TRAMWAY MODERNIZATION IN CENTRAL AND EASTERN EUROPEAN COUNTRIES (Keynote paper)

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Abstract: During the process of the first introduction of tramways in the period 1870 -1900 some 150 cities in Central and Eastern Europe, Russia and Ukraine settled their systems. The technological level of this systems are similar with a level of new tram systems introduced in Western Europe and USA. During the time, especially after the end of Second World War in contrast with Western European countries the mobility in public transport in CEEC continuosly growth generating unbelievable amount of 600-900 rides per inhabitant per year.
After the political changes in CEEC countries in early 1990's, significant degradation of the size of tram systems was happened. Many cities reduce the volume of its network, reduce the number of vehicles and quality of service. In order to prevent further degradation of tram systems in CEEC countries, International Union for public transport (UITP) during the Dresden Tram/LRT conference in 2004, signed the Dresden Declaration about the prevention of tram closured and intensive modernization of existing system. The tramway modernization process usually consist of following key actions:

- Infrastructure modernization (track, power supply, depots)
- Traffic Management issues (segregation, priority on intersections, accessibility, integrated fares)
- Rolling stock issues (capital refurbishment, purchase of new vehicles, energy saving. Comprehensive maintenance
- Modernization management and financing

Some of ideas in this modernization process will be presented, such as:

- Bucharest – conversion of tram line 41 into fast and realiable LRT line 41;
- Budapest – introduction of 52 m tram unit on the Grand Boulevard (transporting over mill passengers per year on line 4 and 6;
- Dresden (former Eastern European City) – moving tram track in centre of street and making joint tram/bus station platforms for easy interchange;
- Belgrade - comprehensive modernization including repositioning of tracks, priority measure and introduction of new low floor tramways;
- Warsaw and Krakow – New track modernization, rolling stock replacements with local manufacturers and introduction of energy saving vehicles (capacitors);
- Prague – Capital renewal of existing rolling stock combined with introduction of low floor vehicles, special stick for visually disabled passengers, construction of new tram sections;

Keywords: Public Transport operation, Tramway modernization, Light Rail, Central & Eastern Europe

1. INTRODUCTION

The development of tramway systems in Central and Eastern European Countries (CEEC) was initiated more than one hundred years ago. Most of the tramway systems were constructed using the highest technical standards at that time. Over the last 10-15 years most of the tramway systems were not regularly maintained within the required technical specifications for infrastructure and vehicles. There are a few main reasons for the deterioration of the condition of tramway systems in CEEC countries:

- Incoherent and unsustainable economic development with high level of recession

- Significant changes in the land use distribution (closure of industrial zones, new commercial space development)
- Unstoppable increase in individual motorisation, above any predicted level

There is no doubt that urban transport systems, especially in large cities, cannot be properly developed to meet the needs of citizens without the appropriate participation of rail-based systems. At the UITP 2004 Light Rail Transit (LRT) Conference in Dresden, participants adopted the "Dresden Declaration. The declaration proposed the key principles for tramway renewal and modernisation in CEEC. The UITP light rail community states the following policy recommendations:

- Tramways are not out-of-date and are no obstacle to transport. The many new systems established in recent years prove that existing tram systems are a solid basis for cities' development.
- Tramways are the only surface mode that is technologically capable of offering high capacity at reasonable investments and operation costs in dense areas.
- To be sustainable and attractive to investors, cities in CEEC should not close down their systems, but should maintain and modernise them.
- Modernised trams, also called light rail (LR), are not only environmentally friendly, but also offer a high quality of service to customers and provide cost-effective accessible public transport for all citizens.
- The best strategy for a city with an old tram system is to draft a political and financial transport roadmap, which bindingly states the long-term objectives for the overall transport policy.
- For the most obsolete systems, the investment priority is in infrastructure. This should include the provision of segregated right-of-way and priorities at junctions.
- Starting a pilot line is a proven method to demonstrate undisputedly the efficiency, performance and incremental development potential of modern light rail systems to politicians and the general public.
- Keeping lines open can only be ensured through high system efficiency. To this end, revenue and investment must be politically secured. At the same time, company management must be resolutely oriented towards efficiency and rationalisation.
- The management of a public transport company should be as independent as possible. Political institutions should be restricted to providing an appropriate regulatory framework and to a supervisory role, which requires the least possible interference with the daily operative work.
- In the restructuring phase at least, investments should be supported by significant public funding.
- Competition between several public transport service providers on the same route is counter-productive to efficient public transport.
- Social fares are only justified if they are properly compensated. No company is able to provide a significant part of its production free-of-charge or with strong rebates.
- Cities that have successfully transformed their trams into modern light rail systems, as well as UITP, are ready to help and transfer their knowledge and experience.

However, the modernisation of tramway systems should be regular tasks for any operator and responsible local authorities. Manny successful tramway operators in Western part of Europe performing continuous modernisation. Some of practical recommendations and experience should be directly implementable anywhere.

The modernisation process must be carefully planned and properly executed. Planning of modernisation and financing of all tramway components is closely connected. The following important issues must be considered:

- Planning must be based on realistic assumptions of the future role of tramways as a part of the whole transportation system.
- Planning must consider realistically all advantages of the tramway technology (energy, noise, pollution, etc) as well as possible disadvantages (traffic congestion, complex financing, etc).
- Financing must be effective and available in accordance with the time schedule.
- Financing must be based on the realistic assumption of the costs.
- Financing has to consider “realistic capabilities” of local suppliers and contractors.
- Financing must support ongoing tramway services and not be a generator for the prolongation of temporarily closed tramway services.
- After investment in modernisation, maintenance budget must secure sustainable operation until the next capital investment steps.

2. PLANNING AND MONITORING

The modernisation process must be carefully planned and properly executed. Planning of modernisation as well as financing of all of its components are closely connected and can’t be underestimated. The current condition of all important components of the tramway system must be assessed. For each vital part of infrastructure (such as track, points, overhead power supply system, etc.) it must be estimated how much time remains prior to unconditional replacement. In the case of an old and not properly maintained tramway system it is important to have an estimation of passenger demand after the modernisation. With better travelling speed or riding comfort additional passenger volume should be attracted.
The most important step in the modernisation strategy is to identify the key tramway performances which have to be upgraded. Performances must be defined in order to support sustainable development of the whole transportation system. In general, modernisation process will contribute in the following subjects:

- Improvement of the environmental conditions;
- Reduction of the energy consumption;
- Reduction of the transportation costs;
- Reduction of the total travel time in the transportation system;
- Reduction of cost for the construction of new roads, interchanges, garages, etc.

It is highly recommendable to adopt an incremental approach. The improvement of each performance element should be gradually determined in accordance with financial availability, available time, competitiveness with level of service offered by private cars, etc. Depending on the local “mobility” situation, a strategy should be proposed which will define the main goals of the tramway modernisation, such as:

- Increase in the average commercial speed (e.g. from 13 km/h to 19 km/h);
- Increased accessibility (e.g. from 0% to 50% level boarding in tramway vehicles);
- Improvement of the reliability and punctuality;

- Improvement of vehicle comfort;
- Reduction of the direct operating cost;
- Reduction of staff numbers.

The modernisation strategy is an iterative process with the following decision steps:

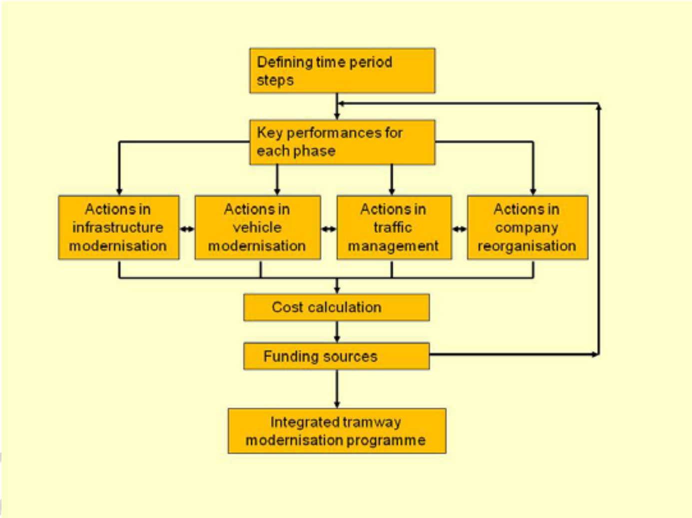

Figure 1. Tramway modernization process, typical sequence of procedures

The modernisation process is commonly executed within a general context of economic and social transition and turbulence. In such a situation, the variation in prices for major components is related to the exchange rate as well as the oscillation of the local labour costs.
It is important to have a well-structured distribution of the modernisation costs for the following main components:

- Track modernisation;
- Power supply system modernisation;
- Vehicle modernisation;
- Traffic management and control;
- Ticketing system modernisation;
- Passenger information system;
- Other costs of tramway modernisation relevant for the local situation.

Monitoring the modernization process on the day-to-day basis is important task. Every delay in execution must be analyses and proper measures activated.

3. FINANCING

Financing is an important element of the modernisation process. It is not very simple to secure financial resources in a context of reduced volume of operations, depressed fares, an unstable cash-flow situation or insufficiently motivated personnel.

Financing is an important element of the modernisation process. The following steps are recommendable:

- identifying the internal financial capabilities (PT company and/or City)
- identifying potential International Financial Organisations (IFO)

- identifying other financial resources (developers contribution, State budget for new investments and production development, advertisement, etc)

The promoters of the modernisation must consider the possibility and chance of getting funds from an International Financial Organisation (IFO). Together with the loan as a basic "product", IFO will support the borrower with free technical assistance and possibly grants for some components (e.g. ticketing system, traffic priority equipment, additional studies, etc). To be creditworthy, a public authority or company needs to fulfil three basic criteria:

- the borrower must be able to run its affairs and repay the debt (including all fees and interest), while maintaining a suitable "reserve";
- all risks must have been identified and acceptable mitigation measures put in place; and
- in case of default by the borrower, the financiers must be able to get their money back (i.e. suitable "security" must be available).

An important step in the process of securing financial support for the modernisation is to decide who will be the promoter of the modernisation: the PT Company or the Local Authority or both. There are advantages and disadvantages of each solution varying in accordance with the local situation. Once the promoter is assigned, he has to start with analytical work. Mainly, the following general questions should be actual:

- Identifying available resources from the Operator budget;
- Identifying available resources from the budget of Local Authorities related to traffic and transportation improvements;
- Possibility of the City borrowing;
- Possibility of getting loan from local banks, business partners of the PT Company or Local Authorities;
- Possibility of selling some assets belonging to the Operator or City, but not directly related to the PT operation (e.g. restaurants, hotels, office space, etc).

The first requirement is to create a reliable revenue stream. Public transport services are generally provided in a regulated market and therefore some form of licensing or contractual arrangements are usually necessary. In the case of public transport, the cornerstone will usually be a Public Service Contract (PSC). Such a PSC should normally apply for at least the duration of the financing, unless the client authority is willing to offer satisfactory compensation at the end of the contract.

Apart from the above-mentioned sources for financing modernisation there are several other sources, which might be considered as a way of financing modernisation. Initially these sources were used for the construction of new tramway and light rail systems in Western Europe. However, in near future these sources are becoming more applicable in the CEEC. The following sources of financing have to be analysed and implemented if suitable:

- In the case of tramway network extension towards a new development area (commercial space, business or residential zones) the "captured value" should be requested from developers;
- Joint development of new rolling stock should be covered with state or local budget for the development of new technologies along with a joint venture between the local company and an experienced manufacturer;

- Construction of tramway tracks, which is commonly linked with intensive labour engagement, should be subsidised with the state or local budget for generating new employment;
- Applying for a Foreign Grant for technical cooperation or joint development in the implementation of new technologies (TACIS, PHARE, etc);
- Installation of modern ticketing and fare system realised via concession for ticketing services and financed by a proportion of the realised revenue;
- Installation of modern and attractive station and stop furniture (shelters, information panels, closed CCTV, etc) financed by the income from commercial advertisement;
- Installation of passenger information systems inside the tramway vehicles (on line or recorded TV) and other advertisements inside and outside the vehicles.

In the past 15 years more than 30 tramway modernisation projects or total public transport redevelopment projects were financed with the support and assistance of an IFO. The cities like Krakow, Belgrade, Gdansk, Budapest, Sofia, etc made notable examples.

4. INFRASTRUCTURE MODERNIZATION

The bad condition of tram tracks, including here infrastructure, track and special track parts, represents a major obstacle to increasing the operating speed and the normal use of modernised trams. As a consequence, this increases the number of areas where speed is low because of the possibility of running off the rails.
The poor quality of the tram track has significant negative effects on rolling stock, through an earlier wear of bogies and wheels, which means extra money for spare parts, materials, energy and maintenance work.

The goal of the Working Group for Tramway Modernisation in CEEC is for each participant city to analyse the weaknesses and strong points of their transport systems, to learn from each other by comparing the performance of their transport systems (transport policy, transport infrastructure and supply, etc.) and to decide what can be improved and how.

The following companies agreed to provide information for Modernization Guidelines: Dresden, Warsaw, Sarajevo, Tallinn and Bucharest.

In ***Bucharest***, the tram system recorded the worst performances in the period 1988-1989 when the general feature of the tram infrastructure was a major degradation caused by length of service in operation, the inadequacy of the technical solutions available at the time of construction and the fact that only a small part of the needed rehabilitation programme had been implemented. The first step in the reconstruction/ modernisation of the infrastructure component was the project entitled “Rehabilitation of public transport in Bucharest”, with a total value of €126 million, relating to the rehabilitation of 110 km single way of tramway line and four depots in the southwest part of the city.

The 110 km single way was chosen taking into account the following criteria:
- technical status of infrastructure;
- operating data;
- status of other transport modes;
- if the area is compact and multi-functional.

All the sections proposed for modernisation use old technical solutions and the degree of wear is not the only indicator of the real situation.

Figure 2.Conditions of tram tracks in Bucharest

In ***Dresden***, 60 km of tram track, around 22% of the whole track network, experienced speed reduction. Almost all buildings belonging to the public transport operator DVD (depots, workshops and administration offices) needed to be reconstructed and could not be operated efficiently. Only two thirds of the vehicles were usable, the rest could not be repaired or were used as a spare part reserve. The passenger information system and the stop systems were unattractive and in no way adequate for being used by disabled persons.

In ***Sarajevo***, the worst performances of the tram system were recorded during the 1996-1999 period, notwithstanding the period of war (1992-1995). The general characteristic of tram infrastructure was major degradation caused by inadequate technical solutions used at the time of construction and also by the need to make changes due to the transport demand on tram lines in peak hours**.** The percentage of use of passenger seats in the direction from the narrower city centre to the outer residential areas is 50% and lower, depending on the section. The tram track is laid on concrete surface and on sleepers. Its condition is mainly very poor which slows down the vehicles. In certain sections the rails are worn out which reduces transport safety. Poor track condition also influences maintenance costs. For that reason it is necessary to implement overhauling and modernisation of the entire tramcar track.

From 1998-2000, KJKP GRAS prepared the “Strategy of public transport development up to the year 2015” anticipating modernisation of the tram mode and its gradual transformation into light-rail transport. The objective of the strategy is to offer an attractive, fast, reliable, safe, economical and comfortable surface public transport. Those projects were of vital importance for the Canton and the city and consequently they were adopted by the Cantonal Government and Assembly in 2000.

In ***Tallinn***, the year 1995 was crucial for the renovation of tramways in the Republic of Estonia because from this year, in the course of major repairs, the tram infrastructure was switched from wooden sleepers to monolithic concrete foundations. If financial resources permit all tramway junctions, tram tracks and cross roads will be reconstructed on monolithic concrete.

The railways are divided into two types according to their installation:

- Loose installation– on wooden sleepers;
- Fixed installation– in general on monolithic concrete base (renovated stretches).

However, there are more stretches of tramway which had been constructed on wooden sleepers and which had been covered with asphalt for public traffic. By 1 January 2007 the overall length of tramways on wooden sleepers was 62% and 38% was on monolithic concrete foundations.

Unfortunately for the past 45 years, due to a shortage of financial means, new tram tracks have not been built in Tallinn.

Only major renovation works have been carried out on tramways on those streets where major street renovation was also carried out.

When evaluating the condition of the rail track, the following issues need to be considered:

- date of the construction of the tramway track;
- rail brand;
- the construction type of the foundation of the rail track (on wooden sleepers, on reinforced concrete prefab bearing beams);
- the real situation of the rail track, wear at straight stretches (measurements on the rail track).

In ***Warsaw***, the upgrade plan consists of several studies; amongst them is the "Pre–feasibility Study of the tramway system upgrade in Warsaw, with an analysis of feasibility of the introduction of bidirectional trams on select routes".

The study analyses the four most important tramway routes for the transport system of the city, which do not serve corridors planned to be served by the underground.
The "Project A" refers to modernisation of 12 km (Banacha – Aleje Jerozolimskie – Gocławek route), as it transports the largest number of passengers and the tramcar runs with an operational speed of 19.5 km/h
"Project B" is another route, of around 9.3 km, in the very centre of the city, with a high number of passengers and a low mean schedule speed, running along Jana Pawla II (John Paul II) Avenue. It is the second route scheduled for modernisation.
The third route planned for modernisation, "Project C", is a tram link situated within the main East-West Route, 7.8 km, partially separated from general traffic. The lack of separation is present within the central part of the route crossing the downtown and on a bridge over the Vistula River and is the main reason for problems existing on the route.

For track modernization more then 15 diferent constructive solution were presented in UITP Modernization guidelines. In this report, only few, the most efficient are presented.

1. B.A.C. Solution (Ballast–Asphalt–Concrete) in Bucharest
This is a monolith solution and it consists of creating a compacted ballast foundation layer with its upper side covered with BAD25. Over this layer, they place a C25/30 cast-in-place concrete, with a foundation and superstructure support layer role.

The superstructure is made of Vossloh W-TRAM elastic fixing, embedded in C32/40 cast-in-place concrete. The diagram of fixings is 0.75 m, according to a layer of 1334 sets/km. Additionally, the concrete is reinforced with polypropylene fibres. The rail used: S49 UIC and NP4aS type. The depth of foundation is 0.70 m.

Figure 3. B.A.C solution in Bucharest

2. BSP49 Solution (semi-prefab double block)in Bucharest

This is a monolith solution and it consists of creating a compacted ballast foundation layer with its upper side covered with BAD25. Over this layer, they place a C25/30 cast-in-place concrete with a foundation and superstructure support layer role.

The superstructure is made of double block semi-prefab cross-spans fitted with Vossloh W14 elastic fixings, embedded in C32/40 cast-in-place concrete. The diagram of the cross-spans is 0.75 m, according to a layer of 1334 pc./km. Additionally, the concrete is reinforced with polypropylene fibres. The rail used: S49 UIC type. The depth of foundation is similar to the one for the B.A.C. solution.

Figure4. BSP 49 sollution

3. Ballast–less NBS track system (New Berlin Streetcar) in Warsaw.

NBS is popular in several German cities and is known also as a Rheda City system.

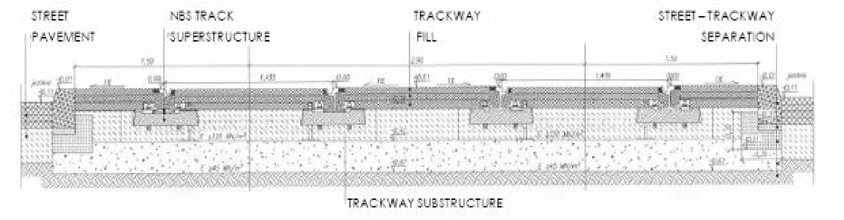

Figure 5. Ballast- less NBS system in Warsaw

The system consists of prefabricated concrete block sleepers, which are embedded in two layers of concrete and a top layer of asphalt after the rails are assembled. The rails themselves are covered with rubber straps fixed to the sides and the foot of the rail. This solution results in rails being permanently fixed to the concrete substructure, and separated (through 10 mm of rubber) from the asphalt surface of the road, which supplies a good vibration and acoustic isolation of the track way.

After setting operation in Bucharest on line 41, the following indicators can be extracted from the operation data: *average transport capacity*, which before rehabilitation was 4,000 passengers/h/route and is now 6,000 passengers/h/route (calculated for 5 passengers/m^2) and the maximum transport capacity (calculated for 6.5 passengers/m^2) is 6,500 passengers/h/route. The route became more frequented and the expectations from the feasibility study are surpassed regarding the number of the passengers. In order to satisfy the transport demand on this route it was necessary to introduce more vehicles (from 28 up to 32) and to modify the frequency of the vehicles.
The estimated cost for the rehabilitation of 110 km single track was 117 mill. €.

For route 41, which was transformed into LRV, the total cost including track, platforms, terminals, substations etc, was around €32 million. RATB estimates fare collection will increase by 10 % after each section is finished, due to the increased transport offer.

- *reduction of operating costs*
    - by 80 % for maintenance and repair of tram track and of electric network
    - by 50 % for repairing and maintenance of the tram cars
    - because the operating speed will be increased, operating staff costs will fall by 5%
- *increase of transport offer*

RATB estimates commercial speed will increase by 20 % on rehabilitated sections, which means an increase in the transport offer.

- *reduction of energy consumption*

At the end of the rehabilitation/modernisation period energy consumption will be reduced by 20%.

Figure6. Newly reconstructed tramway section in Belgrade with CAF tram

5. TRAFFIC MANAGEMENT

The efficiency of a traffic management system can be determined by analysing its capacity to control traffic flows so that congestion can be avoided even when the maximum transport capacity of a road is reached.

In some European cities, operators have achieved, at least partly, their objectives regarding transport efficiency and comfort but most cities still face traffic, noise and pollution problems. Currently, in some cities there is a considerable lack of balance between the use of public transport vehicles (only 20%) and the use of private cars (80%). As mentioned in the Guidelines, an important factor in increasing tramway attractiveness for users is the provision of a transport service that can ensure as high as possible commercial speed and better headways with high degree of regularity and punctuality. For example, on the tram line 41 in Bucharest, the introduction of segregated track led to a 4-minute reduction in the one-way trip duration which is 10% of the duration per one-way trip at that time. Following the implementation of the traffic management system, able to supports tramway operation, the one-way trip duration for trams on line 41 fell by another 16%. At the same time, thanks to this system (SPOT-UTOPIA) the vehicle headway on this route was decreased to one minute without the risk of having grouped vehicles. As result, modernisation works generated increase of 25% passengers. Better traffic management provide reduction in traffic congestion and number of accidents; increase in public transport attractiveness; increase in mobility and accessibility; etc.

The electronic ticketing system was considered as an efficient method to ensure funds for the new infrastructure and improvement of the traffic flow. Over the past years the electronic ticketing system for transport has become a necessity especially due to the need to increase public transport attractiveness. Several methods of phased development approach were discussed and analysed.

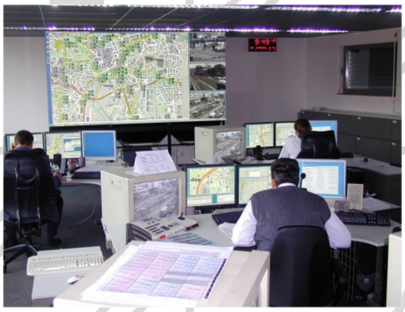

Figure 7. Brno - public transport control centre

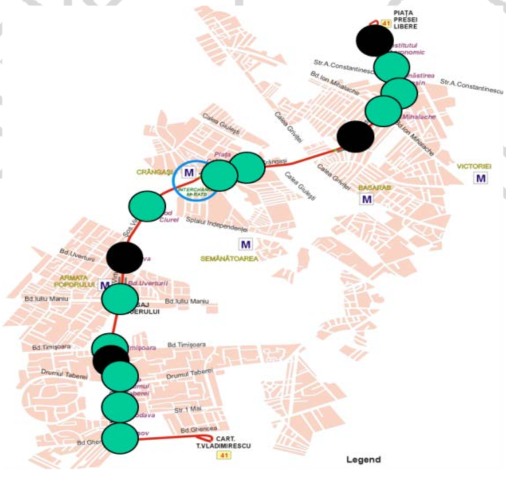

Figure8 - Bucharest - traffic light priority on the modernized LRT line 41

6. ROLLING STOCK MODERNIZATION

Modernised or new rolling stock should attract significant sympathies of the existing passengers and even more for new users. However, rolling stock needs proper quality of infrastructure and traffic management support. Without first, vehicles will be destroyed soon. Without second, they will run empty because of slow speed.
There are several ways to ensure good technical and operational conditions of the tram vehicle fleet and its renewal:

- capital refurbishment, general overhaul (without modernisation);
- vehicle modernisation (of various scopes and types);
- articulated tram made of two refurbished single cars;
- articulated tram with low-floor middle section;
- vehicle maintenance improvements;
- second-hand purchase;
- Procurement of new vehicles.

The decision to determine which activities should be carried out depends on many factors, but primarily on the available financial budget and readiness of managers and politicians to spend more money for new image of the city. It is also important to consider what production facilities could be used for these activities; the operator's own repair workshops, or those of the primary producer of the tram vehicle or the supplier.

There is a very wide spectrum of modernisation variants carried out in CEE countries and cities. The public transport operators in many cities in CEE countries have carried out tram vehicle modernisation in a number of variants. In these Guidelines two modernisation case studies are described in details. However, modernisation can never be the magic solution over the very long term, as modernisation of old rolling stock can hardly be an absolute substitute for the quality and lifetime of new vehicles. Furthermore, there are limits to modernisation: it is not possible to take the same vehicle and modernise it again and again.
Purchase of new tram cars becoming more interesting for more cities. For all transport companies, the strategic decision regarding rolling stock is a long-term decision. It is a very sophisticated process and the right decision should be based on the various aspects to be taken into consideration.

The fundamental issues are:

- financial capabilities for buying new vehicles
- life cycle costs
- adequate facilities for proper maintenance

In general new vehicles have the following advantages:

- Lower cost for electric consumption, as well as energy savings of up to 25%, recuperation energy, more effective drive as a result of advanced technology
- Less time-consuming maintenance;
- High capacity will increase service frequency (especially important on the routes where there are very high passenger flows and bottlenecks);
- High passenger safety (reliable antiskid control system, high performance brake systems);
- New car body design which expresses well the climate in the city;

- Environmentally friendly construction;
- High-quality customer service with comfortable and practical interior design, ergonomic seats, easy boarding for disabled passengers, and air-conditioned passenger compartment...;
- Noise reduction of up to 8 dB;
- Better and versatile (remote) diagnostics, which cut repair time;
- New driver cab and ergonomic control desk/work environment;
- CCTV as a security measure against violence and vandalism;
- Remote dispatching and control systems.

Comprehensive methods for procurement, commissioning and staff training are described at the end of guidelines. It may be useful for the staff in operating companies running old and conventional tramway vehicles.

Figure 9. Bucharest - modernised tramway vehicle

Figure 10. New Combino vehicle in Budapest

7. MAINTAINING SYSTEM SUSTAINABILITY

Modernizing tramway is a difficult task but even more complex tasks are to maintain tramway in a sustainable manner which will eliminate possibilities for another worsening. Doing modernisation is just the first initial frame of the film of successful and sustainable operation. In order to maintain sustainability the following actions must be done:

- Adjusting the number of staff to the highly productive equipment, traffic management measures and modernised or purchased new rolling stock

- Making medium term public service contract's with local authorities which will stabilised variations in income and provide conditions for permanent infrastructure betterment
- Maintaining attractiveness of public transport services, information system and public relation with existing and potentially new passenger

8. BENEFITS OF TRAMWAY MODERNIZATION

It not be easy to calculate direct benefits of the modernization of tramways, because tramway line should be repaired and/or modernized or even close for further operation. Detailed analyze of benefits of modernization was performed after the reconstruction of line 41 in Bucharest. This results and benefits are very common with results in other CEEC cities.
The estimated cost for the rehabilitation of 110 km single track tramway network in Bucharest are presented in the Table 2. Total value of rehabilitation was 117.9 million EUR. For route 41, which was transformed from tramway in LRT, the total cost including track, platforms, terminals, substations etc, was around 32 mill EUR.

Direct benefits

- *from transport activity*
  RATB estimates an increase of fare collection for 10 % after each section is finished, because increase of transport offer.
- *from reduction of operating costs*
  - with 80 % at maintenance and repair of tram track and of electric network
  - with 50 % for repairing and maintenance of the tram cars
- because the operating speed was increased, they observed a reduction of 5% of operating staff cost
- *the increase of transport offer*
  RATB estimates an increase of 20 % of commercial speed on rehabilitated sections which means an increase of offered transportcapacity.
- ***Reduction of energy consumption***
  At the end of the rehabilitation/modernization period the energy consumption was reduced for 20%.
- **Social benefits**

This project has significant effect on entire city life, establishing the important economy in local budget and improvement of life quality.

- *reduction of fuel consumption*
  - increasing the general traffic capacity and flow
  - increasing of public transport attractiveness
  - *saving the passengers time*

9. CONCLUSION

Now it is clear that action initiated during the UITP 2004 Dresden LRT Conference generate full success in preserving tramway system in CEEC. As a positive movement, many cities in out of CEEC like Ukraine, Russian Federation, Kazakhstan and other CIS countries intensifying their efforts in modernization of tramway systems. Nowadays, the process of modernization in CEEC receiving every day more support from local authorities, their States as well as European Union Cohesion fund. Current status of modernization in CEEC is presented in Table 3. It is visible that process is still ongoing having in mind the size of large

tramway system. For example, the total length of tramway network in Budapest and Warsaw is equal with length of new LRT system in 15 French cities. (see table 3)
The prevention of the closure of tram systems in CEEC and its modernization should be considered as a great success of UITP and its professional bodies. The all participants in modernization process are proud with their work and ready to disseminate its experience in other parts of the world.

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