

# *Infrastructure projects classification – Sustainable development perspective*

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**Abstract**—Infrastructure is an indivisible part of our modern life experience. Infrastructure projects are the cornerstone of states' economic growth, development and wellbeing. Nevertheless, it is often unclear what is considered under the term “infrastructure” when thought through. Few scientists explored the term more closely, giving their insights in possible classification of infrastructure projects, most of them adopting division on economic (physical) and social infrastructure. By conducting desk research and focus group research, authors explored new possible approach to infrastructure classification, combining the existing knowledge and three perspectives of sustainable development – economic, social and environmental. The main contribution of this work lies in proposal of sustainable-oriented infrastructure classification. The results of this study may be found useful by researchers, project management practitioners, policymakers and wider interested public in broadening comprehension horizon on infrastructure in general.

**Keywords**—breakdown, classification, infrastructure, project, project management, sustainability

## I. INTRODUCTION

Infrastructure is one of the most recognized terms in project management in general. Many researchers elaborated infrastructure projects success as a critical element in achieving a desirable quality of life [1], economic output and growth [2], urban development [3] and technological change [4]. Infrastructure projects are in scientific research focus, especially in the sense of critical success factors on public-private partnership models [5, 6, 7, 8, 9] or sustainability of their outcomes [10, 11]. Regarding the last element, there is a research consensus that sustainability plays a key role in assessment of infrastructure projects success. Infrastructure is thereby most often a term that is understandable by itself, connected to project investment in transportation, energy or utility sectors. Although extensively researched, up to this point, there have been only a few infrastructure projects classification models. They are mostly distinguished or grouped by cost, time, authorization [12], complexity or uncertainty [13, 14] and type [1, 2, 12, 15, 16]. These divisions are therefore concentrated to specific structure outputs, without connecting it to imperative concept of infrastructure construction – sustainable development.

Although many have been done in the field of infrastructure and sustainability research, there is no found clear relationship between infrastructure project types and sustainability concepts. The main research question of this study is, therefore: How it is possible to combine infrastructure project types and sustainability concept?

Authors find answering this question important in contributing to many aspects, with the main one being identified under terms of better strategical planning of infrastructure investments in general and benefits identification through cost-benefit analysis. Problems dealing with poor infrastructure governance, poor project prioritization according to strategic goals, inadequate project conception, poor competence and capacity development in public sector and lack of understanding of what is going to happen to a project once it enters maintenance phase are well-known in infrastructure projects literature [11, 17, 18, 19, 20]. If we had a clear relation between sustainability aspects and infrastructure project type it would be possible to concept, plan, approve, implement and evaluate those projects on the more effective manner – concentrating on the long-term sustainable impacts.

The planning phase is here especially significant as a cornerstone to future project management and strategic governance. The most common planning tool on infrastructure projects, cost-benefit analysis, tries to quantify user benefits, and subdue them on economic impacts. It is used as a decision-supporting tool that should enable maximal effects in accordance with funds invested and defined aims [21]. However, identification of these benefits is not always detailed in accordance with a project type. Also, CBA does not provide answers as to who will obtain the benefits and who will lose out and excludes the calculation of wider economic impacts [20].

Answering the research question may be found useful to policymakers, consultants, project managers, end-users and wider interested public, as well as academics in conducting their research.

In order to answer the research question, the following methodology was adopted, explained along with the structure of the article.

First, desk research was done on two topics – infrastructure projects classification and sustainable

development. Results of this phase are given in “Infrastructure projects classification” and “Sustainable development”.

Then, a focus group method was adopted in order to create a type-oriented and sustainable-oriented classification of infrastructure projects. This method was selected as a convenient one regarding the research goal – building a sustainably oriented classification, which will contribute to deeper understanding of infrastructure. Focus groups may be found a powerful research method in providing insights into how people think and provide a deeper understanding of the phenomena being studied [22].

Finally, applicable conclusions and directions for further research were given in the last part of the study.

## II. INFRASTRUCTURE PROJECTS CLASSIFICATION

Although most of the people understand the concept of infrastructure comprehensively, it can be hard to give a precise definition of it. As [12] stated, the concept of major infrastructure projects is one that has only recently become commonplace, particularly in the context of project management. Some definitions of (public) infrastructure are connected to its uniqueness – infrastructure is a non-rival, non-excludable good, has high initial investment costs, positive externalities and natural monopolies [23]. Other authors [24] define this infrastructure uniqueness through the provision of services, lumpiness in scope and time, long lifecycle, space-specificity (immobility), and association with market failures.

Infrastructure is a term developed within military [12] but soon expanded on other, nonmilitary areas connected to community quality of life [1], developing mostly in two directions – like economic and social infrastructure [16], with some classifications even including human capital and materials as infrastructure [15]. In his work, [15] elaborates different infrastructure categories according to a variety of authors, namely - personal, institutional, material, immaterial, economic, social, core and not-core, basic and complementary, network, nucleus, and territory infrastructures. Other authors [12] divided infrastructure on hard and soft constituents – the hard one comprising energy, transport, information and telecommunication, flood defence and healthcare; and soft consisting of governance, economic and social infrastructure. On contrary, [25] consider economic infrastructures like transport and energy networks; and social infrastructure consisting of health, education, culture and environmental infrastructure. Similarly, [26] defined infrastructure as economic, human, social and residential building. Analogously, what [26] considers being economic infrastructure, [27] define as services, while their social infrastructure overlaps significantly. American approach may be somewhat different, based on [28], who defines 16 different type-oriented categories of infrastructure.

Regardless different approaches, it may be seen in general, that most of the presented categories divide infrastructure in accordance to dimensions of profitable, physical, core one (mostly called - economic) and wider, unprofitable, soft one (usually known as social).

The way that we divide and categorize things affects our way of thinking and connecting terms and concepts with other ones in complex language and communicational systems. Therefore, it is meant to offer different ways of thinking through these approaches, in this particular case – those connected with sustainability.

## III. SUSTAINABLE DEVELOPMENT

Sustainable development became an imperative global concept due to extreme inequity between the social standard of living and untenable patterns of consumption and production which caused immense economic and social costs that can endanger life on the planet [29]. This is on a special way viable through different EU policies, with clear emphasizing of importance of cohesion, inclusivity and sustainability [30, 31].

The world is currently facing challenges in all three aspects of sustainable development – economic, social and environmental [29] – so-called, three pillars of sustainability [32] – See Figure 1.

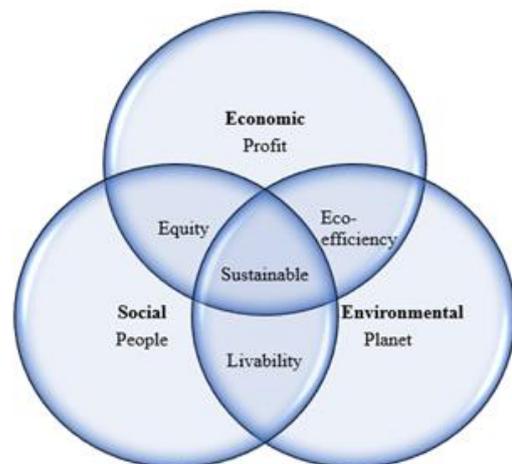


Fig. 1. Sustainability pillars

As it can be seen in Figure 1 (adoption based on [33] and [34]), each pillar has an incentive-inspired imperative – profit, people or planet. When overlapping different aspects of development, intersections occur – equity (economic – social), eco-efficiency (economic – environmental) and livability (social – environmental). When overlapping all of the three pillars – sustainability occurs.

Sustainable development thereby constitutes development achieved in a sustainable way, without getting into a discussion on differences between sustainable development and sustainable growth [32].

For the necessity of this research, authors look on development as a gain of benefits on any level (national, regional, global). Benefits are thereby materialized through changes happening due to projects. If we talk about higher strategic level, projects that provide visible and significant positive changes in people's lives are undoubtedly infrastructure projects. As stated in [35], reason behind this is infrastructure investment potential, not only to boost aggregate demand in the short term but also to bring important benefits over the longer term by broadening the productive capacity of the economy as a whole. Sustainability and project management are natural allies – and there is an increasing effort among researchers and practitioners to integrate these two concepts [36]. As stated by [37], the crucial reason for making sustainable infrastructure is to help drive transformational change. Infrastructure projects have major effects on implementing the principles of sustainable development [11], so the research interest in the topic does not decrease.

Indeed, many has been done in researching different types of sustainability [38] and infrastructure projects challenges such as planning [18, 39, 40], procurement and contracting [41, 42], ex post evaluation [43, 44], strategic governance [45], public sector capacities [19], risk management [46, 47, 48], etc. All of these researches had great successes in addressing different connected questions and areas. But, as stated by [49] although the nexus between infrastructure and growth has received attention in the international literature, the linkage to sustainability has yet to receive the attention it deserves.

From the perspective of this research, this can be easily seen in the overlapping of existing infrastructure categorization with pillars' model. It can be easily seen that there is a missing component – environmental one. Environmental projects, that are gaining benefits for planet, were up to this point categorized both within economic/service and social infrastructure category. Authors believe that these classifications did not provide clear guidelines in context of project management-oriented by sustainable development – nor consequently strategical planning and project governance. Importance of these two elements are strongly stressed in [50] – the policy debate on infrastructure investment should pay more attention to adequate prioritization and planning of infrastructure project, with the first one being a key at all levels of government, and both elements ensuring social inclusivity.

#### IV. SUSTAINABLE-ORIENTED INFRASTRUCTURE PROJECTS BREAKDOWN

In order to create a sustainable-oriented infrastructure projects breakdown, the authors made an initial list of all found types of projects based on desk research given in section II. Then, a group of infrastructure projects management experts were engaged in filling the initial list, and categorizing it within types (activities) and within sustainable categories. Focus group consisting of five project

management experts with rich experience in managing different types of infrastructure worked together in combining and adjusting different types of infrastructure projects within the sustainable pillars' categories.

The initial activities-oriented breakdown may be seen in Appendix 1, and the final outcome may be seen in Appendix 2. Appendix 1 represents division of infrastructure projects based on economy branches, in order to be as close as possible to administrative – i.e. realistic infrastructure management. Thereby, experts had in mind the final goal of this research – connection of project types with sustainability model, so some traditionally related branches (such as agriculture and forestry) were separated into different categories. By observing the classification, experts concluded that there is multidimensional connection between infrastructure project types and sustainability model. Namely, although there are infrastructure categories that can be attached to mostly one sustainability dimension precisely, there are some boundary combinations which may be looking through interdependencies of three basic sustainability pillars (Appendix 2), both explained below.

- **Economic.** Touristic infrastructure is positioned here. Although it has to take care of people and the environment, it generates practically exclusively profit, both in public and private sector.
- **Environmental.** According to today relation of the modern world towards forest and waste issues, focus group concluded that these projects should be exclusively focused on environmental component until they become ultimate social standard regardless public or private interests.
- **Social.** Infrastructure such as defence, justice, recreation, education, science and social questions cannot be measured by profit or impact on the environment but have extremely important role in social development.
- **Eco-efficiency.** Focus group considered agriculture to be a primary economy sector that has to be aligned with all environmental standards regarding trends of pesticide and herbicide usage reduction, and creation of eco-friendly products, along with assumptions for public and private sector economic growth, creation of added value and competitiveness increase.
- **Livability.** Sewage system projects indubitably contribute to the improvement of life quality on certain areas (somewhere even create fundamental conditions), but, at the same time, high standards of environmental protection must be taken into consideration. On the other hand, although forest and waste management projects are types of projects put into environmental category, experts agreed that with an assumption of conditions' creation in

the sense of necessary infrastructure and bounding legal regulations, these two categories of infrastructure could move towards livability category, since they belong to it based on their natural function and general perception.

- Equity.** Most of the identified project categories lay between economic and social aspect of sustainability. These are projects on which a most vivid discussion was developed. Regarding larger or smaller inclination to one of these two sustainability pillars, these projects can be grouped respectively. In accordance to that, communications, transportation and energy are positioned more towards economic component because, although they affect increase in life quality in a large manner and creation of preconditions for social growth and development, they are mostly focused on creation of new values and gaining profit on them. On the other hand, culture and especially health, go further from the framework of exclusive dependency to social character lately. This direction defines offer of services and scope towards profit gaining regardless the common perception that these two categories can be put into social component strictly. The analogous conclusion may be identified regarding sports infrastructure where multifunctional projects are being more looked for. This kind of projects have not only social service side, but also gain incomes, so dependency on public budget can be minimized.
- Sustainability.** Finally, access to clean drinking water is considered to be one of the basic human needs and rights, and, regarding the circular water lifecycle, rational usage of water resources is one of the imperatives of modern society in the sense of management and environment protection. However, from day to day, we are witnesses of many global problems regarding water shortage or lack of safe drinking water. The consequence of this is increase in economic dimension of water resources management, where we invest in water infrastructure all over, but also pay for it more as a community. Due to these reasons, focus group put water system projects in the centre of a model, as a “clean” sustainable project.

From a sustainability perception, infrastructure projects can be looked through a multi-dimensional environment in contrast to generally accepted division on economic and social infrastructure. This research also gained insights in perceiving “traditionally economic” infrastructure as a mixture of different kinds of sustainability aspects. Identification of the group to which infrastructure project belongs can be used in better identification of benefits that project should obtain regarding sustainable development in the planning phase. E.g. implementing afforestation

project in a city cannot have same benefits nor impacts as building a sports facility, because they support different sustainability aspects in their nature. Some benefits cannot be measured through economic impact strictly, without having social or environmental benefits in mind. Benefits of building a theatre in some area would be poorly represented with profit made from tickets selling only. Classification in Appendix 2 brings a more precise look on sustainable pillar to have in mind while defining benefits of an investment, approving investment and harvesting impacts of it. It can also help target measures of impact in evaluating sustainable development after implementation. Gathering those data may improve policymaking and strategic framework under which investments are being approved. This represents a continuous process shown in Figure 2. This Figure also puts sustainable-oriented classification made in this study in context of the need to solve research problem exposed in Introduction.

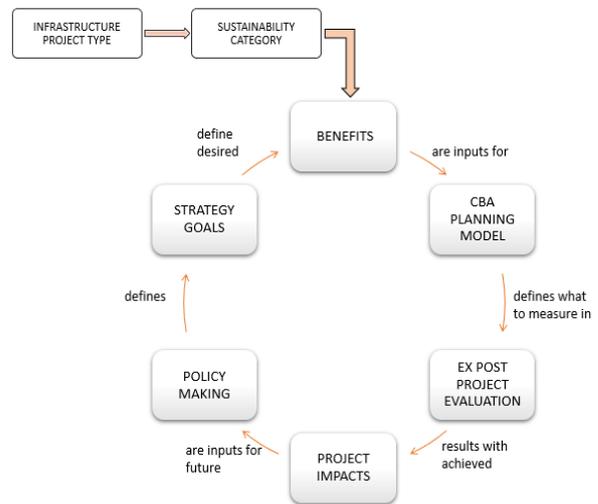


Fig. 2. Sustainable-oriented projects classification and improved projects governance

Most of the infrastructure is partially or fully in scope of construction works because they represent long-termed spatial intervention. So, they prior affect circumstances in which people live and change environment. This is an added reason to approach planning phase of these projects very responsibly, and take all of the relevant and useful information into account from the conception phase (not only the necessary technical and technological data). Also, different types of infrastructure projects have different sustainability priorities – so it would be useful to tailor project success evaluation models in accordance with this.

This study contributes to a better understanding of infrastructure in context of more efficient management of existing capacities and conceptually change of planning paradigm in the direction of strategic thinking while including all elements that, long-termed, affect on social development and protection of environment – i.e. place we live in. As it can be seen out of Appendix 2, most infrastructure projects are

grouped around social or equity component of sustainable development. Therefore, it can be concluded that man, i.e. society, with maximal concern of environment, is, in the end, an imperative when planning infrastructure projects. With that in mind, it is worthy of taking these considerations into account while creating policies and strategies, and have not only traditionally irreplaceable economic growth in focus, but also responsibility towards society and environment as well.

#### V. CONCLUSION

This work gave a different insight into infrastructure projects, by combining its type-oriented classification with sustainability model, with the aim of raising questions on connection between infrastructure and sustainability.

By combining desk research and focus group method, authors answered the research question on connection between infrastructure projects types and sustainability concept with the creation of sustainable-oriented classification of infrastructure projects, whose use was put in context of research problem.

The main importance of this work lies in contribution to the closure of identified literature gap, through created sustainable-oriented classification, whose usage can be found useful in solving infrastructure projects challenges, especially in the part of better benefits identification.

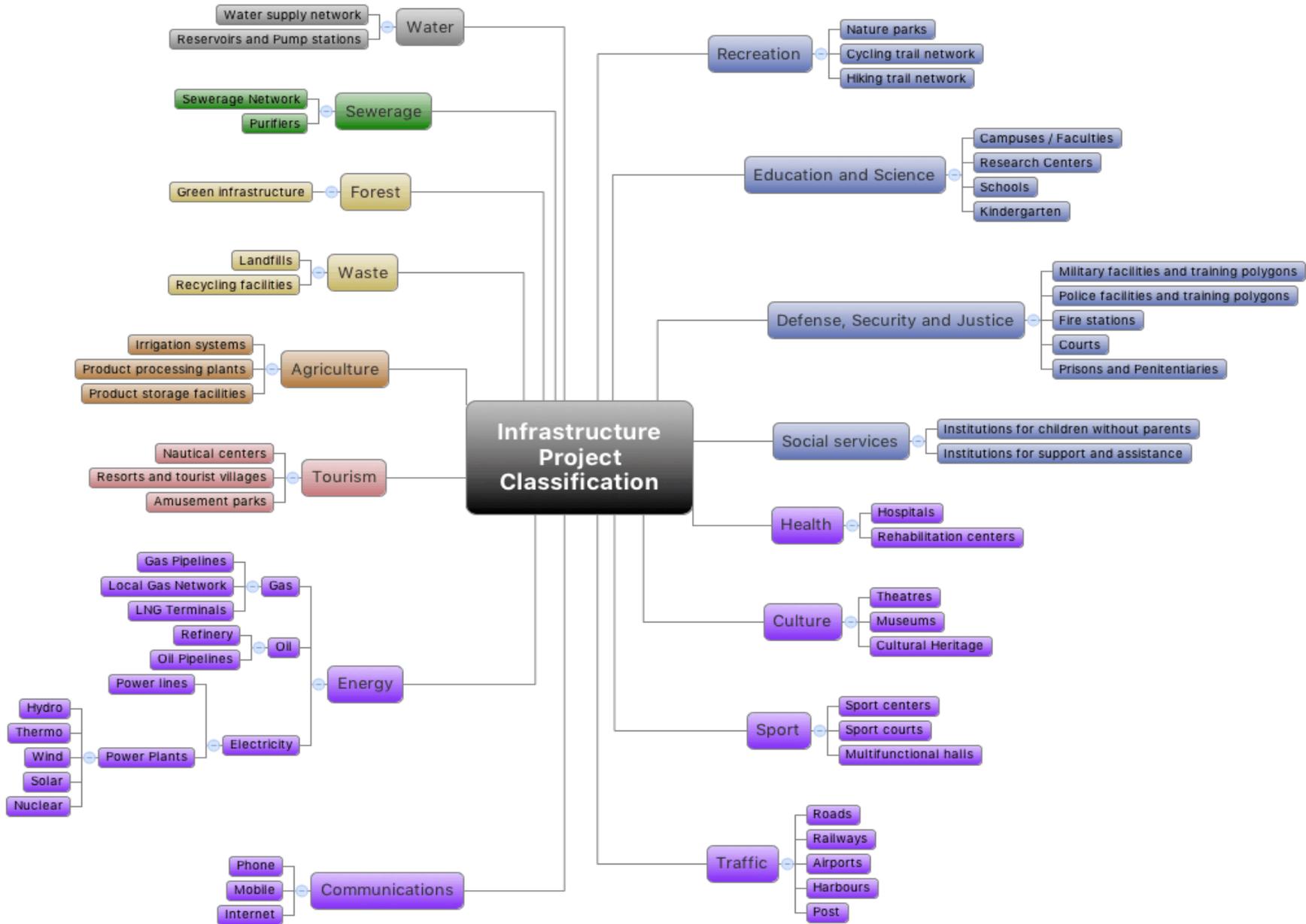
Future research can be directed on the adoption of quantitative methodology approach in linking different categories with components of sustainable development and creation of sustainability success models, in order to obtain more precise picture of sustainable infrastructure. Also, authors do not see this list as final, so other types of infrastructure can be researched in future in order to contribute to creation of unique classification of infrastructure projects. For every type of identified infrastructure project category, a list of all potential benefits may also be identified in future. Moreover, ex-post evaluation models may be developed in accordance to project sustainable category for improved evaluation of real projects' impacts.

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APPENDIX 1: ACTIVITIES / TYPES - ORIENTED INFRASTRUCTURE PROJECTS BREAKDOWN



APPENDIX 2: SUSTAINABLE-ORIENTED INFRASTRUCTURE PROJECTS CLASSIFICATION

