System Dynamics Model for Simulation the most effective elimination of accidental and operational injuries at the Public Transport and prospect of using IT innovations (SBA).

ROBERTO REVETRIA
Dipartimento di Ingegneria meccanica, energetica, gestionale e dei trasporti, (DIME) University of Genoa, Via Balbi, 5-16126 Genoa, ITALY
GULNORA MIRZALIEVA, KODIRJON UMARKULOV
Department of Economics and Marketing, Namangan Institute of Engineering and Technology, 7, Kasansay St., 115160,Namangan, UZBEKISTAN
roberto.revetria@unige.it, gulnoramirzalieva@gmail.com

Abstract: This paper presents an approach to develop a system dynamics model for the evaluation of the quality of accidental and operational injuries elimination efforts at the public transport in developing countries. Capabilities of using IT innovations (Service Based Architecture) not only as a witness but as a service that could bring additional incomes to Public transport companies. This model is based on the results of a case study as well as on literature research. The short introduction of system dynamics method as well as the identified variables with their causal relationships will be presented in the sections. A recapitulation of the findings and prospects on further research conclude the paper.

Key-Words: System Dynamics; Public Transport; Accidental and Operational Injuries; Elimination Efforts Effectiveness; Service Based Architectures (SBA); Info product.

1 Introduction
Transport policy and planning reforms often have significant economic development (macroeconomic) impacts by affecting government and consumers’ expenditures, employment opportunities, resource consumption, productivity, local environmental quality, property values, affordability and wealth accumulation.

Transport economic evaluation tends to focus on certain impacts: travel time, congestion delay, vehicle operation costs and accident cost, as well as parking costs, vehicle ownership costs and incremental costs of induced travel. Transportation policy and planning decisions tend to support economic development to the degree they increase efficiency by reducing unit costs: spends per passenger-trip. Market distortions that underprice transport activity or unnecessarily reduce accessibility options can result in economically inefficient travel, in which marginal costs exceed marginal benefits.

Transportation improvements are often advocated for economic development, and there is an often debate over which transport policies best support economic objectives [1].

Road transport has always been an area in which successfully developed insurance required at high risk of accident, injury, and sometimes fatalities. But how to develop this service in the field of urban public transport in the countries with developing economy where is not subject to the perfection to the system of insurance and lack of the legislative framework.

2 The insurance of public transport is the issue of interest in Uzbekistan
In spite of the fact that public transport remains the safest mode of transportation the issue concerning the adopting the insurance of liability required by law is in a great interest in Uzbekistan.

-conclusions regarding the interpretation and policy consideration of economic impact associated with public transportation
investment. The analysis shows that public transportation investment can have significant impact on the economy, quality of life, and environment and thus represent an important public policy consideration [2].

2.1 The state of traffic and identifying the needs for insurance.

The practice shows that the growth of the welfare of ordinary citizens who are the main users of public transport, the need to ensure their consumer rights at the maximum quality and safe travel with a guaranteed insurance or alternative compensation of losses (health, property of the presence of such cases) increases. This alternative is not a rule or a traditional approach for insurance. Rather than dictated by necessity and the need to develop a centralized control of risks.

The ensuring of the appropriative design and successful implementation of the investments in transport particular in public is therefore of major importance will result prosperous affect.

Consequently, because of congestion routes, climate, traffic, and other factors increase the risk of emergency on the roads. Accordingly, there was a question about improving safety on public transport and in cases which are insurance, the loss would be covered in a timely manner, and compensation for damages (health and property) paid to affected passengers. Identified the need to improve the quality of passenger service by ensuring cash cover in case of loss (health or property). Creating a self-regulatory association itself Fund for timely response to emergencies, insurance is an alternative to public transport. With the improvement and reform of the legislative framework in this area, the fund can be used at the conclusion of insurance contracts with companies that are licensed to carry out this kind of insurance services.

Crowded streets by all means of transport and speeded traffic conditions tend to be the most hazardous factors. And the most important that the public transport should compulsory carry adequate liability insurance to cover the event of a serious mishap [3].

2.2 The determination of the equipped degree by the innovative technologies at the public transport.

Acknowledged that the public transportation of the metropolis an area with the least capacity to adapt and flexibly to make quick decisions for the reforming this system.

Being one of the largest and most populous cities in Central Asia in Tashkent with a population of more than 3 million residents, public transport per day is servicing in average approximately 1.3 million passengers.

Object of the research: “Tashkent City Trans Service” association “Toshshahartransxizmat” that includes 79 companies and enterprises of passengers’ transportation. Currently the project of Computer Aided Dispatch Control, Monitoring and Control of the routes of Public Transport is close to its graduation and in a process of putting it into practice.

3 Public transports in Uzbekistan: potential and prospects, solutions and recommendations

Accordingly to the statistics, there were 370,2 million passengers transported in 2012 by the transport means of the association and the total investments into public transport of Tashkent has already amounted to 340 million USD.

The association “Toshshahartransxizmat”:
- 49 Auto transport enterprises
- 7 Structural enterprises
- 6 Enterprises of electric transportation (trolley buses, trams)
- 5 Centers of services and repairing
- 4 Enterprises of providing spare parts and materials
- Educational center.

3.1 System Dynamics Model Creation.

System dynamics models are used to depict and analyze dynamic systems. These models were originally developed at the Massachusetts Institute of Technology in the 1950s and published in the article ‘Industrial Dynamics: A Major Breakthrough for Decision Makers’ by Jay W. Forrester in 1958. He analyzed relationships and processes in industry [4].
The system dynamics model presented in Figure 1 shows all variables influencing the elimination of accidental and operational injuries. Connections between variables depict, which ones are influencing other variables. The spearhead indicates the direction of the influence. In addition, the spearhead shows the kind of influence as a ‘+’ for proportional influence and a ‘−’ for inversely proportional influence.

**Figure 1. System Dynamics Model for Simulation the most effective elimination of accidental and operational injuries at the Public Transport.**

From the model presented in Fig.1 the cost-minimization approach means any improvement in productivity generated by the adoption of improved maintenance techniques is immediately harvested as headcount reduction. Resources for planned maintenance remain constrained. The organization continues to fight fires and focus on reactive maintenance but does so more efficiently. In contrast, implementing the new policies without downsizing frees up resources that can be reinvested in still more planned maintenance. As breakdowns fall, still more mechanics are released from fire fighting and outages to do even more planned work. Maintenance expenses drop, releasing resources that can be invested in training, parts quality, reliability engineering, planning and scheduling systems, and other activities that cut defects and breakdowns still more. Higher uptime yields more revenue and provides additional resources for still more improvement. For example, upgrading to a more durable type of pump seal improves reliability, allowing maintenance intervals to be lengthened and inventories of replacement seals to be cut. That proactive maintenance policy’ with reinvestment of the results ultimately lowers maintenance costs and boosts uptime. Immediately after implementation, however, maintenance costs increase and uptime falls. Why? It takes time for the planned work to cut the breakdown rate; in the short run the plant must bear the cost of both the repair work and the additional planned maintenance effort. Uptime falls because additional operable equipment must be taken off-line so planned maintenance can be performed. Only later, as the stock of latent defects starts to fall, does the breakdown rate drop. As it does, expenses fall and uptime rises. This worse-before-better behavior is quite common in complex systems. However, if managers do not understand why it occurs or how long it might last, they may interpret the short-run deterioration in performance as evidence that the policies don’t work and then abandon them.[5]

**Figure 2. System Dynamics Model for the evaluation the advantages of using IT(SBA) at the Public Transport.**

Due to their complexity and the high level of customization, these services are difficult to standardize, and consequently, it is somewhat difficult to evaluate their productivity. To sum up, the system dynamics model, which is shown in
Fig. 3, is not finalized, but it is a first step to decompose the service provision process and to identify the main drivers and barriers for service productivity.

Measuring the productivity of IT (SBA) services is an intricate problem because the process and the outcome of services are to a certain degree unpredictable. A first step towards finding ways to deal with the complexity of services is to uncover the main cause-effect relationships. That is an attempt to develop a general system dynamics model for the evaluation of the productivity of services. Due to the complexity and diversity services the presented model is just qualitative. Nevertheless, it offers a good starting point to select a well-balanced set of variables for measuring the productivity of services. More studies are required to improve the quality of the model and to generalize the findings [6].

### 3.2 An Emergency Fund Creation at the Association “Toshshahartransxizmat”

There is no doubt that the public transport should be insured in Uzbekistan as in many developed countries and Russian Federation; it the issue of time. The main tasks are determined as followings:

- the most important task is the creations of an emergency fund at the Association “Toshshahartransxizmat” and accumulation the financial resources for the effective functioning;
- the tariffs for the public transport means should be counted and defined the sums of reimbursements adequately;
- the “new technology” and its unit’s installation works’ expenditures including the costs of software programs should be calculated;
- the additional staff creation should be established at the Association’s emergency Fund and at the Auto transportation enterprise.

The statistics shows that the public transportation means (buses, microbuses, trams and metro) remains the most safety among the other means.

#### Table 1. The number of traffic accidents.

But it should be noted that the frequency of accidents at the electric transport, in comparison to the total number of trams is higher. (5)-sth number of tram’derailments and (2) -two burnedbuses.

The key point in the organization of the compensation buffering fund is the most efficient elimination of accidental and operational injuries at the Public Transport.

#### 3.1.1 (FDP) Fund of Disbursement for injured Passengers.

The fund is formed by taking into account the severity of the loss and the frequency of accidents [8, 9, and 10]. Thus, all the calculations are made considering the specifics of the object and the statistics of accidents on roads, fund of disbursement injured passengers (FDP) is defined as follows (on the severity of accidents):

\[
FDP = \sum C_n A_n (1 + P_r) \;
\]

(1)

Where, \( C_n \) – compensations, for every \( n \) type of losses (degree of damages) could vary from 3 to \( n \);

\( A_n \) – considered quantity of accidents, for every \( n \) (degree of damages) could vary from 3 to \( n \);

\( P_r \) – risk premium (from 5-15%) [8].

Therefore taking into the consideration all facts the compensations for the passengers damages (health and property) are planning to be covered accordingly:

Compensation will include all the expenses:

\[
C_n = Y + R_1 + R_2 + R_3 + \ldots + R_n, \;
\]

(2)

Where, \( Y \) — actual damages;
\[ R_1 \] — expenses incurred by the presenter of claims;  
\[ R_2 \] — expenses incurred by the notary with the consent of the insurer;  
\[ R_3 \] — expenses of service based architecture’s video proof;  
\[ R_n \] — other expenses.

3.2.2(FCR) Fund of Compensation for Planned and Accident Repairing of transport means.

The accidental maintenance costs in the past periods were analyzed in accordance to Table 1.

<table>
<thead>
<tr>
<th>TYPES</th>
<th>N of Transport means</th>
<th>Accidents</th>
<th>Percentage, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buses</td>
<td>2012</td>
<td>1 693</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>1 893</td>
<td>12 (2)</td>
</tr>
<tr>
<td>Microbuses</td>
<td>2012</td>
<td>425</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>425</td>
<td>4</td>
</tr>
<tr>
<td>Trams</td>
<td>2011</td>
<td>102</td>
<td>18 (6)</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>98</td>
<td>16 (2)</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>97</td>
<td>16 (5)</td>
</tr>
</tbody>
</table>

In order to determine all further necessary costs to establish the Fund all expenses, including salaries of Fund’s staff have been taken into account and planned.

In the scheme that is shown above the possibilities of using informational technology (road scan) are considered not only to prepare the necessary information for insurance companies, that is important surely in our case of study, but also data to be sold as an informational product to third parties. Since the passengers are the potential consumers of different sorts of products in this case after Data Mining by sorting, specifying, processing of additional, proper data for different uses, for instance, for the Department of statistics, furthermore the DATA would be consumed by commercial representatives: trade companies, supervisors and dealers for creating marketing strategy of sales, for improving business activity and to make the most effective decisions in several directions.

3.3 The definitions of total amount of the fund and its major activities.

Taking into account and resulting mentioned above expenditures we defined the total fund’s finances presented in the Table 2.

The calculations show the liability of passengers’ payments for every trip riches 15 sum (Uzbekistan currency) it is about $0,0068 extra of trip cost. The search proved that this extra pay for providing safety, urgent compensations for damages and more higher quality of transportation suits completely the consumers (passengers)’s requirements.

<table>
<thead>
<tr>
<th>COSTS</th>
<th>TYPES</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IT(ROADSCAN)</td>
<td>429017600</td>
<td>83840000</td>
<td>902400000</td>
</tr>
<tr>
<td></td>
<td>STAFF COSTS</td>
<td>11700000</td>
<td>35262500</td>
<td>44078125</td>
</tr>
<tr>
<td></td>
<td>INSTALLATION COSTS</td>
<td>200000</td>
<td>200000</td>
<td>300000</td>
</tr>
<tr>
<td></td>
<td>OFFICE GOODS</td>
<td>150000</td>
<td>172500</td>
<td>198375</td>
</tr>
<tr>
<td></td>
<td>FURNITURE AND EQUIPMENT</td>
<td>100000</td>
<td>150000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>ORG TECHNICS</td>
<td>200000</td>
<td>200000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>SOFTWARE</td>
<td>500000</td>
<td>500000</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>PUBLIC EXPENSES</td>
<td>200000</td>
<td>250000</td>
<td>312500</td>
</tr>
<tr>
<td></td>
<td>THE PASSENGERS LOSSES (health or property damages)</td>
<td>108000000</td>
<td>135000000</td>
<td>168750000</td>
</tr>
<tr>
<td></td>
<td>EXPENDITURES FOR THE TRANSPORT MEANS LOSSES</td>
<td>139534000</td>
<td>324000000</td>
<td>4050000000</td>
</tr>
<tr>
<td></td>
<td>OTHER EXPENSES FOR THE TRANSPORTATION IMPROVEMENT</td>
<td>0</td>
<td>983194000</td>
<td>85911850</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>4553460000</td>
<td>5236479000</td>
<td>6021950850</td>
</tr>
</tbody>
</table>

Table 2. Costs for the fund establishing.

The scheme of the traffic accident and the incorporative activity has been considered as following: when the event will be happened the installed innovation equipment immediately informs the Centre of control (Server Base) about the accident. After the collection of information for the determination of the damages and losses (including all passengers’ health faults or death) all the necessary docs and video proofs will be sent to the Association (Fund of Accidents) to be analyzed and financed.
4 Conclusions
Reforming the micro-economic environment with less flexible adaptability must be carried out in phases (step by step) and should have a peculiar interim (temporary) decisions to undertake; the study is specified in investigating the real needs of passengers at present time to be insured and has a goal to provide the recommendations for the best problem solution. We studied the specificity of the industry, identified the necessity in a phased development of the insurability of public transport, took into consideration as an example, the national public transportation association «Toshshahrtranshizmat», specified recommendations, involving modern ITs (domestic and foreign) and planned the budget of actions. In the future, this fund will serve as a basis for full implementation of insurance possibilities much more easily, that will allow maximizing the security by signing contracts with insurance companies that will be engaged in insurance services of the city's public transport.

References:
[3] 3. (MDOT)*About chartering a bus...The Michigan Department of Transportation*