

Transport System and Sustainable Development

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Synopsis

The economic transition of new states associating to European Union after the nineties brings the new approach to transport. This approach creates the unsuitable transport patterns with roads superseding railways in infrastructure and rapid growth individual transport presented by high number of cars. While in the beginning of the nineties the rate of road mode was around 30%, ten years after this number raised up to 70%. Expanding development of road transport has brought high-energy consumption, greenhouse pollution and traffic congestion.

Passenger and freight transport, both private and public, creates an important condition for the development of economic and social activities. The economic growth, competition and employment depend on the perfect functions of transportation system.

The contribution analyses the factors influencing activities of transport system: problem of energy, economic growth and financial questions of future development of transport system.

The economic and industrial development need not accompany a growth of production factors including the growth of energy consumption. Energy conservation, higher energy efficiency, fuel substitution and other activities in the construction and technology research aimed at these factors can result in lower level of energy consumption.

The further transport system development searches two approaches: the transport market with competition and entrepreneurial activities and the unique transport system, which integrates various transport modes. The aimed project of transport system with both, market and unique system approaches, creates the synergy effect of transport system. There are also discussed financial and investment problems. The contribution shows the synthesis transport problems and integrates technical, economic and environmental elements of transport system

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The economic transition of new states associating to European Union after the nineties brings the new approach to transport. These states, Czech Republic among them, are adopting Western Europe's approach. The adoption of this way creates the unsuitable transport patterns with roads superseding railways in infrastructure and economic substitution and recovery presenting big number of cars. While in the beginning of the nineties the rate of road mode was around 30%, ten years after this one raised up to 70%.

The attention is aimed at factors influencing activities of transport system: problem of energy, economic growth and financial questions of future development of transport system. Expanding development of road transport has brought high-energy consumption, greenhouse pollution and traffic congestion. The contribution analyses the transport system from the point of view of two approaches: market with the competition and entrepreneurial activities and project of unique transport system, which integrates various transport modes. Market and unique traffic system approaches, creates the synergy effect of transportation system. The contribution discusses also financial and investment problems. The contribution integrates technical, economic and environmental elements of transport system.

ECONOMIC GROWTH AND TRANSPORT

The economic transition of new states associating to European Union after the nineties brings the new approach to transport. These states, Czech Republic among them, are adopting Western Europe approach. The adoption of this way creates the unsuitable transport patterns with roads superseding railways in infrastructure and economic substitution and recovery presenting big number of cars. While in the beginning of the nineties the rate of road mode was around 30%, ten years after this one raised up to 70%. The following items can represent the reasons for this growth of road transport:

- Heavy-going approach of railway to market competition
- Lack of technical development
- Massive needs of investment to infrastructure and transport means
- Inability to accept changes offered by an economic environment
- Better elasticity of road transport
- Better efficiency of small and medium-sized road transport enterprises

On the other hand, the rapid development of road infrastructure and road traffic increases energy consumption, greenhouse pollution and traffic congestion.

The modernisation of railway and development of suitable road infrastructure, especially in big cities and resident areas, could improve better living standard accompanied by demands for sustainable mobility.

An important condition for the development of economic and social activities has to be considered the passenger and freight transport, both public and private. The economic growth, competition and employment depend on perfect functions of transportation system.

Every entrepreneurial activity tends to the limits influencing their further development. The current changes of economic paradigm, global economics, point out the facts that prosperity and wealth creates the growth of microeconomics. New technologies provide a great deal of this growth. In spite of these technologies, transportation is still an important segment of global economy. On the other hand, transport means demand primary energy resources for its combustion processes.

The economic and industrial development need not be accompanying a growth in production factors, including the growth of energy consumption. Energy conservation, higher energy efficiency, fuel substitution and other activities in the construction and technology research aimed at these factors can result in a lower level of energy consumption.

Energy remains an important production factor of economic growth. Energy resources must be safe and reliable, environment-friendly and will have to be sufficient for the future. None of the contemporary energy resources is close to any of these conditions.

ENERGY CONSEQUENCES

The average figures related to the important industrial sector demonstrating the demand for primary energy sources are shown in Table 1:

Table 1: Demand for primary energy sources

SECTOR	STRUCTURE [%]
Power Engineering	30
Civil Engineering	28
Transport	22
Industry	20
Total	100

Source: EU Statistics

The demand depends on the following factors: change in industrial structure, material changes and substitutions, transport changes, the development of energy technologies with the higher efficiency. These factors can influence the end energy using in sectors as shown in Table 2:

Table 2: Demand for end energy use

SECTOR	STRUCTURE [%]
Civil Engineering	40
Industry	30
Transport	30
Total	100

Source: EU Statistics

It is supposed that the structure will tend to the higher rate of energy used in transport.

Higher rates of energy consumption cause that the current primary energy resources could tend to the limited possibilities of the next exploitation. The primary energy resources are crucial for the next decision process. There is energy problem in the disproportion between countries with low and high income. The former countries want to increase their consumption. The condition of sustainable development based on a steady growth of primary resources exploitation leads to limited consumption in countries with higher income. Changes in energy production and transformation at a higher efficiency should cover the lower energy consumption.

In spite of new technologies, energy production and generation still remain based on combustion of fossil fuels. We face two problems: the environmental impacts of fossil fuels, and the possibility to replace these energy sources. Displacing fossil fuels from their current dominate position leads to a discussion of alternative sources based on the renewable energy.

If we take into account that current fossil fuels cover about 90% of the total world supply, we can have doubts about any long-term solution. Simply restriction the use of fossil fuels will generate adequate incentives to develop and use new energy sources, and will create abundant new energy technologies that do not rely on fossil fuels. But it is apparently belief. There are reasons to doubt that changing relation of prices and thereby incentives to use fossil fuels will bring forth alternation forms of energy in the amounts demanded.

DAMAGE TO ENVIRONMENT, ENERGY CONSUMPTION AND ALTERNATIVE FUELS

The combustion of fossil fuels is the main technology used to earn the energy input for transport means. The advantages and disadvantages of fossil fuels are given through the total fuel cycle: from mining to the waste management. The waste risk of combustion can be characterised through greenhouse effect, city and industrial atmospheric waste and emissions transportation.

Transport can be considered as a contributor of CO (87%), NO_x (57%), CO₂ (22%) and organic pollutants (87%), the contribution of SO₂ is limited (4%). The dioxide carbon is one of factor creating greenhouse effect. The emission of this oxide can be expressed through the following macroeconomic equation [4]:

$$CO_2 = POP * h * en * e_{CO_2} \quad (1)$$

Where CO₂ quantum of emissions [mass unit]

POP population [millions]
 h Gross Domestic Product per capita [GDP/millions]
 en energy consumption of economic system [energy unit/GDP]
 e_{CO2} quantum of dioxide carbon emissions per energy unit (carbon content)
 [mass unit/energy unit]

The emissions increase with the number of population, with growth of economic system, with high-energy consumption in economic system and with the high carbon content in fuel. The population and economic growth will cause the emissions increasing. From Equation (1) follows: the emissions decreasing can be provided by lower energy consumption and lower carbon content in fuel. To decrease the carbon content supposes to substitute the fossil fuels by fuel with low carbon content.

Transport infrastructure is an important part of transport system. The maintenance of the road network during the winter season can cause serious environmental damage. The environment can be influenced by a growing rate of transportation of hazardous freight at a higher density, intensity and speed on the road infrastructure.

The process leading to the energy saving and to the lower rate of emissions can depend on the following three basic items and with their combinations:

1. technical control and technology factors (construction and production of transport means, using of suitable fuel, the range of maintenance and repair)
2. economic conditions (market system, financial and tax approaches)
3. legislative and regulation systems (control of emissions, technical equipment and quality of fuel).

It is not possible to decrease energy consumption and to limit the emissions generation only through technical and technology development of transport means but on the other side is necessary to find new fuels, where the content of carbon is less than hydrogen.

The growth of individual cars and trucks causes problems in the city centres together with the noise and congestion. Due to world statistical figures, around the world 600 million engines are in operation with consumption of about 640 million tons of gasoline per year and 370 million tons of diesel oil per year. If we take into account these numbers, the question is: how to substitute this quantum of fossil fuels by other alternative fuels. Can these sources replace the current sources of fossil fuels? Many persons argued that these sources are available but there are technical and especially economic problems. The renewable sources are not economically competitive with fossil fuels because of the abundance of which has kept their price low. In many cases of renewable technologies are being made for economically competitive with fossil fuels technologies. The future expectation of suitable fuel for environment is hydrogen. However, it is a long way for the hydrogen economy.

The world consumption is about $500 \cdot 10^{18}$ joules and 70 - 90% of which is provided by fossil fuels. Now we need to take into account that the fossil fuels are very concentrated form of solar energy, which is stored over millions of year. The current diluted, not stored, flows of solar energy provide the renewable sources. Large current flow implies a large space and energy must be gathered over large area of land and this production factor will become a scarce resource.

These notes are only questions given to the discussion how to replace the current concentrated source of primary energy of fossil fuels providing the greenhouse effect by the new concentrated form of energy.

RAILWAY AND ROAD TRANSPORT

The structure of transport modes having participation on passenger and freight traffic (it is documented by example of Czech Republic and is given in [3]) was transferred from railway to road mode during period in nineties. The moving of traffic capacity from the railway network to the road one was started during transformation period when the central planned system was left and substituted by market oriented state (restructuralisation, change of foreign trade, forwarding processes, change in society and life style, unemployment, and the growth cars ownership). All these changes would influence the society and development of national economy.

The freight road traffic, after declination, tends to stability. The railway traffic has lower deal of total traffic capacity and freight capacity is still in moving to the road.

Passenger traffic, thanks to the growth of number cars, is more oriented to the individual transport, so that the public bus transport and passenger railway traffic have tendency to be on the low level.

For the future 15 years is supposed the number of individual cars would be around 5 million cars and individual transportation capacity will cover 80% of total traffic capacity. The change of such development must aim at harmonisation of transport market conditions as a whole. The changes will be concentrated at the two items [2, 3]:

- market liberalisation and regulation
- the implementation of economic instruments.

Transport subsystems operate in an environment consisting of various sets of relationships (life level, national and interstate economic, technological, social, ecological and political factors).

The economic and social factors of this environment depend very close to the economy of country in which the mode of transport operates. National economy usually influences the expenditure capital and operating cost and tariff policy of rail transport large enterprises. Current global environment with the rapid changes of demand influences with the high-pressure domestic economy. For this reason, the railway subsystem must operate not only in the frame of one state but also in the frame of European space. Major factors determining the role of a rail transport enterprise in the global economy are the volume of services rendered, the ratio of variable and fixed costs, transport distances, price fluctuations, labour efficiency and resulting profit up and down. A change in the demand of transport is the single most important factor causing the fluctuations in railway expenditure. The ratio of fixed and variable cost to total cost will determine the extent of the change of expenditure due to fluctuating transport demand. The fixed cost involved in operating a railway enterprise makes it difficult to adjust this type of cost in the short term to a cyclical change in traffic volume. The economy affects fixed and variable costs in that during times of normal traffic increases there will be a fall in total unit cost since fixed cost is spread over a large volume of traffic. Fixed cost will decline while variable cost will rise. During a depression the enterprise is faced with the excessive capacity when the demand is going down then total unit cost vary in accordance with the fixed to variable cost ratio.

Global economy and national changes also influence the revenue of a railway enterprise. Resulting factors are real income, price fluctuation and tariffs changes, transport distances and competition from the other modes transport. During economy, upswing the demand for and production of durable goods will upsurge relatively faster than for other goods. Durable goods fall in the higher tariff classes and railway revenue will increase more than proportionately to the volume of transport services rendered. General price increases can give rise to an increase railway transport and for this, also the revenue provided such general increases are not accompanied by an increase in tariffs. Should this occur that portion of the final price, which represents transport cost, would shrink? When general price reductions do not accompany a corresponding tariff reduction, the effect will be the opposite. Competition from alternative modes of transport influences the revenue. The social conditions are going together with the economic changes. Transport services often perform a certain social and economic functions. It means that are uneconomic for supplier but economic for the public. Socioeconomic services are those, which render to satisfy the needs of the society and to serve for its interests. Such services help to raise the living standards or can be oriented politically. Such problem is regulatory intervention.

The technological environment or factors in railway are the results of technical development. For rail transport operation the following technological systems are essential and are constantly changing propulsion systems (diesel or electric), structural systems (track, bridges tunnels), control systems (mechanical, visual, electronic, information).

PROJECT OF TRANSPORT SYSTEM

Two approaches can search the solution of transportation system [2, 3]:

1. the market system and entrepreneurial competition of many transport businesses
2. Integrated network system connects various modes of transport.

The connection and use of both, market and unique traffic system, creates the synergy effect of transport system.

The advantage of road traffic is flexibility with the transportation "door to door". The subsystem fills up the condition of synergy effect internally, but this effect causes the energy problems and damage to environment. The further problem is the competition with other traffic modes. First, we have the bad

information from the transport market because of distorted price signal coming from this market. The main reason is in incorrect structure of costs describing the transportation activities (externalities and their quantification, quality and its measure etc).

The project of suitable freight and passenger transportation using different traffic modes can substitute market problem. The market approach with the strong competition causing the growth of road traffic has been only priority way. Another way is to find better design of transport network using the modernisation of railway core activities to support the important advantages of rail. The substitute, road transport, has brought quite clear consequences: high-energy consumption, greenhouse effect, accidents, congestion and other factors influencing environment. The railway used often to call the mean of early time of last century. However, on other side its network in many cases can be the suitable partner of other traffic modes. For this reason, the future approach should be the way of cooperation of various transport modes and creation of rational transport system. A combined transport in the frame of unique transport system is an example of such cooperation.

The revitalisation and rational design of railway network have two economic consequences connected with the price system and effectiveness of investment. To create the price system means to know the cost structure. The desire is to know the generalised (society) costs as a sum of internal and external ones of transport and transportation activities. The pricing taking into account the covering of these costs must calculate with the following items [2, 3]:

1. efficiency of infrastructure use
2. effectiveness of investment put in infrastructure and its development
3. financial sources of infrastructure recovery
4. efficiency of operators' activities
5. Competition transport modes.

The marginal society costs can ensure the demand of infrastructure efficiency. However, problem is how to provide the recovery and the further infrastructure development. The compound tariff (two-part tariff) with variable and fixed parts can solve this problem. This tariff can caused the failure of competition because of better access of bigger railway operators than smaller ones.

On the one hand the pricing can be based on marginal society costs but on the other hand for allocation can be used the average cost. There are many other reasons for differentiation: fair access vs. price discrimination or the limited access and compound tariffs. If we want to use the social costs or social marginal costs, the pricing is limited by:

- problem of measurement of external costs
- complex approach to tariff (time and space)
- financial consequences (cost – benefit)
- economic fare (customers with higher and lower incomes)
- technical efficiency (subsidiaries and technical railway development)
- perfect competition (transport modes).

The railways revitalisation going ahead in Western Europe and contemporary in the Central and Eastern European Countries must solve not only organisation changes and organisation, but also the economics and operation management, the recovery and further development of railway network. These projects will demand the massive investment and financial sources. The main reasons can be as follows:

1. new countries enter EU are still under economic transformation because of convergence with economic level of advanced countries
2. previous item expresses their economic power and shortage of capital
3. State of transport infrastructure cannot be compared with advanced countries.

The presented items point out that the capital needs aimed at transport infrastructure of new associated states will be more than four times higher than within advanced countries.

The public sources are very limited. Advanced countries use for large projects also private capital. One knows the technology and method called Public Private Partnership. This method and gained experiences cannot apply in new associated countries. The state (public) support can be more moral than really expressed by finance. Private or venture capital demand a higher rate of IRR (Internal Return Rate) and short return back period of investment. Czech Republic and other new associated countries must use another approach. Global economy aimed at the development and welfare of region helps such to create the development and welfare around the world. Transport infrastructure, both road and railway, is base for

economic growth of region. If region is gradually economic, stronger, financial sources will gradually create covering and returning of transport projects investment without government support.

CONCLUSION

The scenario methods as a useful support instrument for optimal decision process can simulate the future states of transport system with the respect to the economic changes. The example of development of scenarios can be proposed and evaluated as follows:

1. scenario of transport system with the respect to macro- and micro- changes of global and national economy
2. scenario concentrating attention to change of environment (clear technologies)
3. scenario of social-economic aspects of structural changes and development of transport system.

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