficult for comprehensive research about safety measures as it is. In addition, different institutions as data owners (police department, insurance companies, and statistics departments) process the data in their own measures since there is no standard descriptive data dictionary in use of all these organizations (Grabowski et al. 2009). As they seek for available information to them, some data that they do not use are omitted, which would be useful for other agencies in their assessment studies.

In the developing countries, usually, agencies are rarely held accountable for safety results that fall within their sphere of responsibility and influence (Bliss 2004). Sometimes the phrase "cause" is used to identify the factor that assigns legal responsibility for the accident (e.g.

driving while alcohol-impaired; exceeding the speed limit). However, in most accident research, the concept of cause has been replaced with the concept of contributing factor (Andrey 2009, Lee et al. 2005). These contributing factors may be the result of negligence as well as inefficiencies in many levels. Furthermore, some TAR datafields have under-reporting problem that even the investigating body is not much aware of. But, this is common in most countries. PENDANT data also confirmed that there is a great bias between their own injury severity data and the Police' own injury severity data, but which may probably be caused both by the individual assessment and differences in definitions of severities and injuries, etc. differentiating culturally and across institutions (PENDANT 2006). Thus, under-reporting and/or under-representation problem plagues the reliability of data gathering process and strongly affects the research results that will be reckoned here for the data of this study.

METHOD

In this study, we aim to diagnose the problems and obstacles to obtaining efficient safety data. By literature survey, some major problem areas about safety and safety-related data collection inefficiencies are highlighted, and grouped into the analysis stages. As a methodology, we contrasted current data collection methods between EU, and some other countries, including Turkey, for each level. The study covers these major issues:

- As the European Commission has targeted to marshal the efforts and exchange of good practice between the member countries and the institutions, we would like to do the same; overview of such exemplary experiences in finding the suitable solutions.
- The TAR data for Urban Izmir's main streets can be analyzed with the field survey data to verify the under-reporting problem in the literature as, first, whether there are truly under-reported data, and then, whether there is any inconsistency between the similar fields observed and the TAR data such as "clarity of lane line markings". But, in the field surveys, some streets are observed not to have clear line markings actually.

The disharmony, difficulties and gathering of irrelevant data may appear at four levels: (1) country and cultural, (2) legal, institutional and organizational, (3) data collection, (4) data analysis and evaluation. The first level concerns problems with the cultural negligence of importance of human life, especially in the developing countries. But, this is an overwhelming issue. At the second level, there exist transparency issues between different organizations and institutions, and willingness to share information and openness to novelties; for the third level; under-reporting issues and missing of useful data that may be caused both by human error. Finally, the traditional TAR format is not scientifically tested, and coupling with wrong data processing with inappropriate methods, plagues the efficiency and reliability of the data. Timely and correct transmission of the data to the interest agencies and institutions is critical, too. Strange enough, the fatal accident data are the most reliable but quite confidential, and the data retrieval is very hard in a non-transparent environment between institutions.

The research method stages can be briefly seen in Fig.2. Then, at the local scale of Izmir, we micro-scaled the confronted problems, diagnosed reasons and proposed appropriate solutions from the real examples. As a method of diagnosis, applications in different systems which best suit to our countries' data set and our parameters are considered ("fusion") for possible place in a new data gathering and evaluation systems. Then, we narrowed down to the key solution areas against the highlighted misfit and deficiencies. Solutions are for the case area of Izmir Metropolitan Area data collection system addressing the mentioned analysis stages.

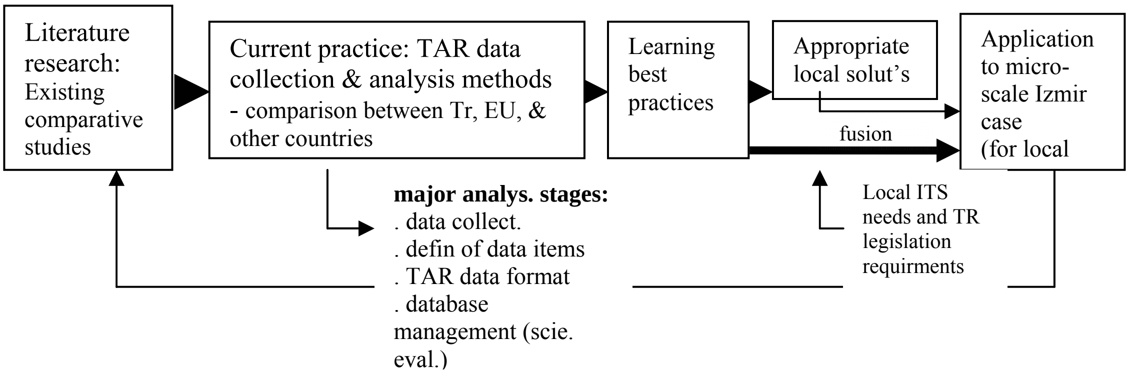


Fig.2. Flow chart of the research method

DIAGNOSIS of INEFFICIENCIES

COUNTRY and CULTURAL LEVEL INEFFICIENCIES

The approaches to the safety issue differ first at country (culture) level. As explained before, different countries collect different types of information by using their own reporting styles while there are differences in accident definitions, also. Some examined solely dead/injured accidents whereas some others gathered all accidents into evaluation. Therefore, it is hard to unite all these differences at a single database. Whether single standard form of investigation is appropriate across all cultures is another question. "one size fits all" approach is criticised (Sampson 2009). Transparency is defined as "the full, accurate and timely disclosure of information" (Elliman et al. 2007). For improved safety, all stakeholders who are in a position to implement changes, should share the accident data.

Countries' cultural heritage that how they treat the "value of life" intervenes. For example, in the U.S., the value of life for one person is 1,500,000 US$, whereas in Turkey this number descends to 15,000$ (Duvarci et al. 2005). This constitutes a major part of cultural (in)sensitivity to the issue. Turkey should sign up for international conventions, in terms of data sharing, learning other experiences and integration to the other global projects, which would also help overcoming the transparency problem at the next level.

INSTITUTIONAL and ORGANIZATIONAL INEFFICIENCIES

At institutional level, the structure of institutions in carrying out the investigations gains importance. Institutions should have structurally and financially independence to carry out the investigations. The issue of transparency and independence between organizations is critical for effective communication. It may be tough for the researcher to obtain the data, since every institution would like to commit, first, its own procedures defined by law and seems not akin to new procedures. In Turkey, severe accidents data are separately processed in a special unit of the Security Department, but not shared with other institutions, or require some protocols. Institutional inefficiency relates to cultural attitude towards accidents that is also acknowledged by others, involving the traditional reporting format. An open-source international data storage by national, local and organizational level may do a great deal about traffic safety and traffic modeling systems for risk assessment (Grabowski et al. 2009).

Another fallacy is that the accident reports that prepared by staff, who are mostly unqualified personnel, or forms are filled out by individuals, in the absence of officials (the new system) for damage accidents. Such filing brings out the reliability problem of data, thus it is open to manipulation. Usually the conflicting questions in the accident report forms cause data confusion and contamination. The quick filling of the forms may let important points to escape so the data do not represent the real conditions of the accident. This problem may be sidelined by a well educated staff for data gathering (Tiglaco, 1988).

DATA COLLECTION INEFFICIENCIES

Inefficiencies are caused by missing data when usually reporting at the accident site. There are two different types of this inefficiency. First there is the issue of under-reporting. During the reporting process of the accidents, environmental factors and the road infrastructure may not seem relevant for the person who fills out the form, and may be disregarded. The second type of inefficiency is that of the environmental factors (such as heavy traffic) around an accident site that may influence the way the data are collected. If there is a road maintenance after the accident that had occurred long time ago, the previous situation may not be taken into account. Such environmental conditions, traffic flow aspects (eg, headway distance), land use and pedestrian density, speed, vehicle occupation ratio, urban and other road infrastructure features, etc. must be collected *when* accidents occur.

DATA EVALUATION INEFFICIENCIES

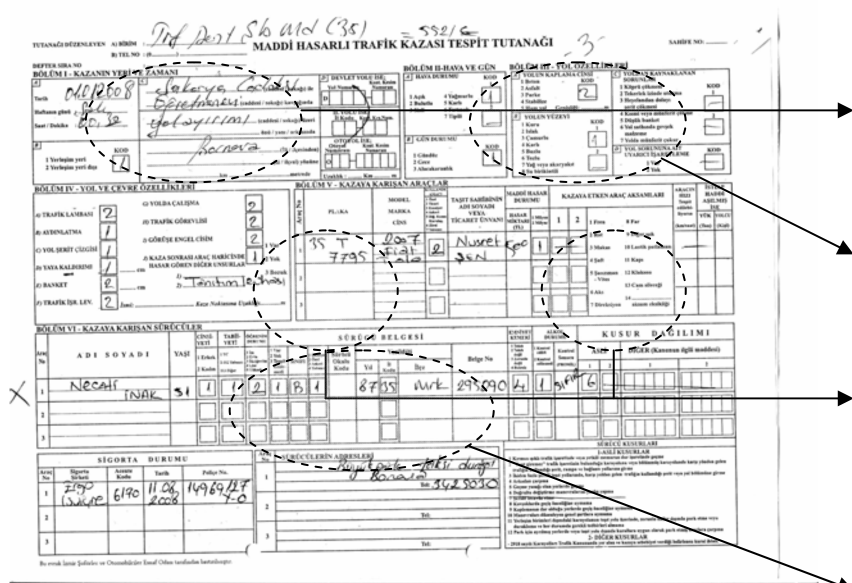
Data contamination is another problem when unsuitable statistical evaluation techniques are used. For success in traffic safety, precautionary measures which are dependent upon the analysis of TARs must be exactly defined. (Erdogan et al. 2008) For example, Miaou and Lum (1993) later used the same data to compare the results of ordinary least squares models with Poisson count models, and found the former severely lacks. “This is to be expected, given the nature of the data” (Kweon and Kockelman, 2004). The nature of the accident data is *erroneous* and also contributes to the difficulty of significant causality of factors; thus no clear modeling or pattern can be captured (Milton et al. 1998).

ACCIDENT DATA MANAGEMENT IN IZMIR CITY

Prior to January 2009, the reporting system in the Turkish case has two different forms: One of them is for the material-damage accidents with no fatalities and injuries on involved parties. The other form is used when there are fatalities and/or injuries in the accident. If a person dies after the accident (at the hospital), it is reported as the general statistics but not as the police report, which causes loss of data safety analysis. In the new system, the parties only fill out a different form together for the insurance companies, requiring no presence of the police, which are later to be sent to TRAMER (Traffic Insurance Center). Traffic police only arrives at the accident lieu; if the parties cannot agree on the accident by themselves; if public property is damaged; if any driver with alcohol; and/or, any hit-and-run situation takes place, etc. In this type of reporting, there may be the risk of erroneous information, as far as obtained from the insurance companies, due to the fact that reality skews in agreement between the parties. But, TAR’s are not adequate for spatial analyses (Erdogan et al. 2008).

INSTITUTIONAL and ORGANIZATIONAL SOLUTIONS

The way data are collected can either be through filling out the TAR forms when accidents occur or using other technological means as video detection systems that can retro-track the conditions of the moment the accident happens. The TAR Form has many problems on its own account. As shown in the Fig 3, the arrangement of the report form used in Izmir has many inappropriate applications explained as in the boxes attached to the figure. Of all, the arrangement of questions is not user-friendly and readable as well as recognizable.



Problem type 1 (crash ID): The addresses are not adequate for research. There are no coordinates given in physically damaged accidents. The address are indiscriminate such as in front of number 9 or worse: in front of the

Problem type 2 (weather & road charac.): No detailed information. One cannot know exact problem unless there is another report telling about physical conditions of the road, which does not exist.

Problem type 3 (vehicle type & env'al fact's): type of vehicle is not definite (bus, car, minivan, etc.). Only brand is given and the researcher is expected to know the which veh. category they fall into. Env'al cond's are evaluated highly subjectively.

General: TAR does not allow enough data on neither the accident nor the physical environment. Available technology is not used in material-damage accidents. There are many obscurities for future manipulation and data contamination. Culpability doesn't explain real factors causing the accident.Crash type is not coded.

Problem type 4 (driver info): There is only data about the drivers but not the passengers. How they had the accident are not asked to them.

Fig 3. A Filled-out sample accident report form used in Turkey and the basic flaws

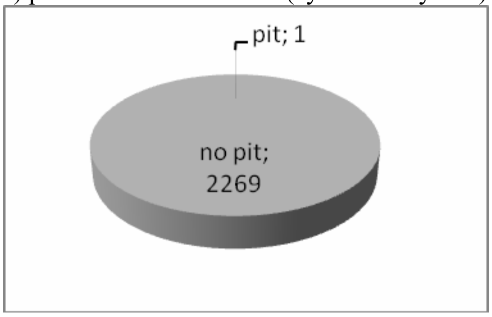
For the transparency and coordination issues in Izmir, technological solutions are available; through mutual consensus between the related organizations (police dept. local government, etc.), a software may diffuse all relevant information through internet, or wireless, among them laterally when the data are coded electronically. Since data gathering at accident lieu are erroneous and time consuming, the data coding needs to be digital and in easily readable format. "Instead of a classic textual reporting system, GPS devices must be integrated in a new coding system for geo-referencing of the accident. Hence, many systematical errors will be automatically eliminated and spatial precision will be increased." (Erdogan et al. 2008).

DATA COLLECTION SOLUTIONS

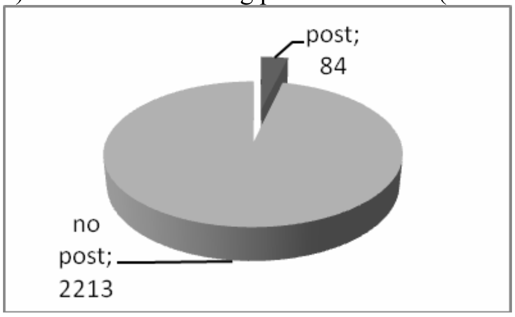
In the accident statistics, the accident responsibility diffuses such as; vehicle itself is 1%, driver is 92%, passenger is 1%, road infrastructure is 2%, and pedestrian is 5% of all the accidents (Yumrukcali 1998). But, such a statement is far from the reality: Usually, there is a known tendency that the courts do not find a state institution guilty but the persons involved, even if some infrastructure failures are observed at the crash site. The police usually worries about opening the clogged traffic, ignoring the intervening infrastructure conditions. Some data are entered without care as "default" values. Such parameters were identified from the field surveys where especially such data items which coincide with similar parameters of TAR form are obscure which might have caused high rates of under-reporting.

We collected around 3000 TAR data for nine pilot streets in urban Izmir area (accident-dense streets); the data are recorded by officials. As a method, either (a) many suspicious data items are contrasted if they tend to have under-reporting problem with those of the field surveys on the streets, or (b) checked whether the value frequency is too low. As a result, some under-reportings were observed via the frequencies of the level values. The alleged under-reporting in those parameters is verified that there are rare data (only one or two) for some levels, as observed clearly in Fig 4.

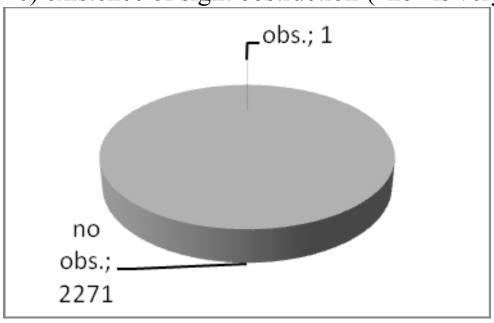
a) pit on road surface (“yes” is very few)



b) existence of warning post about road (“no” is very few)



c) existence of sight obstruction (“no” is very few)



d) existence of road construction(“yes” is very few)

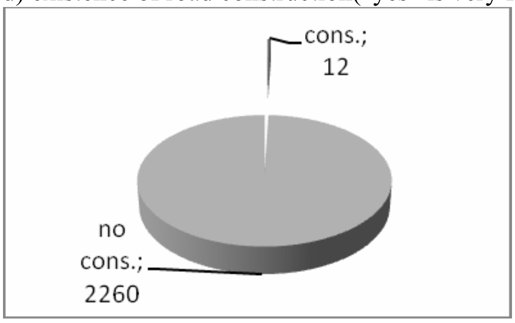


Fig 4. Examples to some under-reported parameters (from Izmir’s Pilot Streets)

For such “pits on road surface” or “warning signs”, GIS maps can be updated through road surface detectors and the places of road warning signs, associating with accident sites. Similarly, for “existence of sight obstruction”, the reporter may not clearly see the significance of effects of clear vision while driving. In TAR value distributions, there is almost only one value checked (ie, under-reporting is too high) for sight obstruction reporting, which may not be actually true as verified by the field surveys conducted a year later that actually there are at least sight obstruction problems in two streets. There are similar inconsistencies between the two data sources for the ‘existence of traffic signals’, ‘clear lane markings’, ‘existence of pits on road surface’. There are obscurities in defining horizontal and vertical geometries, roadside parking levels, distances between junctions, and land uses. GIS data analyses need to be consulted for such site-specific queries. Some parameters as frequency of passing, speed variations, frequency of stops, heavy loadings, U-turns, etc. that adversely affect traffic flow, road surface imperfections can be detected by video camera, and image processor algorithms for the time and place of accidents. Post-event analyses are probable. Also, land use parameters can be added for they might have influence on driving.

As of the field surveys conducted by six observers for each street for two seasons: Both seasonal averages are taken and then two seasons’ average values are aggregated into a single categorical value, a unique value per street per parameter. Data are gathered through personal observations on road conditions (eg, for parking level on the street). Most data items are found similar with those of TAR’s values. Here, only the summary outputs and results are drawn. Among all, ‘lateral clearance through the street’, ‘clear visibility of lane marking’, the curb width’ data fields are verified from the field surveys. For the same streets, the values of the parameters differ between the TAR and the field data significantly. For example, while almost not any ‘no visible lane marking’ is entered as categorical data entry, data from the field surveys says ‘there is no visible lane markings’ for at least 2 streets (out of nine). Similarly, though it says in the TAR data that almost not any street has the lateral clearance problem, the field data report that, at least, two streets have actually no enough clearance. Also, 'vehicle overloading' is most of the time a neglected data entry.

Besides the under-reporting problem, missing parameters were observed, which all can be viewed either by videocamera surveillance and the algorithms to detect event, or by seasonal field surveys such as: (1) design speed (which was also highlighted in the literature previously), (2) horizontal geometry, (3) vertical geometry, (4) the density of pedestrians either along one side or both sides of the road, which gives pedestrian activity around the road, (5) number of the pedestrian crossings per segment (eg, 1 km), (6) the casual pedestrian crossing density, (7) the number of (adjoining) road connections from the sides (as per km), (8) distance between the major juntions (especially elevated), (9) the frequency of passings, (10) speed variations, (11) frequency of stops, alighting and boardings, (12) frequency of U-turns (which is a frequent habit in Turkish case), (13) the level of road-side parkings, (14) types of land-use, and (15) density around the street. Still, some other geographical, land-use and socio-economical data might be included for GIS analyses. The post-incident information gathered after the accident can be matched with the relevant TAR data already entered. Similarly, all other geographical (GIS) or land use data can be matched.

Among such data items, 'lighting' (which is confusing, because relevant only for night time accidents), 'any sporadical pit on the road', 'lateral clearance' (which we mean visiual blight by many commercial ads, and chaotic view of trees, bushes and wires, etc.) and 'the shoulder width' (since, the right lane occupied heavily by vehicles can be assumed as shoulder, or lane reserved for parallel parking, although it is not) need clarifications. Another most important issue is the negligence in recording the exact coordinates of the accident place, which has the vital place in geocoding of the geographic data with other data in GIS analyses. For effective, data recording electronic devices as PALMs can be used that will enable all coded data immediately into the appointed databases, without extra data entrance effort another time from the paper-coded information (classical TAR), which will also avoid the errors or manipulations encountered at data entry from paper to computers. One major contribution of using GIS is geocoding of accident locations (by spatially obtained data) and determination of black spots. GIS software also facilitates mapping and visualizing these spatial phenomena. As seen in Fig 5 explicitly (where accidents spots are mistakenly defined over the sea), mapping will provide a *clear and immediate visual impression* of the accident distributions.

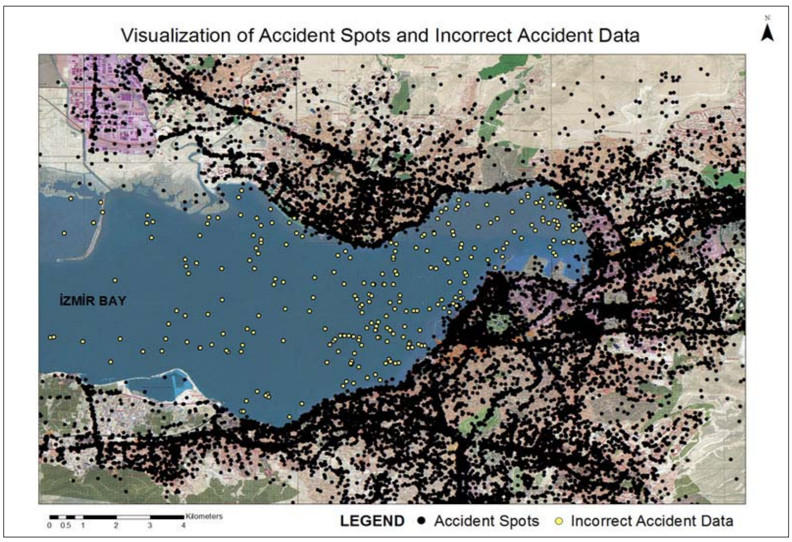


Fig. 5. Visualization of accident spots and incorrect data (Source: Duvarci et al. 2005)

CONCLUSION

There is an inevitable rise of ITS all around the world, upon the acknowledgement that in the long term both the system operators and society accrue benefits from compared to the cost of deployment. However, such systems are data-hunger for, in turn, in producing real-time traffic data, which promise better traffic control, and hence traffic safety. The safety concept should be renewed along with this new outlook.

Our study, first, reviewed various global databases and the diagnoses are derived for ITS compatibility and better data processing, and then, TAR data imperfections for Izmir case, comparing with the field surveyed data. This study showed that, due mainly to the institutional and organizational inertia in adopting new systems and technologies, a smooth transition to new technologies is quite cumbersome. These novelties promise better cost-effective data collection, transmission and evaluation, at least, in the Turkish context. This study showed that the transition into ITS-based traffic safety management can be painful. However, additional road environment and land-use parameters can be collected by video detection systems for better safety analyses since these technologies are already available.

For some unreliable TAR datafields, ITS can promise more reliable results. Also, instead of paper data reporting, online reporting (using palms) *must* be adopted for instant and direct data entry to the central database via GPRS or internet. Simple software which has the ability to eliminate mistakes and draw statistics, and has the ability to permit raw data entry may be a practical solution. This will be a time-saver process and it will require no extra labor to update data manually. Using software and algorithms for automation, more sufficient data would be available and the TAR data must overcome manipulation. A central database and a terminology dictionary openly shared by all institutions would reinstitute the transparency and automation that will put an end to the struggle to maintain administrative post. Also, this database must be consistent with international databases for global integration.

ACKNOWLEDGMENT: This study is sponsored by the Turkish Scientific and Technical Research Institute.

REFERENCES

Andrey, J "Risk Assesment", in *The Geography of Transport Systems,* (eds. J.P. Rodrigue, C. Comtois and B. Slack), New York, 2003

Bliss, T, *Implementing the Recommendations of The World Report on Road Traffic Injury Prevention* , Road Safety Taskforce Operational Guidance for World Bank Staff (Report No: Transport Note No. TN-1), April, 2004

DfT, *STATS 20 - Instructions for the Completion of Road Accident Reports*. Department for Transport (DfT)/UK, 2005

Duvarci, Y, Selvi, Ö, Çınar, A K, "A Methodology for GIS based Urban and Spatial Analysis of Traffic Accidents in Izmir", *TRODSA-2005, Traffic and Road Safety 5th Congress*, Gazi University, Ankara, 2005

Elliman, R K et al, "Proposing a framework for pan-European transparent and independent road accident investigation", Association for European Transport and Contributors, 2007, pp.1-11

Erdogan, S, Yilmaz, I, Baybura, T, Gullu, M, "Information Systems Aided Traffic Accident Analysis System Case Study: City of Afyonkarahisar", *Accident Analysis and Prevention*, 40, 2008, pp. 174-181.

ERSO, In-depth Accident Causation Data Study Methodology Development Report, *European Road Safety Observatory (ERSO)*, 2005

Garrison, W L and Ward, J D, *Tomorrow's Transportation: Changing Cities, Economies and Lives*, Artech House, Boston, 2000

Ghosh, S and Lee, T, *Intelligent Transportation Systems*, CRC Press, London, 2005

Grabowski, M, You, Z, Zhou, Z, Song, H, Steward, M, Steward, B, "Human and organizational error data challenges in complex, large-scale systems", *Safety Science*, 47, 2009, pp. 1185-1194

Griffin, G E, "Life and Health Assurance", *Journal of Water Pollution Control Federation*, 40, No. 7, 1968, pp. 1292-1297

Gwilliam, K, *Cities on The Move: A World Urban Transport Strategy Review*, The International Bank for Reconstruction and Development, Washington D.C., 2002

Hasseea, R, "A GIS Based System for Reducing Road Accidents", Association for European Transport, 2003

Jarvis, J and Kamal, S, "Crash Data System-A New-generation software product approach and a move to improved national systems", *in 4th IRTAD Conf: Road Safety Data*, (Seoul, 16-17 Sept. 2009), pp. 454-459

Khan, M A, Al Kathairi, A S, Grib, A M, "A GIS based traffic accident data collection, referencing and analysis framework for Abu Dhabi" *In Proceeding Codatu XI): Towards More Attractive Urban Transportation* (Bucharest, 2004), Association CODATU, France

Kweon, Y J and Kockelman, K M "Spatially Dissaggregate Panel Models of Crash and Injury Counts: The Effect of Speed Limits and Design", in *Annual Meeting of Transportation Research Board*, (Washington D.C., 2004)

Lee, S B, Taisik, L, Kim, H J, Lee, Y K, "Development of Accidents Prediction Model with Intelligent System Theory", in *Computational Science and Its Applications-ICCSA*, v. 3481 (Berlin/Heidelberg, 2005), pp: 880-888

Miaou, S P and Lum, H, "Modeling vehicle accidents and highway geometric design relationships", *Accident Analysis and Prevention* 25 (6), 1993, pp. 689–709

Milton, J and Mannering, F, "The Relationship Among Highway Geometrics, Traffic-Related Elements and Motor-Vehicle Accident Frequencies", *Transportation* 25, 1998, pp. 395-413

Nordbakke, S, "High Accident Risk among Immigrants in Norway", *Nordic Road and Transport Research*, Oslo, 1, 2009, p.27

PENDANT, General Data Analysis (Appendix 1.), Pan-European Co-ordinated Accident and Injury Databases, 17 Nov. 2006

Rygh, K, "Accident Investigations-Meeting the Challenge of New Technology", *Constituents of Modern System Safety Thinking*, London, 2005, pp. 93-108

RSMS flier, 2009, Available at http://www.ibsplc.com

SafetyNet, Annual Statistical Report (workpackage 1, Task 3), SafetyNet: Building the European Road Safety Observatory, 31 Oct. 2008, Available at http://www.erso.eu

Sampson, E, "ITS Action Plan", *Thinking Highways* 4, No.3, Sept/Oct, 2009, pp. 18-22.

Sohn, S Y and Shin, H, "Pattern recognition for road traffic accident severity in Korea", *Ergonomic* 44 (1), 2001, pp. 107-117

Tiglaco, N C C, "Development of Traffic Accident Information System using Geographic Information System (GIS)", in *Australasian College of Road Safety Conference Proocedings* (Australia, 1998)

Williams, D and Poulovassilis, A, "Combining Information Extraction and Data Integration in the ESTEST System", in *ICSOFT 2006 CCIS* 10 (2008), pp. 279–292

Yannis, G, Evgenikos, P, Chaziris, A. "A Common road accident data framework in Europe", in 4th IRTAD Conf: Road Safety Data, (Seoul, 16-17 Sept. 2009), pp. 89-98