CETRA 2010 17–18 May 2010, Opatija, Croatia
First International Conference on Road and Rail Infrastructure

CONTINGENCY PLANS IN URBAN MOBILITY SYSTEMS

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Abstract

This paper presents a view of urban mobility systems (UMS) behaviour in contingency scenarios and explores the possibility of Belo Horizonte's Contingency Plan replication for the case of Lisbon's UMS. The results of this exercise are presented along with the suggestion of mitigation and preventive measures to be applied for this specific case. Moreover, a normative set for contingency plans formed by four main fields of action is proposed to be applied to any urban mobility system.

Keywords: Contingency Plan, Urban Mobility System, normative set, emergency

1 Introduction

Great dimension emergency events have been the focus of prevention planning due to their economic impact and possible high causalities. Still, recent studies have shown that the economic impact of frequent small incidents can surpass those of a big emergency. Due to these and other indirect impacts, more attention has been paid to Contingency Plans in Urban Mobility Systems (UMS).
This paper presents a view of UMS and their behaviour in contingency scenarios. Belo Horizonte's Contingency Plan is portrait as an example that was used as a base for Lisbon's UMS case study. The results of this exercise are presented, along with the suggestion of preventive and mitigation measures to be applied. As a conclusion for this paper, it is proposed a Contingency Plan normative set, with a flexible implementation scope.

2 Urban Mobility Systems in contingency scenarios

A UMS is a structured and coordinated set of modes, services and infrastructures which guaranties the movement of people and goods. It is composed by several elements, some physical/ material, others organisational/ institutional and also some logical. It plays a key role in the competitiveness and development of a city, being part of its urban system.
The concept of UMS has a holistic approach, where each transportation mode is no longer seen separately, but as part of a multimodal solution. This offers the UMS a certain degree of active redundancy, which in turns reflects in a higher *resilience*, i.e., a greater ability to accommodate and adapt to disturbances, regaining normality in a faster and smother way [1][2].
Frequently the UMS is impacted by *events* that can produce a disturbance in its performance. When these events cause, directly or indirectly, a degradation of the serviceability of an arch/ route/ network they are called *incidents* [3]. Events are associated with a certain *risk*, which is perceived as a combination of probability of the event occurs and the possible negative impacts resulting from it [3]. Risk analysis and management is also a developing subject which aims to treat, monitor and review existing risks, with the greatest economic return possible [4]. The risk assessment process is made of the i) establishment of context, ii) hazards

identification, iii) risk analysis and iv) risk assessment. This method can be aided by the construction of a risk matrix, though its construction may reveal to be a very complex process [3]. The way as an UMS responds to an event is greatly impacted by its user behaviour, which is the hardest input to predict. Several factors can influence it and it has been noticed that users more exposed to incidents have a quicker response [5]. Also, the type of response can be influenced by the available information: users prefer reliable routes as such perceived due to the available information and its trustworthiness [6] or from their previous experience [7]. It is necessary to prepare the information content, the location where it will be displayed and the time when it will be released, in order to avoid negative effects [8][9].

3 Contingency plans

International Strategy for Disaster Reduction – UN/ ISDR [10] defines *Contingency Planning* as a management *process* which analyses potential events or emerging situations and set previous agreements with other entities in order to prepare for a possible response. Emergencies and contingencies are difficult to define and to differentiate between each other.
From the different sources consulted, the Portuguese Civil Protection definition was selected due to the context of this work and because it follows the essence of the other definitions too. It defines *emergency* as a noticeably unexpected event with human (lives), physical (properties) or health / security risks and demands for an also special coordinated response. In the absence of an isolated definition for contingency, a *contingency situation* is presented as one where it is needed to adopt preventive measures and or other special reaction measures, not mobilized at municipal level, upon the occurrence of a serious accident or catastrophe. It also presents two approaches to Contingency Plans, where it is either seen as the same as the Emergency Plan or a part of it, but both consider it to have a set of actions and procedures to face an abnormal event. Such a Plan should act in 3 areas: i) Identification and localization of incidents; ii) Organized and fast response to the incident to reset normality; iii) Evaluation/ Assessment of each situation and implementation of improvements for future responses.
Meyer [11] analyses three case-studies (NY, Boston and Dallas/ Fort Worth) and concludes that the anticipated existence of a crises increases interest and motivation of the stakeholders and allows setting a work deadline. On the other side, uncertainty about the occurrence leads to more obstacles being presented from different intervenient, with the consequent increase of complexity and duration of the planning process.
The author also points out the main two differences between disasters and mobility system disruptions: the amount of warning time available for the preparations and activation of a response and the political atmosphere which may surround transportation services interruptions. Moreover it is important to remember that these situations may represent unique opportunities to implement innovative measures and procedures which, otherwise, would take too long to be adopted or would need to go through a long approval process.

4 Belo Horizonte case

The Contingency Plan of Belo Horizonte [12], the sixth state capital of Brazil, was developed in 2008. It aims to manage contingency situations and is made up of two phases: an initial planning phase and a latter operational phase. The planning phase includes the diagnosis process and defines concepts related with the characterisation of contingencies, a new spatial division for the city with the creation of the operational security units – OSU in order to better respond to the needs of the management process, the organisation of a basic team of contingency reaction and a communication plan towards the users. The operational phase defines all needed procedures to the contingency response and their monitoring.
The main concept to be defined in the *planning phase* is the severity level of contingencies, which reflects both the magnitude of the event and the vulnerability of the mobility system in

the OSU where the event has occurred. The contingency magnitude is classified using a matrix that combine the hour of the event (peak or off-peak), whether there is a need of additional means to answer the event, the extension of the road block (if any) and the need to remove possible obstacles. The OSU vulnerability is attributed by experienced BHTRANS technicians and reflects the flow/capacity ratio. Once the magnitude of the contingency and the vulnerability of the unit are known, the severity degree is obtained by matching this information in a matrix.
The *operational phase* is composed by three sub-phases: declaration of crisis, activation of the contingency plan and results monitoring. Declaring the state of crisis consists on defining a set of actions to be followed by the transportation agency in order to detect, confirm and evaluate the contingency, determining its severity level and activate the contingency alert system. This activation can take place in different sequences depending on the severity level of the contingency and how it evolves. The level of alert does not reflect the seriousness of the contingency – that is done by the severity level – but the status of the contingency process in face of the severity of the situation.
After the declaration of crisis the response procedures are activated in three steps: articulation of actions, logistic organisation and traffic detours and return to normality. The first step concerns the definition of actions to trigger other institutions and the communication with the users. Next the basic response teams are redefined and all the needed equipments requested. The last step defines operational actions and traffic detours with all involved organisations.
Monitoring the results consists of evaluating the implemented actions during the contingency response, done in such a way that all involved parties might evaluate their own performance and propose improvements to the contingency management process. This is done through a set of key performance indicators, collected in monitoring form by the field coordinator.
Belo Horizonte plan also presents recommendations for the future, such as the creation of an information system supported by GIS, the use of radio as an information channel for the citizens and education and awareness campaigns. It also suggests an evaluation and assessment of the mobility network performance, the creation of an inter-institutional group responsible for the plan monitoring and, finally, the elaboration of a training plan involving different agencies to promote joint activity.

5 Case study: Lisbon's Urban Mobility System

As a starting point and to test the applicability of Belo Horizonte's contingency plan, initially it was thought of reproducing its methodology to the city Lisbon. Due to unavailability of all the information needed to fully repeat the planning phase of the process – specifically contingency and OSU characterisation – this work focus only in testing aspects related with the institutional relations and communication with different stakeholders, including users. As a result of the limitations encountered in the first phase, the operational phase was not possible to replicate. Based on the recommendations in Belo Horizonte's work and in different reports from Lisbon-based organisations, a set of preventing and mitigating measures was established for Lisbon.

5.1 Lisbon's UMS characterisation

Lisbon Metropolitan Area (LMA) has over 2.5 million inhabitants, but the city itself has around 720 thousand (forecast used in the current revision of the Municipal Director Plan). Their travel patterns reflect that, in 2001, 41% of non-residents used individual transportation (IT) and 58% use collective transportation (CT), contrasting with 37% of residents using IT, 42% using CT and 21% using CT and walking [13]. The ratio of IT use by non-residents increases with their home distance to Lisbon, and the two biggest factors for this choice are the lower travel time and the low attractively of CT in the home area.

IT and CT road movements are ensured by a road network divided into four levels: structural, main distribution, secondary distribution and proximity and local access. It provides a good spatial coverage to most of the city, except from some hills, Monsanto area and some poor consolidated urban peripheral areas.
Suburban transportation is guaranteed by the train and bus service, connecting Lisbon with suburban areas at metropolitan and even district level. Urban transportation is partially provided by a subway service (Metropolitano de Lisboa) with four lines with 37.7km in 2007 responsible for the transportation of almost 850 million passengers × km. Most of the current lines match the main service axis and the most important subway stations correspond to the main points in the service axis of the city and/ or interface stations with subway line intersection and or multimodality. Integrated with it is an extensive network of nearly 90 bus lines and 5 tram lines operated by Carris, responsible for transporting over 225 million passengers per year. To complement Metro and Carris networks, Lisbon also has 4400 licensed taxis which transport about 4 million passengers per month.

5.1.1 Information services and UMS stakeholders

Transportation networks are just a part of the Lisbon's UMS which also includes many other stakeholders and components. The need for a global, simplified and intermodal ticketing solution resulted in a creation of two cards one for the non frequent users (7 Colinas/Viva Viagem Card) and a monthly pass for frequent users (Lisboa Viva).
New solutions for information access have been developed as well, with "TransporLis" being a pioneer platform in Europe, integrating information on different transportation companies and a geographic information system (GIS) accessible though the internet. Other solutions are being developed, such as Goggle Transit and the new MIT-Portugal project "CityMotion". GERTRUDE (Electronic Real-Time Management for Town-Planning, Transport and the Environment) is a traffic system which monitors and manages in real time traffic flows of the road network, according to the desired conditions.
The Police Department has an Information Technology Division where the Control and Command Centre (CCC) is integrated. CCC has under its care the Emergency Line (112) and the Radio Communications working as centralised platform to gather information about the incidents and coordinate the response, including the activation of other agencies to aid in their field.
Lisbon Metropolitan Transportation Area (LMTA) is an institution with the responsibility to develop transportation policies, strategically plan the transportation system and railway and airline infrastructures needed at metropolitan level, and monitor the development of land management tools.

5.1.2 Lisbon's Plans recent development

Lisbon's Municipal Director Plan (MDP) dates from 1994, but a new one is being elaborated with greater focus on transportation. The city also has a Municipal Emergency Plan (MEP) from 1997 with a new version being prepared and an Emergency Plan for Seismic Risk (EPSR) which second version dating from 2003.
The two first documents characterise de city, define actions to take upon their activation and both foresee the constitution of a "Transportation Group" in the after-emergency period. For special events Lisbon also has a Special Emergency Plans (SPE) elaborated with all the stakeholders and tailored to the specific needs of the event following the same philosophy present on the MEP.

5.2 The Contingency Management Approach in the Lisbon UMS planning

In the plans developed for Lisbon's UMS that were studied, none treated contingencies in a clear and straightforward way. Some studies present some recommendations which can be indirectly related with contingency management. In the case of Lisbon's Mobility study, it

urges that a clarification on the hierarchy of the network be done along with an expansion of the light transportation networks from the heavy interfaces and axis of heavy transportation modes (train, subway). It also supports launching innovative and more flexible types of public transportations, and the adequacy of road collective transportation offer to the existing demand.
Lisbon's Civil Protection Exercise ("Prociv IV/ 2008") report indicates areas to be developed: coordination among different teams and agencies; better communication through fast and effective information and data sharing, the use of a common terminology and the improvement of the computer tool Integrated System of Protection and Help Operations (SIOPS, in Portuguese). It is also suggested that such exercises should be carried out periodically, interleaved with other of smaller dimension and bigger specificity as a way to improve preparedness and develop created synergies among agencies.

5.3 Preventing and mitigating measures proposal for Lisbon's UMS

Considering the Lisbon's UMS characterisation presented and the previous analysis about the contingency management approach in its planning, a group of preventing and mitigating measures are proposed. However, it is need to highlight ta«hat these measures are presented without reflecting the hierarchical importance that is needed for their implementation, nor do they share the same urgency in being implemented.
As prevention measures it is proposed the following:

a Expansion of GERTRUDE to other areas of the city (already foreseen and being implemented); development of a unique traffic management system, transversal to several institutions from the access and information data base point of view; faster and more efficient identification of disturbances in the mobility system; correction of the road network existing conflict points.
b Improvement of the available information: use of variable message signs; better public transportation network information display and access; easy identification of the streets names by car and on foot; and developed information solution for the pedestrian network.
c Exercises and trainings involving different agencies and institutions; support programs aiming the improvement of user regular behaviour, revision of the administrative and operational division of the city; and development of a sub-plan with the aim to inform non-Portuguese speaking users.

To mitigate effects it is proposed a faster identification of the UMS disturbances, a shorter response time and an improvement of available resources management. It is also recommended to improve traffic detouring by use of several alternative routes and complementarily information channels and to guaranty the accessibility of all users, including the soft modes ones.

6 Normative set

Based on the literature review and on the exercise of replicating the methodology of the Belo Horizonte's Contingency Plan for the city of Lisbon, it was possible to develop a normative set for contingency plans to be applied in any UMS. This normative set is divided into four main areas: a global vision of all stages, the involvement of all stakeholders, a unique technological solution for all and the spatial division of the city.

6.1 A global vision: the stages of the process

The process should go through all the stages, not concentrating all resources on the diagnosis and construction phases. The *initial phase* is defines goals and timeline and presents the project to all stakeholders, implementing possible input. It is followed by the *diagnosis phase*

where data is collected, treated and analysed and different agencies are contacted, resulting in the diagnosis report.
Next is the *plan production phase*, with the development of classification systems for events and spatial units, creating the alert system and procedures for each alert level, standard documents and templates and finally developing a monitoring system. The *final phase* consists of the official cooperation agreements, definition of the exercise and trainings program and the final presentation of the project, both internally (focus on operational part and active stakeholders) and externally (communication to the population and other passive stakeholders). It is important to have a simulations and training program as proficiency validation tests in all stages, within an iterative process, in order to implement all the needed adjustments before the approval of the Plan.

6.2 The involvement of all stakeholders

Involving all stakeholders in all the stages of the process is crucial and can be achieve by establishing clear goals and deadlines and an environment welcoming new ideas and suggestions. It is important to also involve the professionals who daily operate in the UMS and the indirectly involved organisations, such as soft mode users associations and the media (e.g. radio).

6.3 One city, one technological base solution (information and communication)

The development and implementation of a unique technological solution allows permanent access to the information, real-time data base update and a good interaction with the system. This creates the bases for an improved communication and information sharing between different teams within the same institution, but also between different institutions.

6.4 City space: internal organisation and external integration

Administrative and operational spatial division should lead to homogenous solutions in each zone, from the social-urbanism, the mobility system characteristics and the resources and procedures point of view. Equally important is for the system to be adopted by all the stakeholders, or at least integrated in their private divisions. From an external point of view, at metropolitan and district scopes, interaction on border zones should be analysed and created solutions with positive effects on both the city and the neighbouring areas.

7 Conclusion and future work

Lisbon UMS still needs to develop its response to incidents, but it is positive to notice there is already a conscience of the city's present reality and several developments are taking place. For the future development of the full Plan it would be beneficial to have an official context including all stakeholders and a multidisciplinary team devoted to it, due to the immensity of data and information available, much of which was not possible to access and process.
Last but not least, there is a positive evaluation of all the work done and some quality results were achieved. It's hoped that this work will support a theory and real contextualization of Lisbon and contribute to present or future projects.

References

[1] Autoridade Nacional de Protecção Civil, Glossário de Protecção Civil, March 2009. (in Portuguese)

[2] International Strategy for Disaster Reduction (UN/ ISDR), ISDR: Terminology. International Strategy for Disaster Reduction, 31st March 2004, http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm

[3] Berdica, K.: An introduction to road vulnerability: what has been done, is done and should be done, Transport Policy. 9, pp. 117-127, 2002.

[4] Nicholson, A.J., Dalziell, E.: Risk Evaluation and Management: A Road Network Reliability Study, 1st International Symposium on Transportation Network Reliability (INSTR), Pergamon, Kyoto, Japan, 2001.

[5] Schmöcker, J.D., et al.: The Impact of recovery Strategies on Platform Crowding, The Second International Symposium on Transportation Network Reliability (INSTR), Christchurch, New Zealand, 2004.

[6] Viti, F., van Zuylen, H. J.: User response to uncertainties, an imperfect information approach, The Second International Symposium on Transportation Network Reliability (INSTR), Christchurch, New Zealand, 2004.

[7] Golledge, R.G.: Defining the Criteria Used in Path Selection. (Chapter/ Paper), Timmermans, H.J.P., Ettema, D.F.: Activity-Based Approaches to Travel Analysis, Pergamon, pp. 151-169, 1997.

[8] Uno, N., Iida, Y., Kawaratani, S., Uno, M.S.: An Analysis of Potential of Providing Information on Traffic Accident to Enhance Travel Time Reliability, 1st International Symposium on Transportation Network Reliability (INSTR), Pergamon, Kyoto, Japan, 2001.

[9] Akiyama, T., Okushima, M.: Practical Information Provision Method on Urban Network with Emergency Conditions, The Second International Symposium on Transportation Network Reliability (INSTR), Christchurch, New Zealand, 2004.

[10] International Strategy for Disaster Reduction (UN/ ISDR), UNISDR - Terminology 2009, 2008, http://www.unisdr.org/eng/library/lib-terminology-eng.htm

[11] Meyer, M.: Contingency Planning for Response to Urban Transportation System Disruptions, Journal of the American Planning Associatio, 48, Vol. 4, pp. 454-465, 1982.

[12] TIS.BR, Plano de Contingência para Atuação em Casos de Paralisação no Sistema de Transportes e no Trânsito do Município de Belo Horizonte, Belo Horizonte, Brazil, 2008. (in Portuguese)

[13] TIS.PT, Lisboa: o Desafio da Mobilidade, Câmara Municipal de Lisboa, 2005. (in Portuguese)