

Assessment of interdependent projects in the infrastructure sector: a new approach to exercising external control



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ABSTRACT

This article presents the main aspects regarding the different types and patterns of interaction found in projects with close dependency relationships, as well as regarding the negative effects arising from the disregard of interdependencies while implementing a group of two or more interrelated projects. It also presents the benefits resulting from efficient management of interdependent projects that contribute to a successful project portfolio. Based on some recent judgments, it is possible to confirm that the Federal Court of Accounts has been moving forward when it comes to assessing interdependent projects. This innovative approach has great potential to contribute to governance in programs and projects in the infrastructure sector by strengthening the integrated, coordinated and articulated planning of a group of interrelated projects. It can also ensure greater optimization of projects, besides efficiency, efficacy and effectiveness of public expenses in this sector, having as an ultimate goal to increase the country's competitiveness in the international scenario and the collective well-being. This new approach goes against the Court's traditional one, which consists of assessing investment projects as an isolated entity, based on a fragmented view of its main components regardless, however, of the existing interactions between those components and, specially, the external interdependencies with other projects of significant synergistic effects.



Keywords: Projects. Interdependencies. Management. Synergy. External control.

1. INTRODUCTION

The annual report on the competitiveness of countries, recently published by the International Institute for Management Development (IMD), indicated that Brazil has moved down one position in the 2016 Global Competitiveness Ranking, falling to the 57th place among the 61 countries reviewed. Thus, the country has dropped 19 positions in a period of six years, being ahead of Croatia, Ukraine, Mongolia and Venezuela only.

According to the report, the main competitiveness weaknesses of the Brazilian economy are the following: low economy performance (55th), low government efficiency (61st); low corporate performance – productivity and efficiency (60th) and weak basic infrastructure (54th). Hence, the increase of the country's competitiveness is related to the improvement of the country's basic infrastructure, which has a direct impact on corporate productivity and efficiency and on performance of the economy.

Weaknesses and bottlenecks in the infrastructure sector restrict the options for the country's social economic development due to the so-called "Brazil Cost". This cost is actually nothing more than the cost, for instance, of transporting harvest on deficient and poorly kept roads, little integration

between railroads, truck lines awaiting to have access to ports with insufficient capacity, increase of freight expenses, low investment in sanitation, poor housing, among others.

To increase the country's competitiveness we need to overcome the weaknesses and bottlenecks in the infrastructure sector. However, in a context of severe fiscal restriction of the federal, state and local governments, the big challenge is to vest more quality in public expenses and optimize results through the implementation of large infrastructure projects in all modalities of transportation (road, rail, water, ports and urban), in energy, petrol and gas, sanitation, urban mobility, communications etc.

In this scenario, the actions of the Federal Court of Accounts (TCU) stand out when assessing the integrated, coordinated and articulated planning and the effective management of the infrastructure projects with close dependency and complementarity relationships. As we shall see, a better understanding of the types and patterns of the interrelationships between the projects holds a potential of minimizing the negative effects resulting from planning and management flaws in inter-related projects.

The objective of this article is to present some relevant aspects of the existing theoretical framework regarding interdependencies among projects and some TCU precedents on the evaluation of interdependent projects in the infrastructure sec-

tor. They have potential to be a new approach to the exercise of external control in that sector which is so important for the country's social economic development.

2. LITERATURE REVIEW

Next, we will present the theoretical framework on interdependent projects without, however, trying to exhaust the topic and its peculiarities, since this shall be the goal of a longer study. Due to the lack of national studies, the types and patterns of interaction between projects and their negative effects and benefits are treated with greater focus by the international literature on interdependent projects in the many areas of knowledge, not limited to infrastructure projects.

2.1 RELATIONSHIP BETWEEN PROJECTS

Investment projects may have three types of relationships between themselves due to technical and/or economic reasons, whenever there is a chance of simultaneous implementation of two or more projects. According to Correia Neto (2009, p. 181-182) and Woiler and Mathias (1996, p. 181), projects may be classified as mutually exclusive, independent or interdependent.

Mutually exclusive projects are those that have the same goal and compete against each other and, thus, cannot be accepted jointly. Usually, the acceptance of one of them eliminates investment in the others (one should choose project A, B or C).

As for the independent projects, they do not have a relationship between themselves. Decisions made regarding one project will not have any effect on the other (it is possible to investment in independent projects A, B and C).

On the other hand, interdependent projects have some precedence relationship between themselves. Therefore, accepting one of the projects depends on the approval of the others. According to Harrison (1976, p. 99-101), in order to know if we are facing this type of relationship, it is enough to ask the following question "can the decision to accept or reject a certain project be made regardless of the decision to accept or reject another project?" If the answer to this question is "No", then the projects are considered "interdependent".

A sector where the existence of interdependent projects stands out is the infrastructure sector, as occurs with the electrical energy transmission lines, stretches of railroads, departure terminals, water supply dams, access roads, airports etc. These projects often require that others be implemented before, jointly with or after another.



The European Commission (2003, p.19) mentions two interesting examples when analyzing interdependent projects:

- a road project connecting city A to city B, which is justified by the perspective of an airport located near city B and the alleged increase in traffic volume: the project shall be analyzed in the context of the joint airport/road system;
- a hydroelectric plant located in X and designed to serve a new industrial unit: if the two objects are interdependent, the analysis shall be integrated, even if the request for financing is for the energy supply component.

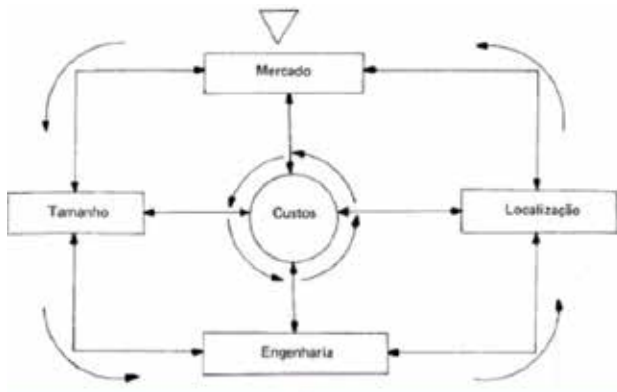
Interdependent projects may present synergy exploration as an outstanding aspect among other outstanding characteristics common to any investment project, such as complexity, interdisciplinarity, risks and uncertainty, among others, which may have higher or lower intensity depending on the peculiarities of each venture.

To Woiler and Mathias (1996, p. 25), synergy appears when there are two or more projects interacting and the result that is more than proportional to the sum of the projects. This occurs with the input-output relationships between projects (port-railroad) or when using common resources for different projects (hydroelectric plant-waterway).

2.2 TYPES OF INTERDEPENDENCIES: INTERNAL AND EXTERNAL

Illustration 1:

Internal Interdependencies



Source: BUARQUE (1984, p. 74)

The second category of interdependencies is the “external” one, which occurs when two or more interdependent projects interact with each other. Tasevska and Toropova (2013, p. 10-12) present five types of external interdependencies more often discussed in literature: resources, market, learning, results and benefits.

Resources interdependencies result from sharing common resources among several projects or from waiting for scarce resources until they are made available by other projects. Market interdependencies occur when a new product enters the market of an existing product or when several projects compete because of equal or similar objectives.

The interdependencies in learning arise when a project generates knowledge that is used by others. Interdependency of results occurs when a project depends on the results of others. Finally, the interdependency of benefits arises when there is synergy resulting from two or more interrelated ongoing projects.

We can also consider other types of external interdependency when evaluating projects. For example, Bathallath, Smedberg and Kjellin (2015, p. 70-71), mention technological and technical interdependencies, which result from the need to take advantage of common technology in multiple projects; or when success or technical failure in a project affects the probability of success or failure in another project.

2.3 INTERACTION PATTERNS IN INTERDEPENDENCIES

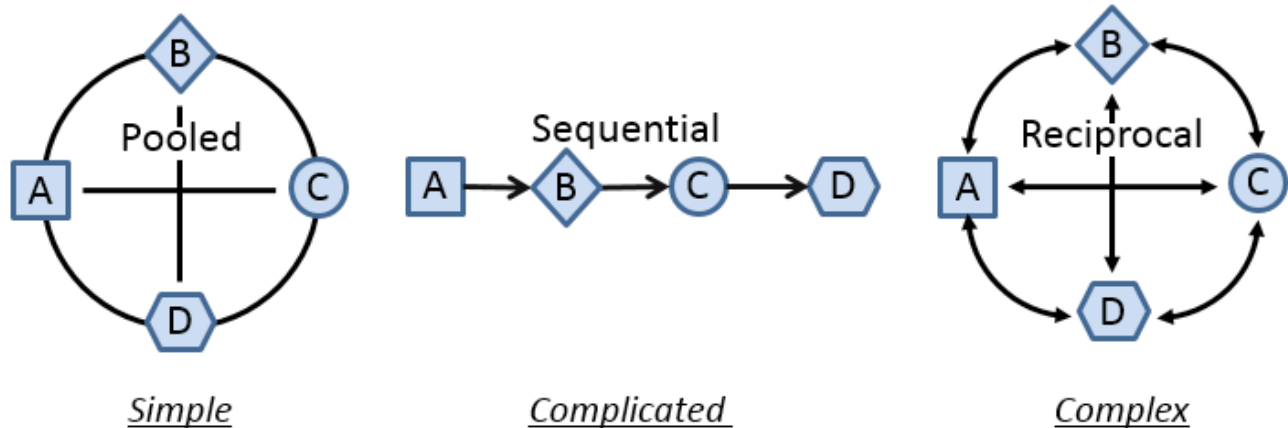
In order to understand projects, besides separating the interdependencies in internal and external, there is also the need to identify different interaction patterns between them.

When adopting James Thompson’s (1967) classification of interdependencies, Bathallath, Smedberg and Kjellin (2016, p. 71-72) consider that interactions in projects take three distinct forms: pooled interdependency, sequential interdependency and reciprocal interdependency. The authors illustrate interaction patterns according with Thompson’s view as follows.

Pooled interdependency is the simplest form. Each project on the portfolio gives a discrete contribution to the whole and each one of them is supported by the whole. That way, the result of the

Illustration 2:

Classification of external interdependencies



Source: BATHALLATH; SMEDBERG; KJELLIN (2016, p. 72)

project may indirectly affect the performance of the project portfolio as a whole. For instance, many times a city's public hospitals network may operate as enterprises with indirect interdependencies because, although it operates separately, the failure of the project may affect the totality of the local network and other units.

Sequential interdependency occurs when it is possible to determine a clear direct relationship of dependence between two or more projects wherein order for a project to begin operating it requires another project's output. This is a high level of interdependency in comparison to pooled interdependency, for the projects depend on one another for good performance. For example, the complementarity of the sequential form may occur between a project for energy generation and another related to transmission lines. The operation of the energy generation project depends on the construction of the transmission lines.

On the other hand, reciprocal interdependency occurs when there is a mutual relationship between two or more projects. This is considered the highest level of interdependency due to the complexity of the interrelationships between the projects. Each project strongly affects the other. This form of interdependency occurs when the operation outputs of a project become inputs for another project's operation and vice-versa. For example, the interaction patterns between road, railroad and port projects. The port will be the departure and arrival

points for freight to be transported through roads and railroads.

2.4 TYPICAL PROBLEMS WITH PROJECT INTERDEPENDENCIES

In practice, several problems may be identified when interdependency characteristics of each investment project are not considered when they are drawn up and evaluated.

Correia Neto (2009, p. 182) highlights three types of problems. The first regards the decision to invest under capital constraint conditions, which limits the number of acceptable projects; the second occurs when the projects have different scales of investments; and the last refers to the existence of projects with a different lifespans, which causes the benefits generated to take place in different timeframes.

In contrast, Holanda (1982, p. 190-191) highlights some practical limitations practices resulting from the interactions between the studies that are a part of investment projects, for example:

- **Relationship between size and market:** the magnitude of the market sets the maximum limit for the size of the project. Therefore, choice of the size can be undersized when not all implementation impacts of other public and private investments in their areas of influence are taken into account. This could result in high levels of idle capacity within the timeframe of the project.



- **Relationship between size and location:** dimensioning of operational capacity and the location of projects shall be defined together because certain projects, due to their nature, are connected to the location of other projects, such as those related to mining, watering systems, hydroelectric utilization etc. In some other cases, the location may be decided considering merely the political nature, which could be the case of the location of airports, ports, refineries etc.
- **Relationship between market and engineering:** wrong choice of technical solutions to define the project's operational capacity without taking into account the market size can lead to bottlenecks related to product flow, especially due to the impact of operational inputs of new investments in the area of influence of the project within the timeframe.

The Ministry of Planning, Budget and Management manual for studies of viability of large

projects (BRASIL, 2009, p. 11) cites two interesting examples of failure when identifying projects with interdependencies. A) the expansion of a port may have its usefulness jeopardized if there are no improvements in the complementary infrastructure, such as roads and railroads that allow for asset arrivals and departures; and b) the implementation of a system for sanitary sewage may only be necessary if there is, in that location, development of an industrial district.

2.5 MANAGEMENT OF INTERDEPENDENT PROJECTS

According to Killen and Kjaer (2009, p. 8), a large part of the literature specialized in project management treats each project as an independent entity, that is, the project is considered individually. Due to the complexities of projects, traditional tools of project management are not enough anymore to deal with interrelated projects, which makes interdependency management an area that needs improvement (HEURICH; KURZAC, 2014, p. 18).

However, recently, some studies began to recognize that projects are not implemented in an isolated manner and that there is the need to understand project interdependencies. Aiming to improve such techniques, Tasevska and Toropova (2013, p. 6) highlight the importance of creating Project Interdependency Management – PIM as an important area of the Project Portfolio Management – PPM.

In the new publications of the Project Management Institute (PMI), interdependencies between projects began to be addressed in their publication called Standard for Program Management. For PMI, according to Valeriano (2014, p. 44), a program “is a group of related projects, subprograms and program activities, managed in a coordinated manner to obtain benefits not available from managing them individually.”

Valeriano (2014, p. 4-5) highlights that while a project is a unique venture of limited duration designed to accomplish a singular goal, a program coordinates and harmonizes the management of interrelated projects. Almeida and Almeida (2013, p. 10-11) note that the focus of a project management

methodology is the interdependency between the projects and resource conflicts, from the beginning, through planning, execution, monitoring and control, until conclusion.

As seen, managing interdependencies between projects should be considered critical to implementing project portfolios successfully. According to Bathallath, Smedberg and Kjellin (2016, p. 68), organizations should be capable of understanding the interdependencies between projects in their portfolio in order to make appropriate project decisions to achieve the best portfolio results and, thus, avoid negative effects resulting from failure in project management.

2.5.1 NEGATIVE EFFECTS

Several recent studies have pointed to different types of problems that could result from inefficient management of interdependencies of projects. For example, Bathallath, Smedberg and Kjellin (2016, p. 76), highlight four groups of negative effects that occur when project interdependencies cited by specialized literature are not considered:



- **Waste of resources:** inadequate allocation of resources between interdependent projects may lead to badly used or deviated resources. A waste of resources would arise when there is improper use and/or sharing of limited resources between projects.
- **Failure to comply with timeline (deadline slippage):** a delay caused by a project may spread to a connected one, resulting in a global delay of the projects. For example, an interdependent project shall not begin its operations until the other is totally concluded.
- **Budget Waste:** not taking into account project interdependencies may lead to a bad selection of projects and, consequently, to wasting financial resources. For example, not identifying interdependency in the planning phase may lead the organization to implement two excluding or competing projects separately.
- **Inter projects competition:** interdependent projects may begin a competition for limited resources inside the organization to gain more power over other projects and, therefore, get more support from top management.

Other damaging effects resulting from not considering interdependencies are mentioned by Tasevska and Toropova (2013, p. 13): risk transfer, short term project resolution, delay in project schedule, lack of professional development, lack of synergy exploration, personal discouragement and cannibalization of resource. Therefore, all these effects might distort budget, deadlines and the estimated revenue affecting negatively the success rate of projects.

2.5.2 BENEFITS

Recent studies show that when project interdependencies are duly considered by the organization, their effective management brings a series of benefits that contribute to average success in a project portfolio, such as: selection and evaluation of more effective projects; easier problem resolution, saving costs, team cooperation, knowledge sharing, time efficiency etc. (KILLEN; KJAERB, 2012, p. 8-10).

A dimension of success in the effective management of interdependencies is related to “exploring

synergy”. Tasevska and Toropova (2013, p. 12-13) argue that this type of management should take into account the interfaces or interdependencies between projects in a way that, when actions are taken, they represent synergy between the projects. In addition, the authors highlight that effective management is a strategic matter for the organizations because it allows for efficient management of resources, overcomes difficulties in decision making, and finds better solutions, among other benefits.

3. TCU'S PERFORMANCE IN INTERDEPENDENT PROJECTS: PRECEDENTS

Traditionally, the main approach of external control actions in infrastructure projects has been the evaluation of the project as an isolated entity that is, not taking into account the forms and patterns of interactions between interdependent projects. Therefore, the sector's problems such as delayed or paralyzed public works, overpricing and low quality, are usually addressed from a fragmented viewpoint.

Recently, some control actions were concerned with identifying possible failures in planning and implementation of investment projects with a close interdependency relationship. These innovative actions have adopted a systemic approach when evaluating interdependent infrastructure projects. As an example, we mention the following TCU precedents:

3.1 WEST-EAST INTEGRATION RAILROAD AND SOUTH PORT COMPLEX

In Decision 3476/2012 – Plenary (TCU, 2012), whose rapporteur was Minister André Luís de Carvalho, TCU found that uncoordinated decisions regarding the port complex lead to a significant divergence between the implementation and operation phases of the two ventures. The result was a contract and the beginning of railroad construction works without a minimum guarantee of the feasibility of the abovementioned complex. The impact of this was estimated by the Court at R\$ 2 billion, due to services revenue cuts and the high costs of fixed capital.

Recently, in Decision 727/2016-Plenary (TCU, 2016), the Court imposed a fine to the managers of Valec, from the Ministry of Transportation (MT) and the



National Agency for Land Transportation (ANTT), in addition to forbidding them to take on any position of trust for a period of five years. Furthermore, TCU determined that the MT coordinate with the government of Bahia in order to mitigate the effects of a possible divergence between the constructions of the West-East Integration Railroad and the facilities of the South Port Complex causing damages to the public coffers and to the efficiency of the system operation.

3.2 ELECTRIC POWER GENERATION AND TRANSMISSION

During the performance audit of the Brazilian electrical system, TCU pointed out some significant systemic delays in the beginning of the operations of the electric power generation and transmission ventures, authorized by the public power between 2005 and 2012. The audit found that 79% of the hydropower plants, 88% of the wind power stations and 75% of the thermal power plants did not comply with the initial schedule for beginning the ope-

rations. In the transmission lines and substations, the delay reached 83% and 63% of the ventures, respectively.

Through Decision 2316/2014-Plenary (TCU, 2014a), whose rapporteur was Minister José Jorge, the Court identified as the main reasons for these delays, environmental issues, lack of studies and lack of monitoring mechanisms by the Ministry of Mines and Energy (MME). These delays increase the risk for energy deficit in the country because they reduce energy offer and system flexibility and they overcharge transmission lines, besides increasing energy costs, which are later transferred to the final consumer.

3.3 AÇAILÂNDIA-BARCARENA RAILROAD AND VILA DO CONDE/PA PORT

During the compliance audit on the viability studies of the project for the construction of the Açailândia-Barcarena railroad and the project for expanding Vila do Conde/PA Port, TCU pointed out some imbalance between the port's and the railroad's de-

mand projections regarding the main products to be transported on the railroad towards the port. Thus, investment plans for the port infrastructure expansion would be incompatible with the demand projections, demonstrating failures in the integrated planning of the two infrastructure projects.

In Decision 2903/2014-Plenary (TCU, 2014b), having as its rapporteur Minister Marcos Bemquerer, the Court issued several recommendations to the MT, to the Ports Secretariat of the Presidency of the Republic (SEP-PR) and to the National Agency for Land Transport (ANTT). The TCU recommended that the technical studies of the abovementioned project observe, for example, the necessary integration and interface with all other existing means of transportation, reciprocal coherence in their demand studies, the availability of expansion areas and the risks for bottlenecks when freight is delivered or the underutilization of railroad infrastructure.

3.4 LOGISTICS CORRIDOR OF BR-163 HIGHWAY

TCU carried out a compliance audit on the Logistics Corridor of BR-163 (Cuiabá/MT to Santarém/PA), which comprises the BR-163 highway, the waterways of the Tapajós and the Amazon rivers, and the Ports of Outeiro, Vila do Conde, Belém and Santana. In this audit, the Court pointed out problems in integrated planning by the bodies in charge of hydroelectric exploitation of the rivers of the logistics corridor and for waterway transport in the Teles Pires, Juruena, and Tapajós waterways. This could lead to the dissociated construction between the hydroelectric power plants and the locks without analyzing the best moment for implementing level crossings.

In Decision 3290/2014-Plenary (TCU, 2014c), whose rapporteur was Minister Walton Alencar Rodrigues, the Court recommended to the Chief of Staff's Office that it promote integration between the hydroelectric planning of the MME and the logistics planning of the MT. The purpose is to ensure that the levels of navigability in the Tapajós river dams, when the studies for concession were performed, meet the transportation sector's need in economical and logistics terms.

3.5 LOGISTICS INVESTMENT PROGRAM: PIL RAILROADS

During the governance audit at PIL Railroads, TCU pointed out that the program was not based



on studies capable of indicating how concurrent modalities compete among themselves or complement the new stretches that integrate the program. This could cause obstacles (logistics bottlenecks) in delivering railway freight due to the incompatibility with the receiving port's infrastructure and its operational capacity and the underutilization of the railroad network.

In Decision 1205/2015-Plenary (TCU, 2015a), whose rapporteur was Minister Augusto Nardes, the Court made some recommendations to the Ministry of Transportation. One was that the Ministry's technical-economic studies should take into consideration the integration of the existing and future railroad network in the PIL planning, together with other modalities of transportation. Another recommendation was that the Ministry should evaluate the possibility of logistics bottlenecks coming up and possible underutilization of the stretches, due to insufficient demand for more than one modality of transportation in the same route or the lack of capacity in the ports to receive and store cargo.

3.6 SANITARY SEWAGE WORKS AND INTEGRATION PROGRAM OF THE SÃO FRANCISCO RIVER (PISF)

TCU carried out a performance audit regarding centralized orientation aiming to monitor sanitation sewage works in municipalities that would benefit from PISF, in the states of Pernambuco, Paraíba, Rio Grande do Norte and Ceará. TCU pointed out that the precarious state of sanitation sewa-

ge in most of the municipalities, together with the lack of agreements in some of them and the several bottlenecks identified in others, indicate that there are risks of pollution of the waters of PISF, which could jeopardize the full achievement of the project objectives.

In Decision 1421/2015-Plenary (TCU, 2015b), whose rapporteur was Minister Benjamin Zymler, the Court ordered that the Ministry of the Cities create an action plan with a schedule for adopting the measures needed to solve the identified problems. TCU also recommended that the Ministry of National Integration intensify actions together with the Ministry of the Cities and the National Foundation for Health, associated with state and local governments, aiming to cover the sanitation sewage services in the municipalities related to PISF that have a direct influence on the quality of waters to be transposed.

4. FINAL REMARKS

Projects are considered interdependent when the positive outcome of one depends on other projects. In general, there may be interdependencies when one project is influenced partially or totally by another in order to develop.

One of the areas that explores different interaction patterns between the projects is the infrastructure sector, not only because of the interactions among the several studies (engineering, market, location, size, among others) that are part of each project, but mainly because of the interdependencies between the various interconnected projects. Usually, infrastructure projects have a high level of interdependencies due to their own characteristics, which involve complexity, interdisciplinarity, risks and uncertainty in addition to synergy.

In practice, several problems are identified when the interactions and the interdependencies in investment projects are not properly considered. Failures in interdependent project planning and managing produce significant negative effects, such as: resource waste due to misuse, budget waste due to a bad selection of projects, non-compliance with the schedule, inter projects competition for scarce resources, among others.

Therefore, we need to understand and manage interdependencies, evaluating the degree of influence of these interactions on the possibilities of achieving

the objective of each project. Integrated, coordinated and articulated planning in addition to the effective management of these interdependencies lead to a series of benefits that contribute to success.

Traditionally, external control actions in the infrastructure sector have considered the evaluation of investment projects as an isolated entity, based on a fragmented view of its main components (cost, period and quality), without taking into account, however, the existing internal interactions between their components and, especially, the external interdependencies with other projects with significant synergy effects.

On the other hand, the reading of some of the recent judgments shows that TCU has been moving forward in evaluation of interdependent projects and that this innovative approach has great potential to contribute to governance in programs and projects of the infrastructure sector by strengthening the integrated, coordinated and articulated planning of a series of interconnected projects. This ensures greater optimization of projects and efficiency, efficacy of public expenditures in the sector with the final objective of increasing the country's competitiveness in the international scenario, as well as collective well-being.

Thus, we conclude that the exercise of regular external control of the infrastructure sector may be improved through a systemic approach that enables understanding of the multiple interdependencies between projects and their effects on a group of interconnected projects. This innovative approach may be applied both in the selection phase of audit subject matters by the technical units as in the planning and execution phase of each control action performed by the audit teams, as well as to monitor the concession stages within this Court.

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