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# Preserving Environment by Clean Energy Public Transport: The Case of Skopje, Macedonia

**Abstract** *Being consecutively ranked as one of the most polluted cities in the world, Skopje, the capital of Macedonia, serves as a suitable ground for introducing new, environmentally friendly public transport. The paper argues the justification of utilization of a monorail as technologically and operationally sound long-term sustainable transportation system. Replacing the current city transport based on diesel buses, with new electric driven monorails, enables sustainability, emissions reduction, and clean energy utilization. The research findings indicate that with only two suitably designed monorail lines, almost 70 % of all city public transportation needs may be covered. Such fast, reliable and modern concept will contribute to air pollution reduction in a large manner. Despite the common claim that monorail costs are unpredictable and extremely high, the study evidence some stylized facts to be reasonably consistent, yet, with a necessity for more in-depth feasibility analysis. The practical significance of the paper is that suggests valuable recommendations for projecting a monorail, as probably the only permanent solution to the slow and inefficient public transport of Skopje, and improving environmental footprint in the same time.*

**Keywords:** *Clean energy; Monorail transportation system; Environment impacts; Skopje*

## Introduction

Constant increase in urban air pollution particularly from road transport and traffic congestion is becoming a growing concern and a very delicate issue for large cities. Skopje, the capital of Macedonia, is facing with rapid use of motorized transport, which is expected to continue to increase in the coming years, potentially diminishing air quality. With more than 650,000 inhabitants and a daily inflow of almost 20,000 people, Skopje is very busy economic and administrative centre in the region, which is rapidly facing a poor air quality. In the winter of 2018, Skopje was ranked for several times at the unfavourable first place on the list of the most

polluted cities in the World. It was noted over 374 μg/m³ of $PM_{10}$ and $PM_2$ particles, being almost ten times more than the critical values, and toping other largely populated and polluted cities like Kolkata (India) 361 μg/m³, Dhaka (Bangladesh) 329 μg/m³, or Lahore (Pakistan) 232 μg/m³.

This results in life quality reduction, along with aggravated potentials for public transportation and commuting within the city. The thorny problem that Skopje encounters is the traffic organization including reduction of traffic congestions, air pollution, and parking issue. With the gradual increase of its population, it becomes very difficult to commute from one to another part of the city in easy, fast and convenient manner. The streets became too narrow to accommodate the increased number of vehicles and the duration of rush-hours sharply increased spreading almost over the whole working day. Although not being the major, traffic is definitely one of the largest air pollution factors along with industrial plants and household heating facilities.

Many countries that face similar environmental problems along with traffic jams, over-crowded traffic and poor public transportation system, firmly determined to construct type of public transportation system that completely differs than Skopje's. China, Malaysia, Korea, Russia and many more introduced the monorail (MR) technology. By following many positive world-wide examples, Skopje may have modern, ecologically friendly and long-term sustainable city transportation system. The main benefits that MR transportation structure provides are:

- It occupies less space since it is elevated above the ground, provides better traffic safety, and it is faster and more secure.
- The construction of the driving system is easy operational and straightforward for maintenance, and provides fairly cheap and simple driving.
- It is almost noiseless, environmentally highly acceptable and recommended for very densely populated central city cores, thus avoiding collisions or traffic accidents.
- It may be easily accommodated within the current transport system enabling transportation of people and goods directly in the city centre by using the so-called hide-in stations, which may be embedded in or side by the existing buildings, shopping malls or any other facilities. All new stopping stations may get added-value by gaining inter-disciplinarily purposes like shopping, meeting and/or marketing places, etc., allowing passengers to get on/off the MR above the main street and
- Keep green areas under the tracks and among pillars enables environmentally friendly footprint of the facility, so cars, people and any other traffic under the tracks may be unobstructed, leading to increase of the space usage.

This paper elaborates a project idea of introducing a new sustainable city transportation model based on light and electricity driven monorail system (Kato et al., 2004; Kuwabara et al., 2001; Nehashi, 2001). In order to meet the aim, the paper is structured in several sections. After the introductory part, the following section presents a brief overview of the literature that explores the issues of clean energy

Table 2: Typical cost for construction of Urbanaut® type monorail [million EUR/km]

| Type of activity | Type I (single line) | Type II (dual line) |
|---|---|---|
| A. Elevated Guideways, Including Foundations | 3.20 (42 %) | 5.85 (41.8 %) |
| B. Passenger Loading / Unloading Facilities (2 Stations) | 0.75 (10 %) | 1.20 (8.5 %) |
| C. Maintenance Yards & Operational Control Facility | 0.50 (7 %) | 1.00 (7.2 %) |
| D. Electrical Power, Signals, and Moving Block Control | 0.45 (6 %) | 1.00 (7.2 %) |
| E. Rolling Stock (3 Single Vehicles or 3 Car Train) | 1.80 (25 %) | 3.25 (26.8 %) |
| F. Fees & Contingencies of A, B, C, & D | 0.75 (10 %) | 1.20 (8.5 %) |
| Total cost (Intermediate Size) [million EUR/km] | 7.45 (100 %) | 13.5 (100 %) |

Source: http://www.urbanaut.com/

extension of the system with other single MR lines to other areas. In the first phase, all stations of the MR system may be well connected with other city's suburb areas that already have active bus lines. This will support utility and increase number of passengers for the MR system at least for additional 50 %, thus achieving usage rate of more than 10,000 passengers/hour. This undoubtedly will improve the feasibility of the whole project.

Therefore, the expected number of passengers may expand at approximately 65 million/year, allowing the average price of at least 1EUR per single use. However, more detailed feasibility analysis is required, leading to financial justification, whereas, everything that may result in investments return rate under 12 years, is strongly acceptable. Due to fact that construction costs for MR is heavily depended on many issues (like: total length of the system, terrain topography, location and current utilities, passengers' requirements, speed, number of stopping stations, etc.), it is necessary for the case of Skopje to make more in-depth feasibility analysis.

Furthermore, a kind of economic evaluation is the cost-effectiveness analysis, which can give strong guidance to decision-makers on what are preferable instruments or packages of instruments to use. Even more, establishing a predictable and consistent policy and regulatory framework may be very important in assisting to attract the private sector financing (Gwilliam et al., 2004: 77).

## Conclusion and recommendations

The research does not attempt to provide a detailed map applicable to solve pollution problems of Skopje, but rather to suggest framework for serious consideration for answering profound issues, like the nature of urban air pollution, pollution

sources, and available resources. Moreover, the study intends to propose some scheme in which local and central policy makers may approach to selection and implementation may occur from internationally based experiences. It places a special emphasis on how to coordinate policies across many sectors that are closely linked to the mitigation of air pollution from city urban transport, in the first line environment, transport, and energy. Greater use of public transportation offers the single most effective strategy currently available for achieving significant energy savings and environmental gains, without creating new government programs or imposing new rules on the private sector.

In this line, the study posts some valuable recommendations for developing MR as probably the only permanent solution that would improve environmental footprint of Skopje. So,

- Skopje is a "flat" city being longitudinally aligned along the river Vardar. Seven municipalities within the city (Gazi Baba, Aerodrom, Cair, Kisela Voda, Karpos, Centar and Gjorce Petrov) are located opposite to the city centre giving the opportunity for easy coverage with MR.
- Skopje has very unfavourable environment history, so investing in environmentally acceptable long-term public transport would be very useful. This might be promoted and supported by the Government, city authorities and various European environmental funds and
- Macedonia is heavily dependent on import of petroleum and natural gas, which instead of being used for transportation, may be used for electricity generation, thus enabling electrically driven MR transportation systems.

By proposing a monorail and electric powered vehicles as efficient public transportation system, Skopje may significantly reduce emissions and achieve pollution reduction. Although being defined as an expensive alternative, MR massively declines the lifecycle GHG emissions. Only with two suitably designed MR lines of about 16 km, almost 70 % of all city public transportation needs might be accommodated. Since it will be positioned above the ground level, the city will gain more green areas, parks, bicycle tracks and parking spots thus enabling environmental improvement. Yet, the proposed project requires considerable economic policy dimension that is heavily dependent on cost-benefit analysis. Hence, Skopje must design and adopt air pollution strategy appropriate to its own circumstances. Namely, environmental and ecological impacts are important, but are only one aspect of urban transport policy, vis-à-vis economic, financial, social and distributional concerns which also come into play. The various dimensions of policy impact have to be balanced in local and national political process.

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