

INFRASTRUCTURAL NETWORKS ON GLOBAL LEVEL

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ABSTRACT

This paper aims to give a broad overview on the development interrelations and on the social as well as the geopolitical significance of infrastructural network in global level perspective. This network is seen as the backbone of the phenomenon of globalization and explains its vital role in the simultaneous recent process, which is localization.

The infrastructural network makes a link and reduces time distance and cost distance between remote places. Via this process, they give floor for the global movements of the factors of production (labor, capital), technology, goods, services, money, information, and externalities. They offer an opportunity for the emergence of the new globalized world economy based on great worldwide connectivity.

The condition of infrastructure is a development indicator. According to infrastructural index numbers, huge spatial disparities can be experienced in the world. These inequalities emphasize the importance of the development of infrastructure all over the world. Lack of infrastructure in a great part of the world is not only a local difficulty but also a global challenge.

The article describes the general financial background of infrastructural investments and it follows that state participation would be inevitably necessary for these great-scale investment procedures directly or indirectly. However, there is not one state on a global level. Nevertheless, a couple of international actors are eager to substitute the lack of a global state in this area of responsibility. This study offers a collection and categorization of the key actors being involved in global infrastructure development.

The infrastructural development implies political benefit on each spatial level from the settlement to the international ones. On the global scene superpowers also use this kind of benefit in their geopolitical fighting.

Moreover, some infrastructural elements have global significance. Not only now but in the past also there was a great endeavor between the powers to control them. This article identifies some of these oppositions and conflicts in relation to globally important infrastructural elements.

INTRODUCTION

Raising the problem: conceptual disorder

Infrastructure is a concept which is widely used in our modern urban society in a lot of parts of the life. This makes the impression it is a simple, well-known notion. However, if we would like to find an exact, general definition we will meet that this is a very difficult task. Besides, neither making a decision on which elements belong to the infrastructure and which do not is an easy challenge. The reason of this is not the lack of information, but the proliferation of definitions and categorizations. A number of scientific branches work with infrastructure and use their special understanding of the concept and give birth to numerous approaches.

Some sources (e.g. Abonyiné, 2007; Brodorits, 2004; Varga, 2014) offer a great collection of infrastructure definitions as well as different lists of infrastructural elements. These clearly demonstrate that there is no general agreement on the meaning of the concept and a lot of various approaches exist in parallel.

The concept of infrastructure is used in a numerous scientific environment as a background for a huge number of social and economic processes. Thus it is applied in connection with lots of topics, therefore it is placed into a number of different conceptual contexts. For example, the notion is widely used in economics, in engineering, in geography, in political science, in sociology etc.

General definition of the infrastructure

If the most general definition is sought, the widely accepted elements of the definition should be identified. These generally accepted statements could be the followings in connection the infrastructure:

- (1) It is developed by societies, thus infrastructure is an artificial object.
- (2) It is a very complex system with different kind of elements, mainly consists of networks.
- (3) It makes repeated human activities cheaper and more efficient in the long run.
- (4) It influences the standard of economy, living conditions of the citizens and development possibilities of societies.'

Economic definitions generally emphasize also that:

- (5) It is not a part of the direct production, but important as a background, more precisely as a precondition of production.

Utilizing these statements we can formulate a new very general definition, which is the understanding of the infrastructure in this article. According to this...

'Infrastructure is that kind of socially improved complex network system, which is not taking part directly in the processes of economy and society. However, this network makes repeated human activities more efficient. Via this, it influences the standard of economy, living conditions of the citizens and the development possibilities of the society.'

Some definitions and lists confuse the concept infrastructure and service or tertiary sector, this is because they work with same or similar elements in a lot of contexts. It is important to emphasize that infrastructure is not equal to services as well as underline infrastructure means the material possibility for an activity, but it is not the activity itself (FLEISHER TAMÁS, 1994).

AIMS OF THE ARTICLE

One of the main aims of this scripture is to offer a certain order in the chaotic conceptual environment in connection to the infrastructure and more exactly to global infrastructural

development. Another important objective is to give a general guideline for an accurate examination of the infrastructure of different local spots in relation to the whole global infrastructural system. The article collects a couple of point of views which could be important in this kind of analyses. Moreover, it provides an explanation for the relationships between the various approaches. Finally, examples of the main global challenges are embedded in the text linked to the appropriate part of the built up conceptual system.

METHODS

The main method of this article is taking into consideration the different concepts, statements, and ideas and utilizing them to compose a new single whole system as well as describing the relationships inside this new entity. Altogether, the method of synthesis was chosen to make an order in the chaos of different approaches. Moreover, the tools of system theory¹ were very useful in the definition the relationships between the different constituent elements and building up a certain model of the conceptual system of infrastructural development. The geographical point of view is occurred to be the most significant in the article, not only because of the method of synthesis but also because the unique characteristic of the different places is kept and emphasized in the examination. They are the most typical technics in this discipline. This is reinforced by that, the development questions are placed in central position in the descriptions and examples.

INFRASTRUCTURAL DEVELOPMENT IN GLOBAL CONTEXT

Conceptual frame of infrastructural development

Figure 1. demonstrates one basic logical chain in infrastructural development. This is described in the next paragraphs and is upgraded in the next chapters.

¹ System theory: It is '...a theoretical perspective that analyzes a phenomenon seen as a whole and not as simply the sum of elementary parts. The focus is on the interactions and on the relationships between parts in order to understand an entity's organization, functioning and outcomes.' (MELE, CRISTINA et al, 2010 p. 127.)

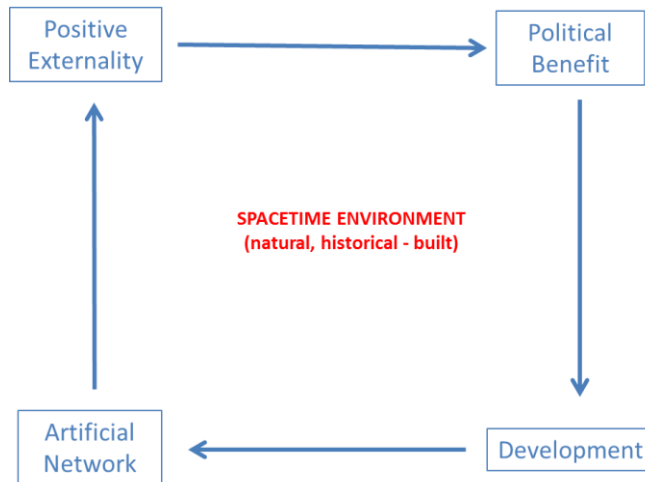


Figure 1. Conceptual frame of infrastructural development

Source: Own construction

According to the previously offered definition: infrastructure is an artificial network. Development of this network has been a historical process on each part of the world. The background of the infrastructural development is a certain spacetime environment. Infrastructure is a dynamic system which is continuously changing. It is improved and deteriorating.

This spacetime environment consists of two main parts. One of them is the natural environment, which was formed during the earth's long history. It is variable in space but more changeless in time. Another main part is the artificial environment, which was built during the human history from prehistoric times and antiquity up to the last weeks and days in our recent times. This built environment is also changeable in time and variable in space. The first one (natural) is like the theatrical scenery of the second one (historical). The natural environment is given. Humans try to continuously modify and fit it into their convenience via building infrastructural elements in order to make human activities easier (or cheaper). Thus the certain actual state of infrastructure is available in every time and in every spot in the world. New development always adapts to the natural environment and previous infrastructural elements. The spacetime environment highly influences the infrastructural development possibilities and costs of the improvement. This means a great role of sociologically understood 'path dependency'² is experienced in the progress of infrastructure. For instance,

² Path dependency: '... the notion of dependence in relation to the path taken highlights the historical dynamic that dictates that once a path is chosen, it is difficult to change it because the processes become institutionalized and are reinforced over time. It becomes increasingly difficult to reverse past institutional choices because not following the rules and standards established by previous choices

this means a pathway was constructed in the ancient times. It adapted to the natural environment, tried to find the best way then. In the recent time, the new road might be right over the same pathway, but the original reasons for its location were only in the past. This is because it was easier (cheaper) to upgrade the old one than finding a new pathway. As a conclusion, we can tell that certain state of artificial infrastructural networks could be found in all places of the Earth in all time and this is the basis of the further developments.

The motivation behind infrastructural developments is that infrastructure provides benefit for the society and economy. However, it typically does not offer a direct utility for the consumers and producers, but the contribution in the processes which offer it. The possibility of usage of infrastructure and the positive effect of the usage by other actors provide great yield indirectly. That is why we can tell that it causes positive externality. Certainly usage of infrastructure also inflicts negative effects, but this is not a motivation behind development, thus only positive things are emphasized in this frame. From the point of view of society, generally, the positive side of infrastructure overcome the negative one. Moreover, from the perspective of one single society member, the positive externality offered by the existence of the whole infrastructural system is enormous. If somebodies can join the infrastructure they will receive the advantage of the existence of the whole network, this is the so-called network externality. On the other hand, if somebodies are fully or partly excluded from the infrastructure they will have a great loss of possibilities.

Typically, the advantages of new or renewed infrastructural elements are easily perceived by the members of the societies. This is because these elements are regularly used in their daily life and they make that easier. All of this offers a great political benefit for those, who improve these infrastructural elements. It is recognized by politics. As a result, politicians often utilize the infrastructural development as a political tool. Consequently, politicians like to make this kind of decisions which distribute resources for infrastructural development for this political benefit. Nevertheless, the economic constraint has to be emphasized, they can only make this kind of decisions if the economic environment gives the possibility to do this.

If decision makers decide to allocate resources in order to develop infrastructure one more step is made in the historical process which results in the enlargement, renovation and/or modernization of the artificial network in a part of the world. Consequently at this point, we arrived back to the starting point of the frame, nevertheless, the conditions of this artificial network are not absolutely the same now than the beginning. Thus this frame demonstrates an improvement spiral, which has broader effects on its environment. These effects are going to be presented in the latter parts of the text. Before this, the driving forces of the system should be emphasized.

(exit option) generates 'costs' in terms of investment, learning, coordination and anticipation. That is why existing institutions are usually modified and not replaced despite their less than optimal nature, and institutional inertia is generated.' (Trouvé et al, 2010. p. 4.)

Inputs and outputs

Inputs and outputs provide ‘energy’ or motivation for the circulation of the spiral in the frame (Figure 2.).

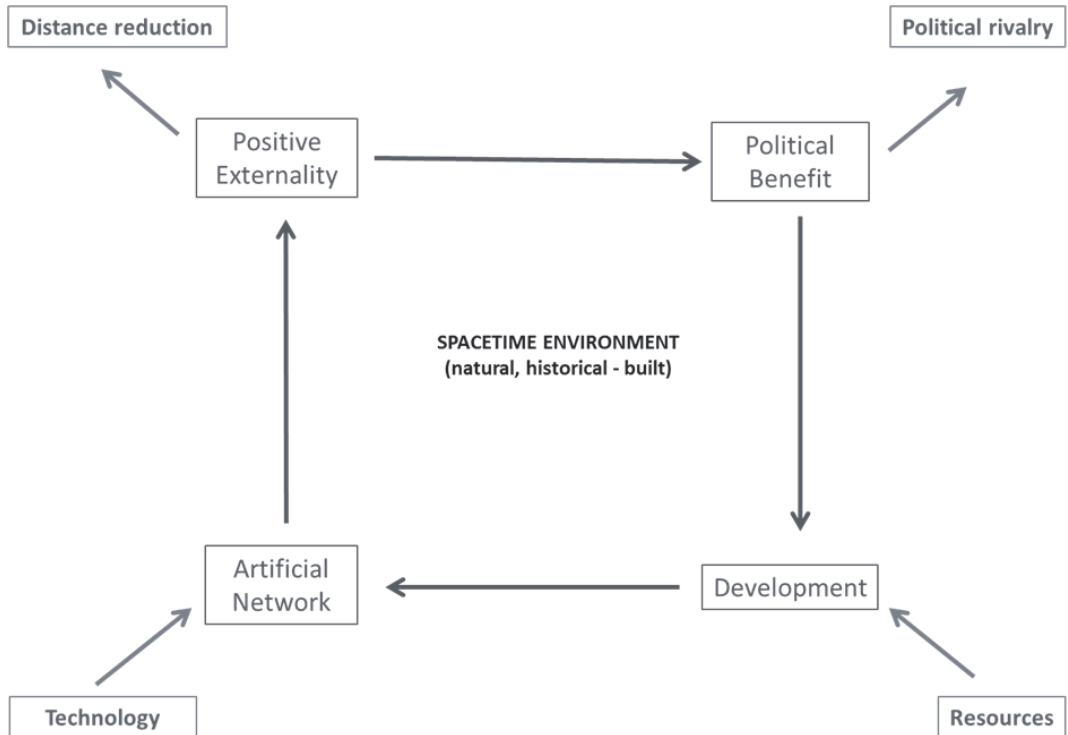


Figure 2. Inputs and outputs in the conceptual frame of infrastructural development

Source: Own construction

Two categories of the inputs are crucial in the described process. One of them is the group of factors of production, theoretically speaking they are labor, capital, land, and other natural resources. They are the resources which should be removed from other economic activities and invested in infrastructure development. As a consequence of this process, a great opportunity cost of the decisions occurs. Moreover, the scarcity of these factors of production gives limitation of infrastructural improvements.

Another category of the inputs is the technological development and new innovations which can be used in the infrastructure construction. They are able to make the existing system better or offer the possibility to build up the previously impossible links or elements.

In total, new technological knowledge provides an opportunity to upgrade even the whole artificial network, however, the previously mentioned factors of production display the reality in this, therefore the limits of the possibilities.

One output of the process is the so-called 'distant reduction' which is the general positive externality of the existence of infrastructure. In some respects, infrastructure distorts the space and brings places closer to each other, while the places without infrastructure are perceived like to be unattainable or to have very long distance from these spots. This phenomenon certainly does not occur in the physical but in the time and cost distance. (Nemes Nagy, 1998) In other words, the places with better and better infrastructure can be reached in shorter and shorter time and by lower and lower costs. In order to reach the places without infrastructure, the greater scale of time and/or money are needed. Ultimately it should be emphasized, time and cost distance have more and more importance in our recent time, especially in the field of economy.

Another output or more exactly consequence is on the side of political benefit, which induces political rivalry to realize the gain from infrastructural development. Political actor's competition for this can be experienced on each spatial level from settlement to the global scene.

Phenomena in relation to the frame

The artificial network of infrastructure with different technological level and conditions draws a certain spatial configuration. This can be described various ways like centralized, grid, only single line system or from another point of view density of network can be measured. This existing configuration is used by different flows like the movement of goods, people, factors of production (capital, labor), technology, services, money, information, and externalities. Movements follow infrastructural network configuration because they can reach other places more rapidly and cheaply his way. Consequently, infrastructural network collects and directs this kind of movements in space. This way appearance of the infrastructural network determines more and less valuable places for different kind of activities in space. The existence of infrastructure is a very important settlement factor in economy and society. Thus the configuration of infrastructure greatly determines the progress possibilities of different spatial entities (settlements, regions, and countries etc.). Not only scientific but also daily experience is that the more developed and richer actors have a greater influence on political power. They are more able to manipulate political decisions, among them decisions on infrastructural development, via this on the transformation of the infrastructure configuration.

Chart 3 visualizes these relationships between different phenomena. More advanced entities have greater political power. Who have more power they can exercise more control on the flows, so they can direct, select and filter the movements. Via this control, they give feedback to and influence the improvement of the artificial network configuration as well as ultimately the progress of different societies.

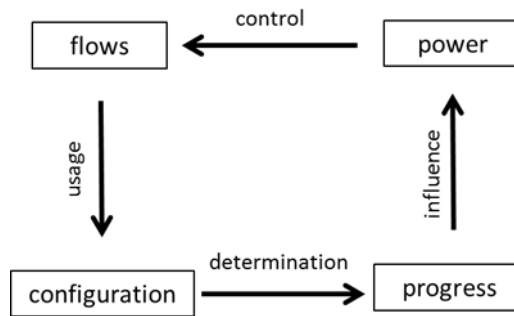


Figure 3. Phenomena in relation to infrastructural development

Source: Own construction

Upgrading to global level

The infrastructural network is a hierarchical system. Development of the elements of it occurs at each spatial level (Figure 4.) from local, microregional via regional, national, international to intercontinental and global.

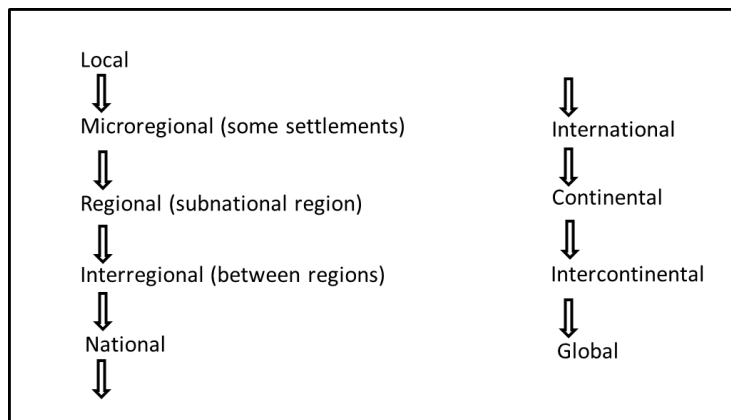


Figure 4. Spatial levels

Source: Own construction

The previously described development process operates in a similar way on all levels, but certainly, the scale of social, economic and political context is different. This hierarchical building is a subset system. That means, if there is a little microregional improvement somewhere this also build in and become a part of the whole global system. These billions of little infrastructural developments ought not to be ignored. They determine the disparities in the density of infrastructural network in different parts of the world as well as formulate the final configuration of infrastructure on distinct places.

However, if only the global level is in focus some new concepts occur which related in the process of infrastructural development. They ought to be embedded in the general frame (Figure 5).

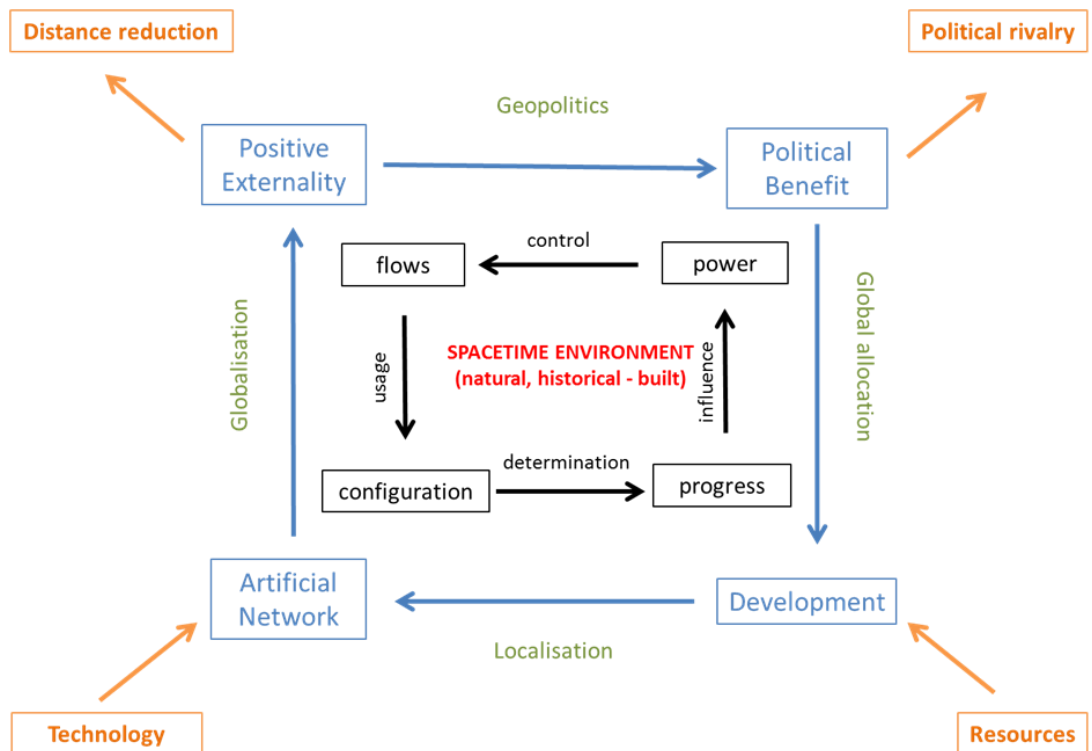


Figure 5. Conceptual frame of infrastructural development on global level

Source: Own construction

First one is 'globalization'. It is a general experience in recent ages that events and decisions on one place cause effects and have consequences on one another - maybe very remote - site of the world. In connection to this, it is often neglected most of these effects and con-

sequences would not be possible without the transmitter medium, which is typically an infrastructural element: road, railroad, pipeline, wire, a telecommunication system and so forth. Great global movements like the global flows of goods, services, people, labor force, capital, money, and information have only become possible thanks to the improvement of transportation and telecommunication systems in the last decades, as well as the gradual reduction of the costs in connection with their usage in long run.

In this relation, global infrastructure can be understood a stable material background, in other words, the backbone of the phenomenon of globalization. Infrastructure 'brings closer' further places in the world to each other. However, this certainly could be true only for those areas in which modern infrastructure has been established. Areas without modern infrastructure seem like very remote and inaccessible areas.

On the whole, that can be claimed, global infrastructure is a precondition of globalization. Global flows follow the configuration of the infrastructure. They seek those areas which are equipped with dense modern infrastructure.

These last thoughts lead us to one other concept, which is 'localization'. Localization means the increasing significance of sub-national (regional, settlement) levels in the economy, in decision making and in culture. At this point that ought to be underlined localization is not the opposite of globalization. On the contrary, localization is a global tendency, which exists simultaneously with globalization and they vitalize each other.

Globalized economy typically seeks ideal places for different activities, however, these places are not countries but certain cities and regions on subnational level. One hand geographical position in an international infrastructure network, on the other hand, the existence of well-developed infrastructure (e.g. for R&D, for headquarters, for advanced production and so forth) in a location offer competitive advantages so they are very important settlement factors in the globalized world economy. Consequently, these conditions attract modern economy and in relation to this advanced factors of production as well as modern technology into that certain area. On the contrary, the areas with lack of infrastructure are avoided by the global movements. Thus these global flows do not participate in the progress. These areas have no opportunity to exploit the economic advantages of globalization. Thus infrastructure is one of the most important factor (but not the only factor!) in the development of the modern globalized economy. This settlement role of infrastructure gave birth to the theories of infrastructural based regional development theories in the last decades (e.g. Aschauer, 1990; Munell, 1990).

Similarly to lower spatial levels, the global level utilization of infrastructure also offers benefit. This positive externality is huge on this level because it offers the whole worldwide linked network for those, who are able to use it.

Global infrastructural development, as well as the globally important elements of the infrastructure network, are generally in the focus point of the 'geopolitics' and geopolitical

oppositions. Political benefits of global infrastructure development and the key elements of the global network are tried to be exploited and controlled by global political actors. Via these geopolitical struggles political actors try to collect strategic allies in the world politics and besides this, they try to control the flows of the strategic resources. This way the strongest political superpowers could direct the global flows and via this, accelerate the progress on certain preferred areas (or decelerate the progress on other rejected areas). Moreover, the strongest global political actors can decide on the ‘global allocation’ of development resources and this way they control the future direction of the global infrastructure development. Through this control, they mainly determine the progress perspectives of different areas of the world.

This controlled global infrastructure development provides a new artificial network configuration. This also collects global flows and gives a little bit different, newer material ways for the further process of ‘globalization’ than before. At this point, the circulation has arrived back the starting point in the spiral of the frame (Figure 5.) in this chapter.

Challenges

At each corner of the frame, different challenges should be identified, which are important issues in connection to infrastructure development (Figure 6.).

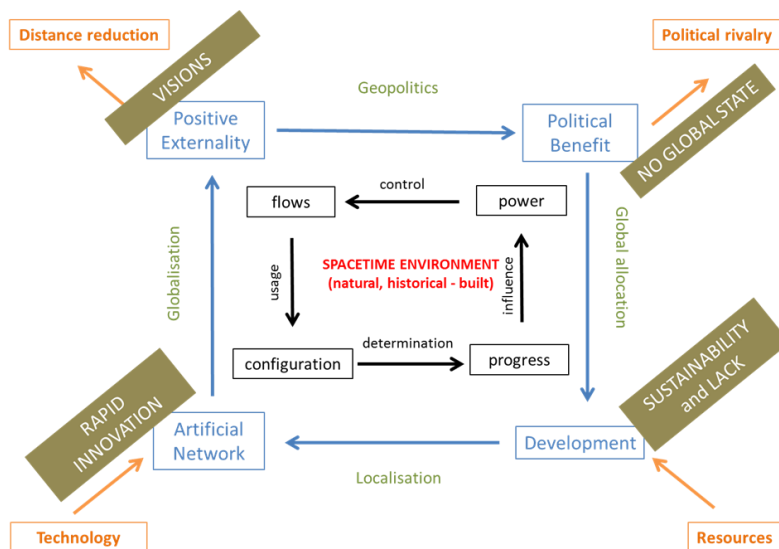


Figure 6. Conceptual frame of infrastructural development on global level with great challenges

Source: Own construction

At first, the artificial network of global infrastructure is continuously deteriorating, thus not only the building but the maintenance of it needed a lot of resources and continuous investments. Moreover, at this corner (Chart 6) the more and more rapid innovation creates newer and newer demand for more modern infrastructural elements which implies new huge investments. At the same time, this process makes the old network of an infrastructural element obsolete. These new innovations follow the typical ways of innovations from the wealthiest nations towards the poor countries (but it is not sure they ever attain these latter ones). For example, this kind of innovations has been in the electronic car market in the recent years. These technological improvements imply the need for building in the electronic car charger network all over the world as the necessary infrastructural background, while the traditional petrol station network might become outdated.

The second challenge is on the corner of development (Chart 6). A huge number of governments could not make the above described continuous investments. In a lot of areas of the globe, there is simply not or is only a quite rare infrastructure. Besides direct consequences, lack of infrastructure causes lots of other social and economic problems indirectly, which also nourishes other negative development spirals. Beyond that, this situation obstructs the local progress, in a lot of cases it results also global dangers. For instance: the lack of sanitation system in Africa could lead to serious infections all over the world. In a way, if viruses reach the global transportation system they could travel everywhere and result in an epidemic in distant parts of the earth or worldwide. Another example is the lack of the perspective of the better life and the attraction of well-off areas drive a lot of people to leave their home and try to migrate to well-developed countries by which they cause social and economic tensions also in that areas. This kind of dangers emphasizes that the infrastructural development all over the world is a global interest not only the local citizens' case.

Another core question in connection to the infrastructure development is the sustainability. One hand, this is also an economic question and more serious in developing countries. However, that ought to be emphasized it is also very important in the rich ones. Great infrastructural investments alone in order to build a new infrastructural element offers only short-run solutions. Continuous maintenance and restoration of the infrastructural elements are also necessary for a long run. Without this latter the great investment is no more than political prestidigitation, it is not a true infrastructural development from long run perspective. On the other hand, sustainability is more and more important question from the ecological point of view, since infrastructural networks, especially transportation and energy networks, direct and transport also the pollution.

The third challenge is the lack of global state and government. In spite of that infrastructural elements are mainly built and operated private business actors, the government generally has a crucial role in financing infrastructural development in all spatial level from the settlement to the national. This is almost unavoidable. It comes from the typical financial nature of the infrastructural developments:

- 1) A great investment is needed at the beginning of development.
- 2) It is a long term investment with the slow return and small profit perspectives.
- 3) A great part of the benefit from the investment is not realized directly by the investor but in the whole society as a positive externality. (E.g. New infrastructure supports economic development.)
- 4) Maintenance of infrastructure is also very expensive (e.g. replacing depreciation).
- 5) Marginal cost in connection with one more user is small.
- 6) Great opportunity costs occur in connection with the investments (e.g. invested resources could be used for another purpose).

These characteristics together do not offer a good business possibility for a typical private business investor. Therefore, state (government) participation is crucial in the financing of infrastructure development. However, as it has already mentioned there is no global state. It follows infrastructural networks all over the world are mainly improved on the national level (or subnational level). As a consequence, the infrastructure development and the location of infrastructure are determined by national interests. It is a strange situation that global infrastructure (which is a backbone of globalization) is mainly improving in the frame of national borders.

Nevertheless, there is infrastructural development financing on international and even on a global level. This does not only mean the nations' bilateral agreements and co-financing on this topic. A lot of international bodies exist which eager to substitute the missing global state in this field (Table 1). Incentives behind this could be the humanitarian point of views, but collecting geopolitical advantages is also important motivation.

Table 1. Group of organizations behind international infrastructural development with some examples

Group of organizations	Examples
International regional integrations	European Union (Trans European Network - TEN)
Multilateral financial organizations	
a) Multilateral development banks (MDBs)	World Bank, African Development Bank, Asian Development Bank, Inter-American Development Bank, European Bank for Reconstruction and Development
b) Multilateral financial institutes (MFIs)	European Investment Bank, Islamic Development Bank, Nordic Investment Bank, OPEC Fund for International Development
c) Sub - regional banks	Caribbean Development Bank, Central American Bank for Economic Integration, East African Development Bank
Aid coordination Institutes (International donors)	Canadian International Development Agency, Swedish International Development Cooperation Agency, U.S. Agency for International Development
Multilateral international organizations	United Nations (United Nations Development Programme – UNDP, United Nations Environment Programme – UNEP, International Telecommunication Union – ITU)
International non-governmental organizations (INGOs)	International Federation of Red Cross and Red Crescent Habitat for Humanity

*Source: Table is own construction. However, the categorization of multilateral financial organizations and aid coordination institutes are from World Bank (<http://web.worldbank.org/WBSITE/EXTERNAL/EXTABOUTUS/0,,content-MDK:20040612~menuPK:8336267~pagePK:51123644~piPK:329829~theSitePK:29708,00.html>)
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A huge number of examples are for geopolitical rivalry in connection with international infrastructural elements and the development of them not only in our recent times but also in the history. As an example here the new multilateral development banks are mentioned (Nelson, 2015).

Between the 1940s and 1990s, only five multilateral development banks were established and no more until the beginning of 2010s. On the contrary of these occasional events, only in 2014-15 two more were founded. Both of these new multilateral development banks links to great, populous and recently emerging countries in the world economy. It seems the leader of this group of the countries is China. They try to increase their significance in the world politics simultaneously with their rising economic weight. One of the tools for this purpose is the development policy including global infrastructure development policy.

New Development Bank (NDB), which is nicknamed 'BRICS Bank', was founded in 2015 by the BRICS countries (Brazil, Russia, India, China, Republic of South Africa). Its headquarter is in Shanghai.

Asian Infrastructure Investment Bank (AIIB) is founded in 2014 by 22 countries in Beijing. Its headquarter is in Beijing.

Their missions are defined against the existing status quo in international development world politics, which is described by 'leadership of the USA'. They intend to offer the alternative of this. The sharpest opposition is mainly between the newly founded multilateral development banks and the World Bank - Asian Development Bank duo (IMF is also generally mentioned in this relation among them, but it is truly a different category because it is not an MDB.)

Here are to quotations from the official website of New Development Bank, which demonstrate the described opposition:

NDB is an '... alternative to the existing US-dominated World Bank and International Monetary Fund.' <http://ndbbriics.org/> downloaded: 26/09/2016

'Unlike the World Bank, which assigns votes based on capital share, in the New Development Bank each participant country will be assigned one vote, and none of the countries will have veto power.' <http://ndbbriics.org/> downloaded: 26/09/2016

Fourth challenges are in the corner of positive externality (Chart 6). They are the future elements of the global infrastructure. They often seem like the 'dreams' of humankind. There are not always resources and/or technology behind them. That is also typical they are monumental ones. Some examples from the recent media:

- Bering Strait crossing (tunnel and/or bridge).
- Bridge over Bab-el-Mandeb (by this a new mainland link between Africa and Arabia instead of crossing the Suez Canal).
- Nicaragua Canal.

- Northeast and Northwest Passage (as an alternative of the existing trade waterways).
- The New Silk Road.
- Trans-Amazonian Railway.

Generally, the emerging China can be found behind these initiatives with a promise of great resources. It tries to make them believable and realistic.

Mankind always liked daydreaming and it is good to think of these possible monumental achievements of the mankind. However, the important question is there will be any responsible decision maker who truly examines that they are all really economic and sustainable investments. Cannot humanity allocate those great resources better way? Or are we only on the playing ground of the superpowers in geopolitical games and this overcomes the rationalities?

RESULTS

This article provided a general conceptual overview in the field of global infrastructure development. Firstly it gave a new definition of infrastructure, which is utilized in the text. Secondly, it built up a general frame of concepts in the infrastructural development and gave the relationships between the notions. Thirdly, the text raised this frame at the global level and place the topic into the global conceptual environment. Finally, the greatest challenges were demonstrated which are seen from the different professional and scientific perspectives. Moreover, examples were given for these challenges. Usage of this systemization of the concepts offers a guideline for the accurate description of the infrastructural developments. In addition, the improved conceptual frame might be upgraded in order to be applied for different purposes. For example typical positions of the different disciplines can be found in the system (Figure 7.).

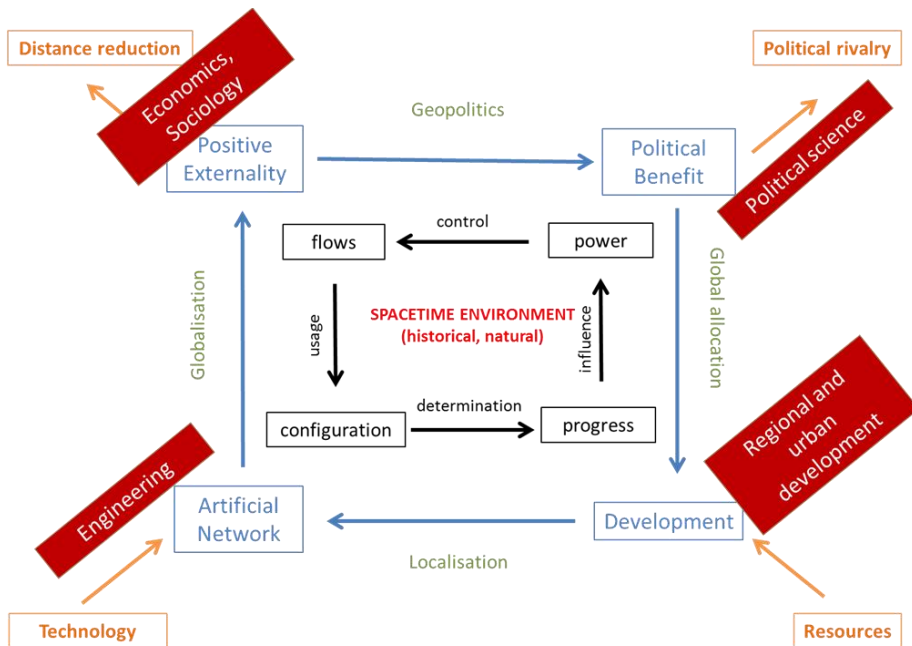


Figure 7. Conceptual frame of infrastructural development on global level with typical positions of disciplines

Source: Own construction

CONCLUSIONS

Infrastructural development is a very complex phenomenon, which has strong relations to numerous academic disciplines and professional fields. This makes its accurate description very difficult. However, the tools of system theory could make it more systematic, while it kept the complexity of the area. This could be useful when not only the specialties and details but the broad, general overview is also important. This is the situation for example if this topic is learned or taught.

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