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EVALUATION OF INLAND TRANSPORT INFRASTRUCTURE PROJECTS

Phased approach to transport infrastructure developments

Draft Guidelines for the phased approach to transport infrastructure projects

Note by the secretariat

At its sixteenth session, the Working Party (TRANS/WP.5/34, para. 17) asked the secretariat to consider possible ways of combining the experiences of various member countries and organizations and propose a draft set of guidelines that could assist member countries when considering to apply the phased approach to their transport infrastructure development.

The note by the secretariat represents a first attempt towards development of the Guidelines for the phased approach to transport infrastructure projects, and a starting point for discussion and additional input by the Working Party towards the finalization of the Guidelines.

Background

At its thirteenth session (in 2000), the Working Party considered the issue of a phased approach to transport infrastructure developments (TRANS/WP.5/28, paras. 25-26). At that session, the secretariat submitted a note on a phased approach (TRANS/WP.5/2000/7) which was used as the basis for discussion. The Working Party agreed that a phased strategy to transport infrastructure development, although limited to specific conditions, could play a positive role in the upgrading of some critical sections of the existing networks under the strong budgetary constraints prevalent in many member countries.

In this context, the Working Party invited the Project Central Office Project Central Office (PCO) of the UNECE Trans-European North-South Motorway (TEM) and the UNECE Trans-European Railway (TER) to undertake an analysis with a view to identifying: (i) acceptable intermediate standards and (ii) those sections in the TEM and TER transport infrastructure networks where such standards could be applied. In order to promote further investigations in the above-mentioned two areas, the Working Party also invited the UNECE TEM and UNECE TER Project Central Offices to consider the possibility of convening a Workshop on a phased strategy to transport infrastructure development and to report thereon subsequently to the secretariat. At the Working Party's fourteenth session (in 2001) both UNECE Project Central Offices transmitted the required information to the Working Party (TRANS/WP.5/2001/4).

Following the request by the Working Party, the UNECE TEM Project Central Office organized a meeting on the Motorway Stage Construction (Prague, 2002) and informed the Working Party, at its sixteenth session (in 2003), about the conclusions and recommendations of the experts participating in the meeting (TRANS/WP.5/2003/1). At the same session, following the request by the Working Party, the secretariat provided the information obtained from the Governments of Finland and Norway, as well as from the European Investment Bank (EIB), on their relevant experiences with the phased approach to transport infrastructure development (TRANS/WP.5/2003/2 and TRANS/WP.5/2003/2/Add.1/Rev.1).

Drawing mostly on the documentation mentioned above, this note by the secretariat contains a preliminary draft of the Guidelines for the phased approach to transport infrastructure projects for consideration by the Working Party.

Introduction

Infrastructure, in particular in transport, is an important element of facilitation of international trade and economic development allowing distribution of economic and other benefits and gains to populations living along the integrated infrastructure network.

Although each type of infrastructure has its own features and poses a particular challenge, developments of transport infrastructures, in particular at the Pan-European level, have led to the emergence of "interoperability", "interconnectivity" and "inter-modality" as three interrelated, multi-dimensional concepts that include both institutional as well as technical

considerations[1]. These concepts became essential elements in infrastructure planning and development at the regional and international level.

In addition, trends in international traffic and the capacity of available infrastructure have led to a growing congestion on main transport arteries and hindered further integration of transport networks at the European level. Based on analysis of the trends in the past 25 years, it has recently been observed that, while investment in transport infrastructure has decreased in 13 Western European economies, their transport intensity on average has increased. The divergence between income and transport growth was much more pronounced for freight than for passenger transport. The overall observation confirmed that the dependence of the overall economic activities on transport services has increased with a growing demand for infrastructure services[2] as the consequence.

The recent ECMT Ministerial Conference also considered Recommendations for improving national systems of transport infrastructure planning[3], and among proposals particularly relevant for consideration of the phased approach, were those concerning procedures for assessing new infrastructure.

In this context, the central place in the evaluation of any investment project was given to cost benefit analysis. A degree of caution was called for when considering the adoption of the multi-criteria methods. In cases when new infrastructure was being integrated into an existing network – in the case of a new infrastructure programme, it was recommended that the assessment should address the programme as a whole and not only a component of the project, and had to evaluate the return on a given infrastructure as additional or competing links were added.

The fact that, in certain situations, transport infrastructure was seen as a limiting factor of transport development, compounded with severe budgetary constraints, called for the increased attention of international organizations and institutions aiming at better integrating international transport networks.

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[1] ***Inter-operability*** implies that transport equipment can operate on either side of the border equally efficiently. This means common technical specifications, or at least sufficient flexibility in specifications. It also means common institutions such as licenses, insurance, waybills, computer and information systems, safety standards, and labour laws and practices. Without these features, there is the need for consignments or passengers to change carrier at the border even if the same mode is used on either side. ***Interconnectivity*** is largely, but not exclusively, a technical matter in its relationship to infrastructure. Railways require the same gauge on either side of a border to be efficient and, with electric locomotion, the same power system. Roads must be of comparable engineering quality to carry heavy trucks. But there are also operational considerations. Timetables for public modes of transportation using the integrated infrastructure network, for example, need to be coordinated across boundaries for full efficiency. The concept of ***inter-modality*** is not strictly only a trans-border concern but involves the more generic issue of being able to switch between transportation modes at minimal generalized cost (i.e., the full costs of movement including delay costs, transshipment, etc.).
Button, K.J.: "Effective Infrastructure Policies To Foster Integrated Economic Development", Third African Development Forum Addis Ababa March 2002, United Nations Economic Commission for Africa.

[2] Recent trends in Transport Infrastructure Investment, Part 1: Report, CEMT/CS(2004)4/PART 1, 2004.

[3] Recommendations for improving national systems of transport infrastructure planning, CEMT/CS(2004)5, 2004.

In the European Union, these considerations have led to the revision of TEN, identification of new infrastructure priority projects, and a new look at financing schemes for infrastructure development, with a view to eliminating bottlenecks and integrating more remote European regions with the core of the continent's transport networks.

In 1998, the Transport Infrastructure Network Assessment (TINA) exercise preceded the accession of new member countries to the European Union. The objective was to assess the infrastructure needs of the new member countries and ensure smoother integration of their transport networks into the one of the European Union. This was followed by similar infrastructure assessment studies focusing on the Balkans and South-East Europe, and other EU adjacent regions, which remained outside of the enlarged European Union (TIRS, REBIS, etc.).

The need for an efficient use of limited funds became imminent in many countries and it has also led the UN to contribute to this growing international interest in assisting national authorities to achieve higher integration of their national transport infrastructure networks with that of the continent. "A Set of Guidelines for Socio-Economic Cost Benefit Analysis of Transport Infrastructure Project Appraisal" published by the UNECE in 2003 was a product of WP.5 efforts to provide guidance, primarily but not only to CIS member countries, when their project proposals were submitted to the various financing institutions for selection and appraisal. The objective was to ensure a broadly comparable basis for alternative infrastructure projects.

The UNECE TER and TEM Project Central Offices, working together with their respective member countries, have developed the TEM Standards and Recommended Practice and Technical standards and operation parameters for the TER network. In the course of their activities, in 2000, both offices undertook an analysis with a view to identifying acceptable intermediate standards and sections of their respective transport networks where such standards could be applied.

Bearing in mind the above considerations, a phased approach could thus be viewed as a potentially viable strategy towards developing infrastructure network (whether in order to construct missing links, provide intermodal interface facilities or increase the capacity of the existing network and ensure the smooth flow of traffic where it is slowed by congestion) in situations where the budgetary constraints impose limits for the construction of the full-scale project ("all at once") as justified by a sound economic and transport analysis.

Concept of phasing

Phasing is a common approach in many economic sectors, industries (petrochemicals, energy, etc.) as well as in the provision of infrastructure services (water supply, electricity, sewage). In the transport sector, infrastructure projects are usually elements of national infrastructure development programmes that might cover the entire transport sector, several modes or a single transport mode.

A series of individual infrastructure projects are commonly considered against the available budgets, assessed and prioritized for implementation in phases over a specific period of time. In addition to budgetary constraints, other limitations (limited planning, administrative and construction capacities) call for a careful phasing of the investment over time. Selection and

ranking of individual projects is necessary in order to invest in those projects where overall benefits related to costs are greatest.

Two dimensions of phasing could be distinguished – spatial and temporal. *Spatial phasing* is the selection and prioritization of projects from an investment programme while *temporal phasing* is the staggered provision of infrastructure specifications of a specific project, such that capacity levels harmonize supply with traffic demand rising over time. In a *narrow sense*, phasing could be defined as the adaptation of design and capacity parameters of a specific project over time[4]. In spite of practical problems with the implementation of the temporal phasing of the project, it is this dimension of phasing and the approach based on it that will be used in the context of this note and Guidelines thereon.

The *purpose of the phased approach* is to break the project into smaller phases and allow time for completion and signing-off for each phase of the project. A phased approach can help authorities and financing institutions to minimize risk and ensure the incremental success of their projects.

As demonstrated by many infrastructure projects, phasing has often been applied in urban transportation systems, road and railway projects, or in cases of multimodal phasing. In rail projects, railway lines were electrified, equipped with signalling and safety systems and double tracks were built to manage rising demand. In road transport, a common option for phasing has been the construction of a 2x2 motorway with preparations for future extension to 2x3 lanes. In these cases, the first phase includes the necessary provisions for capacity extension in a following phase (land reservation, design of structures in order to accommodate additional lines in future, etc.)[5].

Selecting a phased approach

The decision to choose a phased approach for implementation in an infrastructure project has to be made on the basis of careful considerations involving, among others, *estimated savings in construction and other costs in the first phase*. At the same time, the selection of such an option should not affect the *level and the quality of service* of the given infrastructure section nor should it result in *deterioration of traffic safety* both during the intermediate phase and in the course of the delayed construction of the final infrastructure project.

Each network segment should, throughout its lifetime, operate *within the pre-established level of service*. This could be achieved by:

- immediately constructing the infrastructure with the general characteristics determined by specific standards and with capacity such as to guarantee the pre-

[4] TRANS/WP.5/2003/2/Add.1/Rev.1.

[5] One example from the EIB experience speaks of a road project in which it was recommended, in the light of traffic levels, to build only one lane per direction of the originally proposed motorway. Compared to the full motorway solution, for the initial phase, planning costs were 90%, land acquisition and preparation of the alignment 100%, structures and tunnels 65%, road surfaces 60%, etc. The economic rate of return was improved by 25% through proposing a phased approach.

established level of service (if the infrastructure in question is motorway for example, each carriageway will have a minimum of two traffic lanes in this case).

- another way of achieving the same objective could be through an initial construction stage and subsequent expansion stages in line with the expected growth in traffic demand, maintaining the level of service offered to users within the pre-established level of service (in the case of motorways, the initial construction stage should guarantee the pre-established level of service for the traffic volumes forecast in the first 10 years of motorway operations[6]).

Another criteria that should be taken into account is that the *final phase should be relatively easy to complete* and that the *total (undiscounted) costs of both the intermediate and the final phases should not be too high* in comparison to the costs of the construction of the full-fledged part of the infrastructure.

When making the decision as to whether to undertake a phased or another approach, in addition to elements on the demand side, elements such as *time saving, operation costs, accidents and environmental impacts* should be used to assess the benefits and disadvantages of a project. As cost benefit analysis is commonly applied for evaluation of transport infrastructure projects, the same analysis should also be applied to screen projects intended to be implemented in phases and their comparison with alternative complete projects.

The UNECE TEM PCO analysis showed that, in most cases, the *only feasible phased approach in road infrastructure development is construction of one carriageway* (with at least overpasses ready for both carriageways). In the case of relatively low traffic volumes in the first year of operation of motorways, the impact of this solution on traffic safety has not been significant, and construction of the second carriageway in the future was relatively easy while related traffic disturbances were limited. The analysis further showed that *other phased construction options, such as lowering the design speed in the first phase, deletion of shoulders or construction of temporary at-grade intersections, etc. do not provide substantial savings, result in high second stage costs or in increased accident rates both during the intermediate period and during the construction of the second stage*[7].

TEM Standards and Recommended Practice provide helpful insights into the type and values of acceptable intermediate infrastructure standards[8] for a phased approach. TEM Standards *do not recommend other possible phased solutions* – either one two-way (1x2) carriageway with level crossings or 2 one-way carriageways with level crossings. Aimed at being applied to the TEM network, the Standards comprise the basic elements to be taken into account by the phased motorway construction design[9].

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[6] TEM Project Central Office: "TEM Standards and Recommended Practice", Third edition, Warsaw, Poland, 2002.

[7] Several TEM member countries confirmed that they occasionally use one carriageway as a first motorway stage in particular circumstances, while other approaches (lower design speed, no shoulders) have never been used.

[8] Annex to the document TRANS/WP.5/2001/4, Levels of service for single two-lane highway (initial motorway construction stage) segments.

[9] According to TEM Standards and Recommended Practice, the stage construction could generally be considered with regard to all TEM network road sections having the annual average daily traffic in 2000 less than about 12,000 PCU/day.

TEM analysis showed that a *detailed assessment of advantages and disadvantages* of the phased approach should always be carried since each particular segment of infrastructure might have different characteristics (type of terrain, traffic volumes and composition of traffic flows, number of bridges and tunnels, number of accidents, etc.). The evidence shows that, without taking into account users' costs and costs of accidents, the *costs of construction* of only one carriageway are about 30% of the standard (dual carriageway) motorway construction costs. The total nominal costs of a phased construction are usually higher than the costs of the "all at once" approach, but real (discounted) costs are almost always much lower, depending on the time span between the first and second phase of construction and on the rate of inflation. In addition to considerations of costs and benefits in the sense of traditional cost-benefit analysis, *environmental and wider socio-economic impacts* should also be taken into consideration when considering implementation of the phased approach.

The phased approach for road infrastructure based on *construction of only one carriageway in the first phase* is acceptable when low traffic volume is expected in the first years of motorway operation. However, traffic safety requires particular attention during the first phase and should not be negatively affected by the selection of a phased approach. The layout design, for example, for the first carriageway should include appropriate sections with sufficient overtaking visibility (which is not of concern when a motorway is constructed) and should make it clear to the user that he/she is not driving on a motorway.

The study recently carried out by the Finnish Road Administration compared various implementation models for the improvement of ordinary two-lane road in stages[10]. The results of the study indicated that, in Finland, it is *worthwhile developing the long two-lane sections partly as ordinary two-lane road types and partly utilizing new road types*. In this comparison, three undivided new road types were considered in particular – an overtaking lane road equipped with a median barrier, a wide two-lane road, and an ordinary two-lane road with overtaking lane sections and a median barrier.

In the case of narrow, busy roads with poor geometry in Finland, it was noted that *overtaking lane roads equipped with median barriers could bring feasible improvements*. In particular, this solution can bring valuable benefits in traffic safety as serious head-on collisions could be avoided. Improved overtaking opportunities also enhance traffic flows. The *positioning of single overtaking lanes* in parallel or consecutively was equally effective, although implementation in parallel was found to be slightly cheaper and safety impacts were not quite as good as in the consecutive implementation model. Parallel positioning could be justified for

[10] P. Likkanen, R. Granlund and T. Peltonen: The Improvement of Main Roads in Stages – A comparison of Implementation Models with New Road Types, Helsinki 2002, Finnish Road Administration, Traffic Engineeering. The objective was to compare the cost effectiveness of the implementation models with regard to implementation and maintenance cost on the one hand and benefits like traffic safety, traffic flow, competitiveness and transport economy on the other hand. The study compared an ordinary two-way lane road type, an ordinary two-way lane with single sections for overtaking, a wide lane road, a wide shoulder road, an overtaking lane road, a narrow four-lane road and an ordinary motorway. Implementation models consisted of the improvement of the present road in 1-2 implementation phases or the building of a new road. The implementation paths were chosen so that the selected road types could be upgraded in a way that the investments made in the previous stages did not need to be dismantled.

environmental reasons or if the road section will later be upgraded to a full four lane cross section.

In cases where the existing road is wide, has a good geometry and has a satisfactory safety record, a *wide shoulder road* could bring a feasible improvement. Implementation costs in such case are moderate when compared to new road types and the impacts are positive. If, however, the traffic volume is high (8,000 vehicles or more daily) the wide lane road is considered as a better solution.

When busy ordinary two-lane roads are improved into dual-carriageway standards, it is feasible to consider *narrow four-lane roads as well as ordinary motorways*, which are clearly cheaper solutions than high standard motorways and still have almost as good safety impacts.

From the overall cost-efficiency point of view, the study concludes that, in most cases, *it is reasonable to aim directly at the final target stage*, although in some cases, for example, due to insufficient financing, it may be reasonable to choose an intermediate solution to avoid serious safety or level of service problems. In these cases, the feasibility of the implementation path must be considered from the construction-engineering point of view as well.

If *safety* of the particular infrastructure section needs to be improved, it should always be verified whether the desired level of safety could be achieved by smaller safety improvements. These improvements are usually much cheaper and typically they could involve actions like grade separated pedestrian and bicycle crossings, improvements at intersections (channelling, staggering, give-way spaces, view area improvements, etc.), road lighting with yielding poles, etc.

It should be borne in mind, however, that *cost-effectiveness is not the only or even the best indicator* for comparison of infrastructure improvements; therefore, the final decisions for the staged implementation procedure must be based on general transport policy objectives.

The same kind of principle as described above has also been used in *railway investment* in Finland. Most track sections in Finland are single tracks (only the main railway lines are two-track sections). If the volumes are insufficient to back up two track solutions, additional capacity can be achieved in a much cheaper way by constructing overtaking and passing track sections[11]. In general, taking into account the specificities of railways, similar elements will have to be taken into consideration when evaluating the feasibility of implementing the phased approach in railway transport.

When considering the various features of the phased approach and the criteria for selecting this approach in each particular infrastructure project, it is recommended that the relevant authorities further elaborate and address the following aspects:

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11 In the Helsinki Metropolitan area, commuter train traffic has increased significantly, which has led to insufficient track capacity on the existing main tracks. This capacity problem has been solved by introducing the city track concept, where additional tracks dedicated only to commuter trains have been constructed next to the main railway line. This has allowed a significant increase in commuter train supply as well as freeing capacity for long distance traffic.

- it would be desirable if a consistent phased approach to infrastructure development could be agreed upon at a regional level;
- it would be useful to have established a typical motorway cross-section within the region;
- phased construction of motorways should be considered in all cases where the present (i.e. construction starting year) annual average daily traffic (AADT) volume is less than 12,000 PCU;
- a transparent assessment and ranking based on network and scenario related cost-benefit analysis, complemented by sensitivity tests and risk analysis is recommended in all cases;
- required level should be ensured in intermediate motorway stages;
- adequate land take arrangements should be ensured at the outset of the project;
- all infrastructure structures (such as bridges and tunnels) should be built to final required parameters (height and width).
