Politecnico di Torino

Master's Degree in Building Engineering
A.y. 2023/2024
March 2024

Driving Factors of Concession Period in Public Private Partnerships

The case of Italy and Western Europe

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Abstract

Public-Private Partnerships (PPPs) are crucial for infrastructure development and delivering public services, as government entities collaborate with private sector organizations to achieve long-term objectives. One critical component of PPP contracts is the concession period, during which Special Purpose Vehicles (SPVs) handle financing, construction, operation, and maintenance of public assets. The concession period carries significant implications related to project risk, revenue, operational expenses, profitability, and bankability. There is currently a lack of studies that explore the factors influencing concession periods in national and international PPP programs, particularly for social infrastructure projects reliant on availability payments. The research work conducted as part of this thesis work aims to bridge this gap by identifying and analyzing the impact of various potential factors on concession period duration using linear regression analysis on a dataset of healthcare PPP projects in Italy as well as various social PPPs in Western European countries. The study contributes theoretically to understanding the factors driving concession periods in PPP projects and offers insights for a balanced approach to PPP project planning, regulation, and associated strategies. Practically, it enables decision-makers to negotiate concession periods that optimize project success and sustainability in public infrastructure endeavors.

Keywords: PPP; risks; project delivery; SPV; healthcare PPP; public infrastructure; decision making; social PPP, PFI

1. Introduction to Public Private Partnership

Public infrastructure constitutes the backbone of any modern society, encompassing an extensive array of physical and organizational structures and facilities. These vital assets are either owned, operated, or financially supported by the government or public authorities, contributing significantly to the seamless functioning and advancement of society. Their pervasive impact extends to various facets of communal life, playing a pivotal role in fostering development, ensuring well-being, and driving economic prosperity at the local, regional, and national levels. Public infrastructure can cover a wide range of sectors, and examples include transportation systems, utilities, communication networks, public buildings, and social infrastructure like schools and hospitals.

The importance of public infrastructure can be understood through various perspectives; through economic development by enabling the transportation of goods and services, trade and commerce, and providing the essential energy infrastructure for industrial activities; through job creation due to the demands for planning, construction, and maintenance of these structures, contributing to economic growth and stability; direct improvement in the quality of life through the creation of public spaces and recreational facilities, as well as accessible and reliable transportation systems to reduce travel time; improving of education and public health facilities through the realization university, schools, hospitals, clinics, etc. projects; enhancing connectivity and communication and facilitating the exchange of information using broadband and mobile networks; and finally incorporating environmentally sustainable practices and ensuring resilient and adaptable planning against natural disasters and climate-related challenges.

Hence, that is why it is important to consider, and experiment with if need be, the various execution methods and contract schemes that might be optimal for the successful, efficient, and cost-effective realization of these public infrastructures. Accordingly, a review of some of the main project execution methods for public infrastructures, some of which are newer and others considered more traditional, is available below:

- Design-Bid-Build (DBB) in which the government or a public agency directly contracts with an architect or engineering firm to design the project, and then proceeds to put out the

project for competitive bidding, from the result of which the chosen contractor constructs the project according to the approved plan.

- Design-Build (DB) in which the public entity contracts with a design-bid firm, which is responsible for both the design and construction phases of the project, streamlining the process and potentially accelerating project delivery.
- Construction Management at Risk (CMAR) in which the public agency hires an external construction manager during the design phase, and the construction manager subsequently becomes responsible for managing the construction process. In this type of contract, the construction manager assumes some level of financial risk, often guaranteeing a maximum price for the project.
- Build-Operate-Transfer (BOT), also known as Public-Private Partnership (PPP) or Private Finance Initiative (PFI), is a type of contract which usually involves a public agency and a private entity. The private partner may design, finance, build, operate, and maintain the infrastructure for a specified period, before transferring it back to the client, which in the case of public infrastructures would be the government/public agency.

Public Private Partnerships (PPPs) could be considered the more developed and newer of the aforementioned, and differ from the others on two key accounts; the partial financing of the project by the private entity, unlike other contract types in which the main client, aka the public entity, is responsible for the monetary sponsorship of the project; and the temporary assignment of the operation and maintenance of the public infrastructure to the private entity, and subsequently allocating the corresponding potential risks.

The general scheme of Public Private Partnerships is as follows; a public infrastructure project is put out by the public entity, for instance in the form of a call for bids. Sequentially, various private entities called Special Purpose Vehicles (SPV) put forward their bids for the projects. These SPVs are formed by a gathering of several private firms to fulfill a particular and often temporary purpose. SPVs are useful in various financial, business, and investment transactions to isolate certain risks, protect assets, or achieve specific financial, tax, or regulatory objectives. In the case of PPPs, the formation of SPVs further helps enhance the expertise as well as the financial capability of the private partners involved in it. Moving forward, after one of the bidders is

nominated by the public agency, the chosen SPV becomes responsible for the design, build, operation, and subsequent maintenance of the public infrastructure in the form of a concession. In addition to that, the private entity helps fund the project to a degree using the SPV equity, private debt, as well as public contribution. This public contribution can be in the form of direct monetary subsidies, either in large initial amounts or spread into annual instalments, or alternatively by providing guarantees on the SPV profit margins. Finally, after a predetermined concession period has passed, the operation of the public infrastructure is transferred back to the public authorities.

Public Private Partnerships can further be defined as cooperative ventures between government entities and private sector organizations [1]. They involve a collaborative arrangement where both parties contribute resources, expertise, and capital to achieve public infrastructure projects and deliver public services [2]. In these projects, the private sector provides its expertise in handling the risks related to the construction and operations of these projects, while the public sector provides legal frameworks and, frequently, funding to carry out public projects [3]. PPPs are largely used for infrastructure development and service delivery in developed and developing countries [2].

To be more comprehensive, it is not without merit to note that PPPs may take various forms, and the following key features may vary depending on the type of the project and contract specifications, and can bring with them a variety of benefits for both the public and private partners:

- Shared responsibilities: Both the public and private partners contribute to the project in terms of financing, expertise, and resources to variating degrees. As a result, the risks and rewards are often shared between the two parties.
- Risk allocation: One of the advantages of PPPs is the ability to allocate risks appropriately. The private sector may take on certain operational and financial risks, while the public sector retains control over policy and regulatory aspects.
- Innovation and efficiency: Private sector involvement often brings innovation, efficiency, and cost-effectiveness to projects. Private companies are motivated to deliver projects on time and within budget to maximize returns on their investment.

- Long-term agreements: PPPs typically involve long-term agreements, often spanning several decades. This provides stability and allows the private sector to recoup its investment over an extended period.
- Performance-based contracts: Contracts in PPPs are often structured based on performance criteria. Payments to private partners may be linked to the successful achievement of predefined outcomes or service levels.
- Financing models: Private partners may secure financing for the project through a combination of equity, loans, and other financial instruments. This helps spread the financial burden and attract private investment.
- Public input: PPPs require careful consideration of public interests, and mechanisms are often in place to ensure public input, transparency, and accountability.

Accordingly, Public Private Partnerships have several key components that could affect the overall performance and stability of the PPP contract, as well as ensure long-term effectiveness and profitability of the project for both the public and private partners. One of these would obviously be the monetary investment that is needed for the realization of the project. This investment can include any capital investment in the initial construction phase of the public infrastructure project, as well as the costs related to those needed for the operation and maintenance of the facility, continued wages, or miscellaneous expenses. In addition, these costs may be covered by equity of the shareholders, through leveraging private debts, or by receiving government budget in the form of public subsidies. Hence, the amount of monetary public contribution and the subsequent percentile share of the required project investment by the public entity is also an important component that is of interest for decision-makers. Other potential important factors include equity to debt ratio for the sake of project profitability and bankability, the size and number of the private companies that together form the SPV entity, the time and duration of the contract procurement and award to the chosen bidder, the complexity of the project and the number of years for construction, as well as the population using the facility and the country in which the public infrastructure is located. Finally, one other very important factor in the duration of contract in which the private entity has the responsibility to operate and maintain the public infrastructure and then transfer back to governmental bodies.

Hence, we come to the main purpose of this thesis which is to analyze the effect of these components on carrying out PPP projects in a successful way, and whether there is a relationship between the aforementioned factors and how they interact with and influence each other, mainly focusing on the business case of PPPs in the contracting stage of the project. The result of this research work have culminated in the realization of two research articles, both on the influencing factors on the duration of concession periods in PPP projects.

To give an initial overview, the first paper named " *Driving Factors of Concession Period in Healthcare Public Private Partnerships*" focuses on the extent to which the various components and factors present in a PPP contract can affect the duration of concession, and whether their relationship is positive or negative in prolonging period in which the concessionaire has to operate and maintain the public asset. This paper primarily focused on PPP cases in Italy that are carried out in the public health sector, namely the construction and renovation of hospitals, clinics, specialized health centers, or nursing facilities. The second paper on the other hand, whose results are ready at the time of this thesis being written and is currently in the pre-text stage, incorporates a higher number of social projects, be it hospitals, schools, administrative buildings, entertainment complexes, accommodation, military centers or even prisons, and further extends the scale to some other western European countries such as Germany, France, the Netherlands, and Belgium. Though similar to the first paper, the second paper has also focused on the concession period as its result variables, and makes use of some similar factors as the previous study, though adding also some country-related variables such as GDP per capita.

Finally, before moving on to the research papers' analyses and the influencing factors on concession periods, it is not without merit to first showcase a summary of a literature review of some previous research work that has been conducted in the field Public Private Partnerships. The comparison of the result of these papers, almost all of which are in the case of Italian PPPs, enable us to find out about the course of development of PPP projects in Italy, and help better show the possible gaps that possibly justified the research work that was done as a part of this thesis undertaking.

2. Literature review

Initial papers focus on the development and effectiveness of the first real PPP contracts in Italy. One such example, [45] attempted to compare the effectiveness of PPP contract compared to traditional project procurement methods by analyzing contractual PPP project cases of the early 2000s based on their value, concession procedure, as well as percentage of projects actually conducted and followed through. Their findings indicate that in both cases of public and private initiatives following a PPP scheme, the projects showed improved results compared to traditional procurement, whether in design, construction over cost, and time delay. As a part of their research results, they proposed for the risks related to technical matters and the provision of services to be assigned to the private sectors, while the public sector only having to take care of management and "how" the health services are to be provided. In addition, they found out that it is recommendable to follow a gradual annual payment or commercial revenue finance scheme rather than upfront public payments to increase financial efficiency, though naturally this too has the potential risk of overburdening the public budget in the longer term.

Similarly, [53] analyzed some of the healthcare PFI projects that took place in Italy throughout the early 2000s, in which they carried out an empirical analysis through interviews using questionnaires filled by subjects responsible for the PFI of each healthcare trust. Understandably, they found out that the early PFI projects in Italian health care system mainly only considered the profitability of the private partner rather than the public in the long run, and lacked a specific normative framework on PFI. This was most probably due to the fact that in the preliminary stages of the development of PFI projects in Italy, the governing authorities mostly viewed as a scheme to make up for budget shortages and lack of funds in the short-term which were needed to realize some of the healthcare construction or renovation projects, and they mainly sought the short-term monetary investment that the private sector could offer. As a result, there were no particular frameworks in place to regulate PFI contracts in a way that would ensure the preservation of the long-term benefits and profitability of the public. Nevertheless, the profitability of the private sector was ensured by the public partner in order to build trust and attract SPVs to engage in PFI projects. As a result of their research, the aforementioned paper suggested the thorough ex-ante evaluation of a PFI from an economic point of view to enable the public organization to foresee

the future running of the partnership and to plan strategies for confronting possible opportunistic behavior of the private partner.

To determine the performance of PPPs, [14] analyzed more than a dozen privately financed cases for Italian National Healthcare Service (SSN) to assess the profitability of PPP project of SSN and potentially identify excessive rates of return for private investors at the expense of the public partner. It accomplished that by first estimating the Weighted average cost of capital for the projects and then comparing it to their respective internal rate of return (IRR) and net present value (NPV). As it turned out, most of the projects were estimated to be highly favorable for the private investors, and the healthcare organizations were in part covering too much of the PPP initial investments through public financing. In order for the public healthcare authorities to be able to improve Value for money in their PPP projects, the paper pointed out at the need for public organizations to come up with ways of standardizing PPP contracting, one example being treasury-mandated contractual clauses which specify a sharing of the gains in the case of refinancing.

To analyze the effects of some of the risk factors in BOT contracts, [12] considered a set of pay toll-road projects. They performed the linear regression analysis statistical method to analyze the positive/negative effects of identified BOT risks, independent variables, on BOT capital structure, response variable. They identified 12 potential risk parameters, which were categorized into five main sources of country-related indicators, financial, revenue, project, and those related to SPV structure. Through their findings, it was showcased that inflation rate, investment amount, construction duration, and number and size of SPV partners have a significant effect on deciding the equity share in BOT projects.

In another study, [40] also used regression analysis to determine the influence of risk factors, this time on the level of public funding, focusing on Italian BOT hospital projects. Among the variables that were identified to be significant factors for deciding the amount of public funding are project size, SPV solidity, concession period, and public burrowing. On the other hands, there were other potential factors that were ruled out either due to high multicollinearity, unideal significant p-factors, and low responsiveness, namely healthcare infrastructure index, banking and financial service index, location, catchment population, and number of services provided by the hospital.

[39] further utilized linear regression analysis to determine the effect of risk factors on PPP capital structure, specifically the amount and payment system of Unitary Charges (UC) based on the

allocation of risks to the SPV as a form of risk premium. In their study, this time they carried out the analysis on PPP projects that were conducted in the United Kingdom. Among the potential risk factors that were analyzed, regulatory quality, employment rate, hospital capacity, and construction time intervals were identified to be significant factors of the UC amount. It should further be noted that inflation rate, government effectiveness, private credit was disregarded from the analysis due to the presence of high collinearity between the variables. In addition, the paper arrived at the conclusion of the influence of public and private sectors' experience in forming contractual agreements on the PPP project capital structure and the amount of unitary charges, stemming from the fact that PPP project scheme have been going on for a longer period in the UK than in Italy, thus benefitting from higher performance and effectiveness as well as more efficient regulatory frameworks.

In another study, [46] made use of multiple linear regression (MLR) to analyze the influence of identified potential risk factors, translated into parameters, on Equity share. In this paper they studied a significant number of BOT projects in the fields of power and transportation infrastructures as well as social facilities financed by World Bank across a multitude of countries. Considering that this time their study was conducted based upon cases from various countries, more nation-related influencing factors were also taken into account. As a result of their analysis, they found out that government effectiveness, GDP growth, revenue risk, investment size, project complexity, construction duration, and average size of partners proved to be the influential risk factors on the result variable which was the project equity share.

As a continuation of their work towards analyzing the effects of potential risk factors in PPP projects using linear regression analysis, [48] did another research study to determine the influence of risk factors on Debt Ratio in various Project Financing Initiatives in energy industry. The results of their statistical analysis indicated that country stability index, construction duration, concession period, and SPV solidity or partner size are influential factors that may affect the project debt ratio, while parameters such as government effectiveness and regulatory quality were dismissed due having a high variance inflation factor which is an indication of the presence of multicollinearity. The outcome of their research could potentially help investors and SPVs to better choose their project financing strategies to enhance the project profitability and improve risk management.

After the latest Italian legislation in the year 2016 that aimed to regulate the PPP contract and make them more efficient, some later studies attempted to reevaluate the efficiency of PPP contracts and study their development throughout the first two decades of the twenty first century. Among those studies was [54] who did an attempt to analyze and compare several first generation healthcare PPPs, so called DBFMO contract, along with a couple of second generation PPPs, the so called Light Model. They came up with an Inductive/deductive research approach to bridge the gap between research and practice, focusing on the viability of DBFMO investment, and better introducing the Light Model PPP. In short, the "light model" typically refers to a simplified or streamlined version of the traditional DBFMO structure. This newer PPP model reflects a tailored approach to project delivery that balances the objectives of both the public and private sectors while simplifying certain aspects of the contractual framework. It aims to make PPP projects more feasible, attractive, and manageable for all parties involved. In any case, [54] concluded that DBFMOs can result in rigidity and lack of transparency for the provision and services, as well as excessive profit margins for private investors, public administration, or SPVs. According to them, while traditional DBFMOs can be useful for developing countries with the inclusion of noncore services by the SPV within the contract, it was originally only utilized as a source of private fund and is not efficient for developed countries, for those which the Light model is preferred. Overall, they suggest the creation of better regulations and more efficient national PPP management units for more effective monitoring of healthcare PPP contracts and their business case.

In a later study, [41] analyzed a set of first generation PPP projects implemented in the healthcare sector in Italy between 2002 and 2014 for the construction of new hospitals. They conducted a PPP performance assessment by using two dimensions of Value for Money and Contract Stability. The cases were classified based on their governance to local/decentralized, centralized, and collaborative. They findings indicated that while local and collaborative PPP governance systems saw more over cost and overtime, the centralized system for construction of the health facilities went through more renegotiation of the contract. A limitation of their study was the fact that they considered only the Italian cases that were awarded and carried out before the 2016 legislation on public private partnerships, meaning during which there were not yet specific institutional guidelines, legislation, or means of monitoring PPP cases.

After conducting a review of the aforementioned papers along with other papers of similar nature, it was found out about a lack of particular analysis of PPP projects' concession period and also the potential risk factors and influential parameters that might affect its duration, and particularly for Italian PPP cases at that, it was deemed appropriate to proceed with the research with a focus on optimal concession periods and the risk variables that could affect its length in the contracting and business case preparation stage of PPP projects. In the following sections are available the introduction into concession period, its conceptualization and implications, as well as the considered methodology for conducting an appropriate analysis.

3. Introduction into Concession Period

An essential aspect of a PPP contract is the concession period, which refers to the time during which a business entity, namely, Special Purpose Vehicle (SPV), is responsible for financing, building, operating, and maintaining a public asset before transferring it back to the granting authority [4]. The duration of the concession period may span from 10 to 99 years, but usually lasts from 20 to 30 years. A typical concession duration is set as a fixed 30-year long period, such as in bridges, pay toll roads, and other transport infrastructures [5]. However, a reasonable length of the concession period must be determined and negotiated in order to compensate the SPV with an appropriate return on investment and risk taking [6]. Thus, ensuring an appropriate period of concession is important for the following reasons from different aspects:

- Financial Viability and Return on Investment (ROI): The concession period directly impacts the financial viability of the project. It determines the duration over which the private sector partner can recover its initial investment, generate revenue streams, and earn profits. A longer concession period provides the SPV with more time to recoup its investment and achieve a satisfactory return.
- Risk Allocation and Management: The concession period influences the allocation and management of project risks between the public and private sectors. A longer concession period allows the SPV to spread its risks over a more extended timeframe, mitigating the

impact of uncertainties such as market fluctuations, regulatory changes, and unexpected operational challenges.

- Cost Recovery and Financing Considerations: Infrastructure projects typically involve substantial upfront capital investments and ongoing operational costs. The concession period must be sufficient to enable the SPV to recover these costs through user fees, government payments, or other revenue streams. A well-structured concession period ensures that the SPV can secure financing on favorable terms and meet its financial obligations throughout the project lifecycle.
- Operational and Lifecycle Considerations: The length of the concession period must align with the operational and lifecycle requirements of the infrastructure asset. It should allow the SPV to effectively maintain, operate, and manage the asset over its entire lifecycle, ensuring optimal performance, reliability, and safety for users and stakeholders. Longer concession periods provide the SPV with greater incentives to invest in preventive maintenance, upgrades, and asset renewal activities.
- Market Dynamics and Revenue Projections: The concession period should take into account market dynamics, demand forecasts, and revenue projections for the infrastructure service or facility. It should allow the SPV to capture projected revenues and adapt to changing market conditions over time. Flexibility in concession terms may be necessary to accommodate fluctuations in user demand, technological advancements, and competitive pressures.
- Government Objectives and Policy Considerations: The concession period should align with the government's strategic objectives, policy priorities, and long-term infrastructure plans. It should strike a balance between promoting private sector participation, ensuring value for money, and safeguarding public interests. Negotiating a reasonable concession period requires close collaboration between the public and private sectors to achieve mutually beneficial outcomes.

A vast literature reports cases of PPP projects where the duration has implications on the risk profile and financial viability, such as municipal buildings, urban infrastructures, and social facilities [7,8,9]. The following now focuses on the adverse implications that an overly extended concession period might have on the public, private entity, as well as the PPP project as a whole.

In fact, the concession period has several significant implications. Firstly, longer concession periods increase project-related uncertainties and risks, as economic, political, and social conditions can change over time, affecting the project's viability and regulatory environment [10]. Extending upon the risks associated with longer concession periods, the following are some of the types of uncertainties that might come along with extended periods and their respective implications on PPP projects:

- Economic Uncertainties: Long-term economic forecasts can be challenging to predict accurately. Economic downturns, fluctuations in interest rates, inflation, and currency devaluation can significantly impact project revenues and financing costs. Extended concession periods amplify these uncertainties, potentially exposing both public and private partners to financial risks.
- Political and Regulatory Risks: Political landscapes and regulatory environments evolve over time. Changes in government policies, legislation, or regulations can directly affect the profitability and operational dynamics of PPP projects. Longer concession periods increase the exposure to such risks, as governments may enact new laws or policies that adversely impact project revenues, operating conditions, or contractual obligations.
- Technological Obsolescence: Rapid technological advancements can render infrastructure assets obsolete or less competitive over extended concession periods. Innovations in construction methods, materials, and operational technologies may emerge, making existing infrastructure less efficient or cost-effective. PPP agreements must incorporate provisions for technology upgrades or adaptation to mitigate the risk of asset obsolescence.
- Social Dynamics and Stakeholder Expectations: Societal values, preferences, and expectations evolve over time, influencing infrastructure usage patterns, environmental standards, and community engagement requirements. Extended concession periods necessitate robust stakeholder engagement strategies and flexibility to accommodate changing social dynamics while maintaining project viability and sustainability.
- Climate Change and Environmental Risks: Climate change poses significant challenges to infrastructure resilience and longevity. Rising sea levels, extreme weather events, and changing environmental regulations can impact infrastructure design, construction standards, and operational resilience. Longer concession periods require comprehensive

risk assessments and adaptive strategies to address climate-related risks and enhance project resilience.

- Market Volatility and Competitive Pressures: Market dynamics and competitive pressures in sectors such as transportation, energy, and utilities can fluctuate over time due to technological disruptions, market consolidation, or shifts in consumer behavior. Extended concession periods amplify the need for robust risk management frameworks, market analysis, and competitive intelligence to adapt to changing market conditions and sustain project profitability.

Moreover, longer periods lead to higher Operational Expenses (OPEX) for the private partner due to maintenance, upgrades, and labor costs [11]. Additionally, longer concession periods prolong the payback period for private companies, impacting cash flow and financial viability [12]. Extending upon the implications of longer concession periods on project cash flow, with longer concession periods, private companies may experience delays in generating revenue from the project. Revenue streams, such as user fees, availability payments, or government subsidies, might take longer to materialize, especially if demand for the infrastructure service or facility ramps up gradually over time. Extended concession periods also typically require private companies to secure long-term financing to support project development and operations. Longer loan tenures or bond maturities may result in higher interest expenses and financing costs over the project's lifecycle, reducing cash flow available for debt service and dividends. In addition, operating and maintenance expenses associated with the infrastructure asset tend to rise over time due to inflation, labor costs, technology upgrades, and regulatory compliance requirements. Longer concession periods necessitate sustained investments in asset management, maintenance, and lifecycle renewal activities, contributing to higher operating expenses and reduced cash flow. Moreover, longer payback periods limit private companies' ability to realize returns on their investment and achieve targeted rates of return within a reasonable timeframe. Delayed cash flows and prolonged capital lock-in may erode the project's overall ROI and reduce the attractiveness of future investment opportunities. Finally, prolonged payback periods may affect the valuation of PPP projects and investor confidence in the company's financial performance and growth prospects. Investors and lenders may perceive longer concession periods as increasing project execution risks, liquidity constraints, and exposure to adverse market conditions.

Furthermore, longer durations may result in higher Capital Expenditures (CAPEX) during the construction phase to ensure long-term performance [2]. To further elaborate on that, longer concession periods necessitate higher quality standards and durability requirements for the infrastructure asset to ensure its long-term performance and resilience. The need may rise to invest in premium materials, advanced construction techniques, and innovative technologies to enhance the asset's lifespan and minimize maintenance needs over time. Private partners must also consider the total lifecycle cost of the infrastructure asset, including construction, operation, maintenance, and renewal expenses, over the concession period. Investing in higher-quality materials, equipment, and infrastructure design during the construction phase can help mitigate future operational risks and reduce lifecycle costs associated with asset maintenance and repairs. In addition to that, longer concession periods expose private companies to greater operational and performance risks over time. Investing in robust construction practices, replacement of redundant systems, and state-of-the-art safety measures during the construction phase can help mitigate risks related to asset degradation, technological obsolescence, and regulatory compliance throughout the concession period.

Moreover, longer concession periods result in the need to anticipate future demand growth and capacity requirements for the infrastructure asset over its operational lifespan. SPVs might need to invest in additional construction and expansion activities during the initial phase to accommodate projected increases in user demand, population growth, or changing market dynamics over time. Furthermore, longer durations may require incorporating technological innovation and adaptation into the infrastructure design and construction process. Private entities may invest in flexible and scalable infrastructure solutions that can accommodate emerging technologies, regulatory changes, and evolving user preferences over the project's lifecycle. Finally, PPP projects with a longer concession period must possibly comply with some stringent regulatory requirements and environmental standards throughout the asset's lifecycle. In order to implement sustainable construction practices, renewable energy solutions, and environmentally friendly design features that align with regulatory mandates and stakeholder expectations, private companies may incur higher CAPEX during the construction phase. These capital commitments tie up financial resources and limit the company's ability to allocate funds to other investment opportunities or operational needs.

Longer concessions also may trigger detrimental impacts on public funding in the long term due to the longer payback periods for the SPVs [13]. Several factors may contribute to this:

- Reduced Budget Flexibility: Longer payback periods for SPVs result in extended timelines for the repayment of private sector investments and the realization of returns. This may limit the availability of public funds for other critical infrastructure projects, public services, or budgetary priorities, constraining the government's budget flexibility and financial capacity to address emerging needs and priorities over time.
- Increased Debt Service Obligations: Extended concession periods require the government to honor its financial commitments, including debt service payments, availability payments, or revenue-sharing arrangements with the private sector partners. Higher debt service obligations associated with longer concessions can strain public finances, increase borrowing costs, and divert resources away from essential public services, social programs, or infrastructure investments.
- Opportunity Costs and Fiscal Constraints: Longer payback periods for SPVs may result in opportunity costs for the government, as financial resources tied up in PPP projects cannot be allocated to other pressing needs or strategic initiatives. Fiscal constraints arising from prolonged concession terms may limit the government's ability to address socioeconomic disparities, promote inclusive growth, or respond to unforeseen economic challenges and crises.
- Impact on Future Budget Planning: Longer concessions introduce uncertainties and risks into the government's long-term budget planning and forecasting processes. Fluctuations in macroeconomic conditions, interest rates, and revenue projections can impact the government's ability to meet its financial obligations and maintain fiscal sustainability over the concession period, potentially leading to budgetary deficits or austerity measures.
- Political and Regulatory Constraints: Prolonged concession periods may face political and regulatory challenges, as changes in government priorities, leadership, or policy frameworks over time can affect the implementation and financing of PPP projects. Political uncertainty and regulatory instability can undermine investor confidence, delay project execution, and increase the cost of capital for future infrastructure investments.
- Public Accountability and Transparency: Longer concessions require enhanced public accountability and transparency in the management and oversight of PPP projects.

Governments must ensure robust monitoring, reporting, and evaluation mechanisms to track project performance, assess value for money, and safeguard public interests throughout the concession period, mitigating the risk of financial mismanagement or regulatory non-compliance.

Understanding the driving factors behind concession periods is then crucial for effectively regulating PPP contracts [14]. Although there are countless papers on models to determine "optimal" concession periods of PPP projects [4,11,13,15,16,17], far less attention has been devoted to understanding the determinants of the concession period based on evidence from projects conducted within national PPP programs. Moreover, the definition of an adequate concession period becomes more complex for social infrastructure PPPs, particularly under an availability payment mechanism. To contribute to addressing these gaps, this study conducts a statistical analysis of PPP projects to build or renovate Italian healthcare facilities in order to analyze the main factors that may influence the concession period of PPPs. This is expected to contribute to a better definition of the concession period, especially for social infrastructure that does not rely on user payments.

4. Conceptualization of PPP Concession Period and its Implications

The concession period denotes the timeframe during which the concessionaires are entrusted with the responsibilities of financing, constructing, operating, and maintaining a public capital asset before its eventual transfer back to public authorities [13]. This temporal dimension assumes profound significance as it encapsulates several pivotal facets of the project.

Primarily, the concession period functions as an indicator of the protracted uncertainties inherent in the project. A protracted concession period augments the spectrum of uncertainties and risks associated with the undertaking [18]. Prolonging the partnership's duration extends the window within which various risks and uncertainties may manifest [17]. Economic, political, technological, and societal conditions can undergo substantial transformations over extended periods [15], thereby impacting the project's fiscal feasibility, demand forecasts, regulatory frameworks, and

operational milieu. Effectively managing these uncertainties becomes increasingly challenging with the elongation of the concession period, potentially resulting in unforeseen expenditures, performance gaps, or disputes between the public and private stakeholders.

Moreover, protracted concession periods entail a lengthier provision of operational services, consequently yielding higher overall OPEX. As the partnership endures over an extended timeframe, the private partner assumes responsibility for the sustained maintenance and operation of the infrastructure or the continuous provision of services. Over time, operational outlays, including maintenance, repairs, upgrades, and labor costs, are prone to escalation due to factors such as inflation, evolving market dynamics, and aging infrastructure [19]. Additionally, as the project evolves and technological advancements materialize, the private partner may necessitate investments in modernization or the adoption of emerging technologies, further amplifying operational expenditures [15].

Moreover, the concession period significantly affects the determination of the payback period of the SPV's investment. Longer concession periods result in a delayed payback period for the private companies involved and the private equity invested in the public project [11,12]. Extending the time frame for revenue generation may trigger multiple underperformances such as gradual project ramp-ups and lower accuracy in long-term demand [20,21,22]. Moreover, prolonging the payback period for the SPV impacts project cash flow and long-term public payments. From a public sector's perspective, longer concession periods mean a prolonged duration of public payments and an increase in long-term subsidies paid by the government because the project IRR is significantly higher than the public debt interest rate [2]. Additionally, during the concession period, the long-term public payments necessarily imply diverting funds from the public budget and potentially impacting other public expenses [23].

Furthermore, a longer concession period can further be detrimental as it can lead to a larger Capital Expenditure (CAPEX) in the construction phase. As the SPV takes the operation responsibility for a longer period, it may need to invest more upfront capital during the construction phase to ensure the infrastructure meets the expected standards and requirements for a larger concession period. This may involve additional spending on higher quality materials, enhanced design features, technological advancements, or future proofing measures [24]. While this approach aims to

minimize the need for major upgrades or costly modifications in the later stages of the project, it also requires more upfront financial resources.

As a consequence, it is crucial to determine the driving factors for the concession periods of healthcare PPP projects. The first step towards this endeavor is analyzing the potential driving factors that influence the length of the concession period. Conducting a comprehensive analysis of these factors can help improve decision making, and enhance the performance and sustainability of PPP projects [25,26].

The interplay between project risk and concession period is intricate, dynamic, and profoundly influenced by the nature and magnitude of the associated risks [27]. These risks yield substantial influence over the economic feasibility of projects, alongside their capacity to allure investments and secure financing [4]. The rationale behind this lies in the potential for risks to precipitate substantial financial losses and obligations, consequently undermining the financial robustness of these projects and diminishing their attractiveness to investors and financiers [28].

The risk profile characterizing PPPs typically delineates the probability and potential consequences of events that could impact the project's cost, schedule, or performance during the concession period [29]. A multitude of factors can exert influence on the risk profile, encompassing technical intricacy, legal and regulatory prerequisites, market conditions, financial exigencies, and environmental hazards [17].

PPPs inherently bear a higher risk profile compared to conventional procurement methodologies due to their protracted engagement between the involved parties across multiple lifecycle phases, ranging from planning and design to construction and operations [30]. To further elaborate on this, first of all PPPs involve complex relationships between public and private sector entities, necessitating extensive collaboration, negotiation, and coordination across various stakeholders. The prolonged engagement increases the likelihood of disagreements, conflicts of interest, and challenges in aligning objectives and expectations between the parties. Secondly, PPP projects are subject to evolving regulatory frameworks, legal requirements, and contractual obligations throughout the concession period. The prolonged engagement heightens the risk of regulatory changes, compliance issues, and legal disputes, which can impact project timelines, costs, and stakeholder relationships. Moreover, public private partnerships are exposed to market and economic dynamics, including inflation, exchange rate fluctuations, interest rate volatility, and

macroeconomic uncertainties. The extended engagement increases sensitivity to external factors, such as changes in consumer behavior, competitive pressures, and geopolitical risks, which can impact project revenues, operating costs, and investor returns. Last but not least, the protracted engagement in PPPs exposes stakeholders to operational and performance risks across the asset lifecycle. Issues related to asset management, maintenance, service delivery, and user satisfaction may arise over time, requiring proactive risk management strategies, performance monitoring, and continuous improvement initiatives to ensure project success and stakeholder satisfaction.

The concession period underpinning a project delineates its framework, incorporating the roles and obligations of the public and private counterparts with respect to elements such as financing, revenue, and risk [31]. The PPP business model necessitates meticulous design to ensure the project's fiscal viability and judicious allocation of risks [32]. A fair allocation of risks between public and private sector partners further incentivizes efficient project delivery, mitigates potential liabilities, and safeguards public interests. Meticulous design involves identifying, assessing, and allocating risks across various project phases, including design, construction, operations, and maintenance, based on each party's expertise, capacity, and risk tolerance.

In addition, an effective private financing initiative ensures the delivery of value for money and achieving efficiency gains compared to traditional procurement methodologies. Efficient design of the PPP contract focuses on optimizing project outcomes, minimizing lifecycle costs, and maximizing benefits to stakeholders, including users, taxpayers, and investors. This may involve adopting innovative procurement strategies, performance-based contracting mechanisms, and incentive structures to incentivize private sector participation and drive continuous improvement. PPP projects additionally require transparent and competitive procurement processes to attract qualified private sector partners, promote market competition, and enhance project transparency and accountability. They further necessitate active stakeholder engagement and collaboration throughout the project lifecycle to build consensus, manage expectations, and address concerns effectively. Fostering constructive dialogue, building trust, and aligning interests among diverse stakeholders, including government agencies, investors, lenders, contractors, suppliers, and end-users is a given in order to promote project success and sustainability.

The correlation between a PPP project's risk profile and its concession period is intricate. A heightened risk profile typically mandates a more substantial financial commitment from the

private partner, consequently influencing the concession period. In essence, the private partner may demand a greater return on investment to offset the heightened risk, potentially resulting in longer concession periods [33]. Consequently, the business model must be artfully devised to strike an equilibrium between risk and return for both parties.

To mitigate the impact of risks on the PPP concession period, it is imperative to adopt suitable risk management strategies tailored to the precise nature and magnitude of these risks. This means an exhaustive comprehension of the risks associated with specific infrastructure types, along with the technical, financial, and regulatory challenges they may pose. One approach to risk management in PPP projects involves the adoption of a risk-sharing business model, entailing the apportionment of risks and rewards between the public and private sector partners [34]. This approach ensures that both parties have a vested interest in the project's success and are incentivized to embrace optimal risk management practices. In a risk-sharing business model, risks associated with PPP projects are identified, assessed, and allocated to the party best equipped to manage them effectively. This allocation is based on each party's expertise, resources, risk tolerance, and ability to influence project outcomes. By distributing risks across multiple stakeholders, the risk-sharing model seeks to mitigate the impact of adverse events, uncertainties, and contingencies that may arise throughout the project lifecycle. As a result of effective risk distribution, stakeholders will not see a need for longer concession period to make for potential monetary losses, which also further helps reducing long-term risks.

Another approach involves optimizing project design and development to enhance the economic viability of PPP projects without requiring an increase in the concession period, thereby diminishing financial risks and other prospective liabilities. Furthermore, optimizing project design and development contributes to risk mitigation by addressing potential sources of uncertainty, variability, and project delays upfront. By conducting thorough feasibility studies, risk assessments, and value engineering exercises during the project planning phase, PPP stakeholders can identify and mitigate risks associated with design flaws, construction delays, cost overruns, and operational inefficiencies.

The mitigation of these risks further augments the social and environmental sustainability of PPPs [35]. Improving project design can elevate the project's social sustainability through fostering inclusivity, accessibility, and community engagement. By integrating stakeholder feedback,

addressing community concerns, and establishing avenues for local participation and employment, PPP projects can yield favorable social outcomes and bolster the welfare of impacted communities. Moreover, by optimizing resource usage, curbing energy consumption, and mitigating environmental footprints, PPP initiatives can advance sustainable development objectives and advocate for the conscientious management of natural resources.

5. Research Methodology (Paper I: Driving Factors of Concession Period in Healthcare Public Private Partnerships)

This paper presents an analysis of the various factors influencing the concession period in PPP projects. To achieve this, the first step is to identify a set of potential variables that could serve as influencing factors in the model. Subsequently, a statistical analysis method is employed to measure the effect of the chosen factors and their relationship with the concession period.

The analytical process unfolds in several distinct steps. The initial phase involves the meticulous identification of a set of potential variables that could serve as influential factors within the model. These variables are carefully chosen to encompass a broad spectrum of potential influencers on the concession period, taking into account past research and practical considerations. Once the potential variables were identified, data from real cases were gathered. To collect data on healthcare PPP cases, a triangulation approach was employed, drawing information from diverse sources including scientific literature, public databases, Italian newsletters, and direct access to the contracts of some PPP projects. In the first paper, a total of 28 healthcare PPPs initiated in 2004, with a total value of EUR 3.2 billion, were considered for analysis.

To give a little context about the analysis method utilized for this study, a series of statistical and semi-qualitative analysis methods, such as QCA, were all initially considered when conducting exploratory analyses on the gathered data. Considering the scaling nature of our data and the cases studies, it was decided that a statistical analysis method would be more appropriate compared to the QCA. Among the available statistical analysis methods, linear regression as well as ANOVA analysis was taken into account and tested upon. As for the ANOVA analysis, the results proved

inconsistent when considering the concession period as the result variable. Surprisingly, the ANOVA performed relatively well when considering instead the public share percentage as the result variable, which could in turn be interesting for further studies in the future.

In the end, a statistical regression analysis was chosen and conducted to identify significant drivers of PPP outcomes. This statistical technique enables the testing of the influence of independent variables on the chosen dependent variable, the concession period. It is worth noting that the correlation among the independent variables is closely examined to ensure that there are no collinearities among them.

5.1. Driving Factors for the Risk Model

This section presents the potential driving factors that may significantly influence the concession period of PPP contracts. The chosen variables include project investment size, project construction scale, project capacity, project normalized cost, public share, public experience, SPV size, and catchment population. Table 1 provides an overview of these factors.

Table 1: Potential factors influencing the Concession Period

Independent Variables	Quantifiable Parameter	Acronym
Investment Size	(Total Investment in €m)	InS
Project Construction Scale	(Construction period in years)	CoP
Project Capacity	(Hospital capacity as in No. of beds)	PrC
Normalized Cost	(Cost per bed)	CPB
Public Share	(percentage of Investment)	PSh
Public Experience	(year of contract award)	YCA
SPV Size	(No. of equity holders)	NoEH
Catchment Population	(No. of people in the served province)	CPop

The first variable considered is the overall investment size of PPP projects, which represents the total initial investment required to build or renovate the healthcare facility. It encompasses the sum of Public Financing, Private Debt, and Equity contributed by the SPV undertaking the project. Current practice and extant literature require considering the size of the project investment when estimating the concession period [36]. Similarly, construction costs have been considered in previous research as a potential factor affecting the concession period [13,16]. A couple of explanations could potentially justify the possible influence of total initial investment on concession period. First of all, the length of the concession period is often correlated with the time needed for the private sector partner to recoup its initial investment and generate returns. A higher initial investment may require a longer concession period to allow the private sector partner sufficient time to recover costs, earn profits, and achieve the desired ROI. Moreover, a larger initial investment may necessitate higher levels of debt financing to fund project development and construction. Longer concession periods provide greater flexibility for debt servicing and repayment, spreading the financial burden over an extended timeframe and reducing the annual debt service obligations for the private sector partner.

In addition, the length of the concession period is often aligned with the expected lifespan and amortization period of the infrastructure asset. Projects with higher initial investments, such as transportation networks or utility systems, may require longer concession periods to amortize capital costs and accommodate ongoing maintenance, renewal, and replacement expenses throughout the asset's lifecycle. As a final factor, the total initial investment also influences revenue generation and cash flow projections for the project. Projects with substantial upfront investments may require longer concession periods to achieve financial sustainability and meet revenue targets, especially if revenue streams are dependent on user fees, government payments, or other sources of income that materialize gradually over time.

The project construction scale, represented by the duration of the construction period, is another potential factor indicating the complexity and scale of the overall project [37]. Multiple studies have previously used the construction period as an indicator of project complexity and its impact on the concession period [13,17,38]. On the one hand, larger projects with longer duration of construction may be expected to be positively related to the concession period. To further elaborate on this, the start of revenue-generating activities is typically tied to the completion of the

construction phase in PPP projects. Projects with extended construction periods may experience delays in revenue commencement, impacting the private sector partner's cash flow, debt servicing capabilities, and overall financial performance. Longer concession periods may be required to provide flexibility to accommodate revenue delays and ensure financial sustainability. In addition to that, construction phases entail inherent risks related to project delays, cost overruns, supply chain disruptions, and regulatory compliance issues. Longer construction periods increase the exposure to construction-related risks, potentially impacting the project's financial viability and operational performance. Extending the concession period allows the private sector partner to mitigate construction risks, implement risk management strategies, and ensure project completion within agreed timelines.

Conversely, extant research also supports larger public projects can benefit from greater economies of scale, and, consequently, higher potential revenues that may result in shorter concession periods [39]. To further expand on this topic, as the scale of production or service delivery increases it usually results in the decrease of unit costs. In PPPs, larger projects enable the consolidation of resources, bulk purchasing, and streamlined processes, leading to lower per-unit costs for construction, operations, and maintenance. These cost efficiencies contribute to improved project economics and financial viability. Larger PPP projects also have the capacity to generate higher revenues due to increased demand, user volumes, and service utilization. Projects with greater scale and scope may attract more users, customers, or tenants, resulting in higher revenue streams from user fees, tolls, rents, or other sources of income. Additionally, larger projects may offer opportunities for ancillary revenue generation, such as advertising, sponsorship, or commercial partnerships. This means that the private partner is able to recoup initial investment costs and achieve profitability within a shorter timeframe. Consequently, accelerated revenue realization may facilitate shorter concession periods while maintaining financial sustainability.

The capacity of the healthcare PPP projects is also considered for the analysis, reflecting the number of patients the hospital can treat at a given time. Higher capacity could potentially generate higher revenue for the SPV over time. With higher patient capacity, healthcare facilities can diversify and expand their service offerings to meet the healthcare needs of a larger population. This may include introducing new medical specialties, clinics, diagnostic imaging services, rehabilitation programs, wellness initiatives, and preventive care services to attract patients and

generate additional revenue streams for the SPV. Literature highlights the importance of revenues and related uncertainties as determinants of concession periods [16]. Previous studies have also considered hospital capacity as a potential factor, though primarily focusing on public finance and project performance parameters [39,40,41]. This entails assessing indicators such as service quality, patient satisfaction, operational efficiency, clinical outcomes, utilization rates, revenue generation, and long-term viability of healthcare facilities operating under PPP models.

The normalized cost per bed is another factor considered to incorporate the investment made for each patient that can be simultaneously treated in the hospital. The normalized cost per bed is a financial metric that calculates the average cost incurred to establish and maintain each hospital bed in a healthcare facility. It takes into account the total investment made in constructing, equipping, staffing, and operating the hospital, and then divides it by the number of beds available for patient care. This factor could indicate the intensity of the investment and identify specialized facilities with particular complexities or risks. In addition to that, the normalized cost per bed helps PPP stakeholders understand how efficiently resources are utilized within the healthcare facility. A lower normalized cost per bed indicates that the investment in hospital infrastructure and services is spread across a larger patient population, suggesting greater efficiency and economies of scale in healthcare service delivery. This parameter has been utilized in studies of toll road PPP projects to account for the project's normalized cost [42,43]. The normalized cost per length in road PPPs allows for benchmarking and comparing toll road PPP projects against industry standards, best practices, and similar projects regionally, nationally, or internationally. This metric enables stakeholders to evaluate the project's cost competitiveness, pinpoint areas for enhancement, and devise strategies to enhance cost-effectiveness and financial performance over time.

Moreover, the public share, representing the proportion of the initial project investment paid directly through public subsidies, is another significant factor. Several studies have attempted to use public financing and government subsidies as a determinant of the concession period [4,36,44]. A balance between the level of government subsidies provided and risks borne by the private sector is crucial to the concession period [4]. On the one hand, a higher public share of investment can mitigate perceived risks for private sector partners. With greater public investment, private investors may be more willing to accept shorter concession periods as they feel more secure about

the project's financial stability and profitability. This increased confidence in the project's viability can lead to more favorable concession terms and shorter durations. In addition, a higher public share reduces the financing burden on the private sector. Private investors may require shorter concession periods when the public sector provides a significant portion of the upfront capital investment. This reduces the duration over which private investors need to generate returns, making shorter concession periods more feasible.

On the other hand, while it may seem counterintuitive, a higher public share of investment in PPP projects can sometimes result in longer concession periods. An increased public share often implies a lower risk appetite for private sector investors. In such cases, private investors may seek longer concession periods to spread their investment risks over a more extended timeframe, allowing for more gradual revenue generation and a longer period to recoup their initial investments. Moreover, private investors typically seek assurances of long-term financial sustainability before committing significant capital to PPP projects. A higher public share of investment may signal a lack of confidence in the project's revenue potential or profitability. To compensate for perceived financial risks, private investors may insist on prolonged concession periods to ensure sufficient time to achieve desired returns on their investments.

The year of contract award, serving as a proxy for the experience of the public authorities in regulating and carrying out PPP projects, is another factor considered. Public authorities' experience in regulating PPP projects tends to evolve over time. In the early stages of PPP implementation, regulatory frameworks may be less developed, leading to longer concession periods to accommodate uncertainties, mitigate risks, and provide flexibility for adapting to changing regulatory environments. As public authorities gain experience and refine regulatory processes, concession periods may become shorter, reflecting increased confidence and efficiency in project implementation. In addition, the experience of the public entity in managing PPP risks and securing project financing can influence concession period lengths. Inexperienced authorities may adopt more conservative risk allocation strategies, requiring longer concession periods to accommodate private sector concerns and ensure project bankability. As authorities become more proficient in risk assessment and project financing arrangements, concession periods may shorten, reflecting improved risk-sharing mechanisms and investor confidence. The effect of increased public experience in PPP projects has been pointed out in previous studies [45].

Moreover, as time passes, the PPP-enabling legislation is enhanced, in particular for Italy. The last legislation in this regard is the Italian Legislative for Public-Private Partnerships, which came into effect in 2016. Previous research has pointed out how public authorities focused primarily on utilizing private financing sources rather than adopting a value-for-money approach in PPPs procured decades ago, which resulted in imbalanced profit gains by the private sector in those projects [14]. In the early stages of PPP implementation, there was often limited emphasis on adopting a value-for-money approach. Public authorities were primarily concerned with securing private financing and delivering projects within budget and schedule constraints. As a result, the assessment of project feasibility, risk allocation, cost-effectiveness, and long-term value creation may have received less attention during project planning and procurement processes. In addition, private investors and concessionaires, motivated by profit-maximization objectives, negotiated terms and conditions that favored their financial interests over the public good. This could include higher revenue shares, guaranteed returns, or favorable risk allocations that disproportionately benefited the private sector. In some cases, the absence of competitive bidding processes and transparency mechanisms contributed to imbalanced profit gains for the private sector. Public authorities may have awarded PPP contracts through non-competitive processes, leading to limited price discovery and negotiation leverage for the public sector. This lack of competition allowed private investors to extract higher profits without facing competitive pressures to optimize project costs and deliver value for money. Public and private sector experience in PPP undertakings has also been pointed out as an important factor in previous studies [39]. Overall, it is expected that the more recent the contract award, the better the experience and capacities of the public sector in managing PPPs.

Furthermore, the size of the SPV participating in the PPP project is considered another potential factor that could affect the concession period. A higher number of companies and stakeholders in the SPV may indicate a stronger capacity to deal with project tasks. With more companies and stakeholders involved in the SPV, there is a greater potential for diversification of expertise, resources, and capabilities. Each entity brings unique skills, experiences, and networks to the partnership, enhancing the SPV's collective capacity to manage project tasks effectively. This diverse pool of talent and resources can strengthen the SPV's ability to address complex challenges, mitigate risks, and optimize project outcomes. In addition to that, a larger number of companies and stakeholders in the SPV enables broader risk sharing and mitigation strategies. By distributing

responsibilities and liabilities across multiple entities, the SPV can better manage project risks, withstand unexpected disruptions, and safeguard against single points of failure. This risk diversification enhances the SPV's resilience and reduces the likelihood of delays or failures that could impact the concession period. Previous studies have considered the SPV size as a potential contributor to the project risk [46].

However, a large number of partners in the SPV could be the result of higher perception of risk and complexity of the project. Projects perceived as high-risk or complex often require comprehensive risk mitigation strategies. In such cases, involving a larger number of partners in the SPV allows for risk diversification and the pooling of resources, expertise, and capabilities from various stakeholders. By spreading risks across multiple entities, the SPV aims to enhance resilience and minimize the potential impact of adverse events or uncertainties, which may necessitate a longer concession period to accommodate risk management efforts. Moreover, investors and financiers may perceive projects with higher complexity and risk profiles as less financially viable or more challenging to finance. To attract investment and build confidence among stakeholders, the SPV may need to demonstrate a robust partnership structure with a diverse array of reputable companies and institutions. The involvement of multiple partners in the SPV signals a collective commitment to project success and may contribute to securing financing arrangements that support a longer concession period. Finally, a large number of partners in the SPV might also increase the occurrence of contractual and management issues [47]. Managing a large number of partners in the SPV presents governance and coordination challenges, particularly in terms of alignment of interests, communication protocols, decision-making frameworks, and dispute resolution mechanisms. Addressing these challenges requires time and effort to establish effective governance structures and foster collaborative relationships among stakeholders, potentially prolonging the concession period to accommodate the complexities associated with managing a diverse partnership network.

Finally, the Catchment Population is added to the analysis. It represents the number of people the hospital or facility must serve in a given area or province. The catchment population has been used as an influencing variable for project outcomes in previous studies [40]. First of all, the size and capacity of the hospital infrastructure must align with the needs of the population. A larger catchment population may require a larger hospital facility with more beds, specialized

departments, and advanced medical equipment to adequately serve the community. Designing, constructing, and outfitting such a facility may extend the concession period to ensure that the hospital infrastructure meets the projected demand for services over the long term. Additionally, a higher Catchment Population may impact the project's profitability, and thus can be considered to assess its potential influence on the PPP Concession Period. A greater catchment population typically translates to a larger patient base and higher patient volumes, which can generate greater revenues through patient fees, insurance reimbursements, and other sources. Extending the concession period may allow the private partner to recoup its investment and achieve sustainable financial viability by leveraging the revenue potential associated with serving a larger catchment population.

Before proceeding with the statistical analysis, it is crucial to convert the identified independent variables into quantifiable parameters. A summary of these parameters is provided in Table 1.

Regarding the investment size, the total initial investment of the project is considered, as recommended by previous studies [17,36]. As mentioned previously, this investment encompasses all project costs in the initial stages including procurement, land acquisition, resources, construction, and other related miscellaneous expenses. It also can be considered the sum of equity capital, private debt, and direct public contribution that help fund the project investment demands. The project construction scale is measured by the construction period, defined as the number of years between the financial closure and the beginning of operations [40]. For the hospital capacity, the number of beds in the facility is considered, following the recommendations of previous research [39,41]. It should be noted that choosing the sheer number of beds as a variable for hospital capacity is a simplification, as it is possible for certain facilities to offer different and specialized services, but to a lower number of patients, which in this case will not be considered in the variable. The independent variable of project normalized cost is quantified by dividing the capital investment by the number of beds. This would also be a simplification as it does not account the type and the quality of different medical services that might be offered by the healthcare facility. To determine the public share, the overall percentage of project investment covered by the public sector is considered [12,39]. This public share only considers the major direct budgetary contribution done by the public authority within the beginning stages of the project, and does not include annual or periodic contributions that are supposed to help fund the operational expenses

(OPEX) after the culmination of the construction stage, nor does it include indirect contributions such as a guarantee of profits or a guarantee of the SPVs Debt Service Cover Ratio (DSCR) for the companies' private debts. The size of the SPV is quantified by the number of equity holders participating in the SPV, as recommended by past research [48]. The equity holders include the direct shareholders that take part either in the financing, construction, operation, or maintenance of the project and have a stake in it during the concession period, and does not include any private contractor companies separately hired by the SPV. For the catchment population, the number of inhabitants in the province where the facility is located is used as a parameter, as previously considered in extant literature [40]. Although considering the whole province population could be a simplification and does not include the size of the provinces or an accurate coverage distance of the hospitals, it was nevertheless chosen as the appropriate variables as it can further be an indirect indication of the difference of capabilities between the various provinces in planning and carrying out PPP projects in an efficient manner, as is apparent in the previous studies.

Public experience is represented by the year of contract award, indicating when the PPP project was awarded to the SPV. It was chosen as the preferable variable to represent public experience compared with other year-based potential variables, such as year of procurement or start of construction activities. The rationale behind using the "year of contract award" as a metric for public experience is rooted in the assumption that public authorities' knowledge and proficiency in handling PPPs have likely evolved and improved over time. Over the years, governments and public entities have gained valuable experience in structuring, negotiating, and managing these complex partnerships. This experience has been accumulated through trial and error, learning from past projects, and adapting to changing economic and legal environments. When governments first began engaging in PPPs, they often faced challenges related to project design, risk allocation, and contract negotiation. These early experiences highlighted the need for continuous improvement and learning, which grows as time passes. As a result, public authorities have become more adept at addressing the intricacies of PPP agreements. PPP legal and regulatory frameworks are enhanced over time as a result of a deeper understanding of best practices and lessons learned from earlier projects. Regulatory improvements often translate into more effective governance and oversight of PPPs, contributing to better outcomes and a more mature PPP market. As governments increasingly turn to private sector partners to deliver public infrastructure, the industry responds with innovative solutions and standardized practices that improve as time passes. This evolution

has encouraged both public and private parties to adopt more sophisticated approaches to project development. Experience has also sharpened the decision-making abilities of public authorities who are now better equipped to assess the suitability of a project for the PPP model, determine risk-sharing arrangements, and evaluate potential private sector partners. This enhanced decision-making process can lead to more successful project outcomes.

5.2. Data Collection

To gather data regarding healthcare PPP cases, multiple sources were triangulated. The information regarding the business case of PPP hospital projects was complemented and refined through the analysis and comparison of multiple sources. These sources included scientific literature, public databases, Italian newsletters, and direct access to the contract of some PPP projects, facilitated by the involvement of the authors in those projects.

One of the authors acted as a consultant to the Regional Government Evaluation Board of PPPs and could collect first-hand data from the main contract documents of 13 PPPs. Complementary, 15 additional projects were gathered through a comprehensive content analysis of public databases and scientific literature related to PPPs and concession periods. The literature search included the following keywords: PPP, Public Private Partnership, Build Operate Transfer, BOT, private finance initiative, health care project, hospital project, PFI, and concession period. The search was focused on papers related to Italian cases spanning from the year 2003 to 2023. From the resulting papers, the authors screened and analyzed PPP projects specifically related to healthcare to gather data on the business cases of these projects.

For the purposes of this paper, the selected healthcare cases are a set of 28 PPPs initiated in the year 2004, with a total value of EUR 3.2 billion. Most of these projects are already in the operation phase, while a few are scheduled to begin construction in the year following the time of writing this paper.

Having established the model and with access to the data set of the PPP healthcare projects, Table 2 provides a summary of the Italian healthcare PPP projects and the statistical distribution of the

corresponding independent parameters, which are hypothesized to influence the concession period. The table includes the lower, median, and upper quartiles of the data, along with the corresponding standard deviation.

Table 2: Healthcare projects database summary table

Variables	Acronym	Lower Quartile	Median	Upper Quartile	Standard Deviation
Investment Size (€m)	InS	74.48	113.95	137.43	84.85
Project Construction (years)	CoP	2.15	2.90	5.00	2.15
Project Capacity	HoC	403	545	670	369
Cost/No. of beds	CPB	0.16	0.21	0.28	0.15
Public Share	PSh	0.30	0.58	0.63	0.21
Public Experience	YCA	2005	2007	2012	7
No. of equity holders	NoEH	1.0	1.0	2.3	2.3
Catchment Population	Cpop	539849	768112	972223	979950
Concession Period (years)	CcP	23.45	25.00	27.53	4.73

5.3. Data Analysis

In the model, the Concession Period (CcP) is the response variable, representing the number of years during which the SPV is responsible for operating the project.

To identify the significant parameters among those considered, a linear regression test was conducted, which is a widely-used method in literature for identifying significant drivers of PPP outcomes [39,40,46,48]. Linear regression analysis makes it possible to statistically test the influence of independent variables on the chosen dependent variable and reveals positive or negative relationships between them [46]. SPSS was used as the analytical tool to conduct the

regression test. It was found out to be superior and more accurate compared to some other statistical tools, such as Microsoft Excel.

In this type of analysis, a positive correlation implies that variations in the independent variable result in corresponding changes in the dependent variable in the same direction. Conversely, a negative correlation indicates that changes in the independent variable lead to opposite changes in the dependent variable.

It must be noted that the correlation among the independent variables must be checked to make sure that there are no collinearities among them. This can be achieved by calculating a Variance Inflation Factor (VIF) for each of the independent variables. The absence of multicollinearity can be guaranteed if the VIF value is low. Variables with high VIF values, indicating unacceptable levels of collinearity, must be excluded from the regression analysis.

6. Results

An exploratory analysis is first carried out in order to verify the reliability of the independent variables and to check for any multicollinearities between them. Table 3 shows the analysis results based on the mentioned database by considering all the independent variables.

In order for the results to be valid, the significant p-factor must be of a certain value, which would, in turn, show the reliability of the independent variable in question. A mean value of 0.05 was chosen as the benchmark for the significant factors. In addition, a multicollinearity analysis is carried out in parallel to make sure that the dependent variables are not overly affecting each other. This is carried out by calculating a Variance Inflation Factor (VIF). Ideally, this value would be between 1 and 5 so that we are able to reject multicollinearity.

A first analysis was conducted, indicating that the variable of CPB has a VIF value of more than 5, indicating the existence of multicollinearity between CPB and other variables, resulting in its removal.

Table 3: Results of Linear Regression Analysis

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1483.407	379.5283251		3.908554125	0.001029602		
InS	0.037052089	0.013344793	0.65331123	2.776520343	***0.012446879****	0.435328977	2.297113341
CoP	-0.475024682	0.434383267	-0.215499708	-1.09356119	0.288566863	0.620653074	1.611206071
HoC	-0.003344215	0.003213619	-0.263530698	-1.04063819	0.311820377	0.375831516	2.660766744
PSh	-11.23263105	4.044398631	-0.493593652	-2.77733035	***0.012425336****	0.76308348	1.31047261
YCA	-0.725099131	0.188557994	-0.923808985	-3.84549664	***0.001184946****	0.417634735	2.394436851
NoEH	1.015433233	0.44582713	0.518731326	2.27763894	***0.035182352****	0.464666015	2.152083363
CPop	1.67244E-06	7.9337E-07	0.359741649	2.108020978	***0.049308904****	0.827607691	1.208301967

Note: * Italic bold shows significant p-factors less than 0.05, pointing to the reliability of the variables.

The results of the final analysis, after the removal the variable with a VIF, are given in Table 3. In essence, the regression assesses the relationships between the Concession Period (CcP) and multiple independent variables. It can indeed be observed that the removal of CPB has had a positive impact on the reliability of the other independent variables. Moreover, variables of InS, PSh, YCA, NoEH, and CPop have shown significant p-factors that render their influence on the dependent variable a reliable one, while CoP and HoC do not show to have a noteworthy influence on the PPP Concession Period. Also, there are no longer any multicollinearities among the remaining variables, and all VIF values are under 4 as recommended by previous sources [46], indicating that the dependent variables are not overly affecting each other. Consequently, the result of the regression analysis performed can be expressed as:

$$CcP = 1483.41 + 0.04InS - 11.23PSh - 0.73YCA + 1.02NoEH + 1.67 \times 10^{-7}CPop \quad (1)$$

In order to validate the results of the analysis, some tests on the regression residuals were conducted. The histogram of the residuals resembles a normal curve, thus demonstrating the normality of the data set (Figure 1). The normal probability plot shows that the residuals are

normally distributed, and they generally follow a straight line with few significant outliers (Figure 2). In addition, the residuals versus fits test (Figure 3) does not show evidence of systematic error in the residuals of the regression. Finally, the residuals versus orders test (Figure 4) shows no indication of the presence of trends, time series, or periodicity.

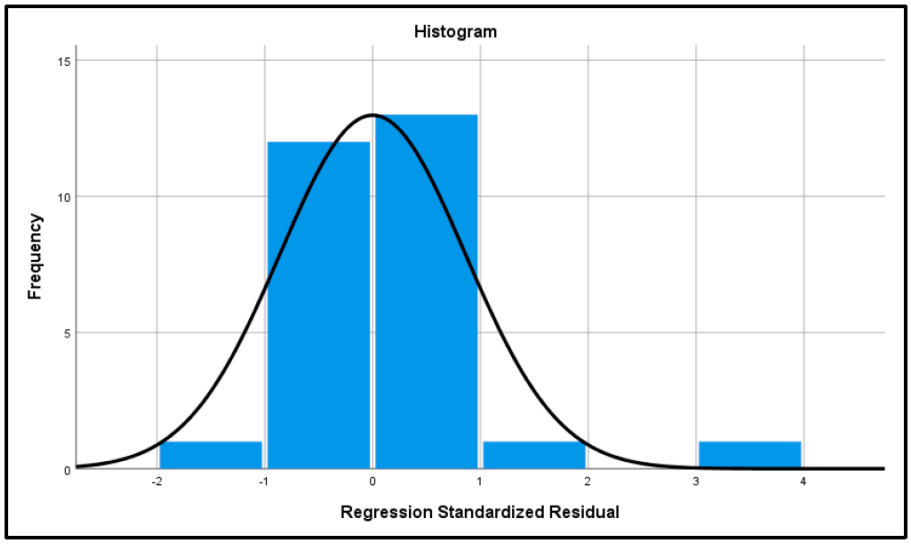

Figure 1: Histogram of Residuals

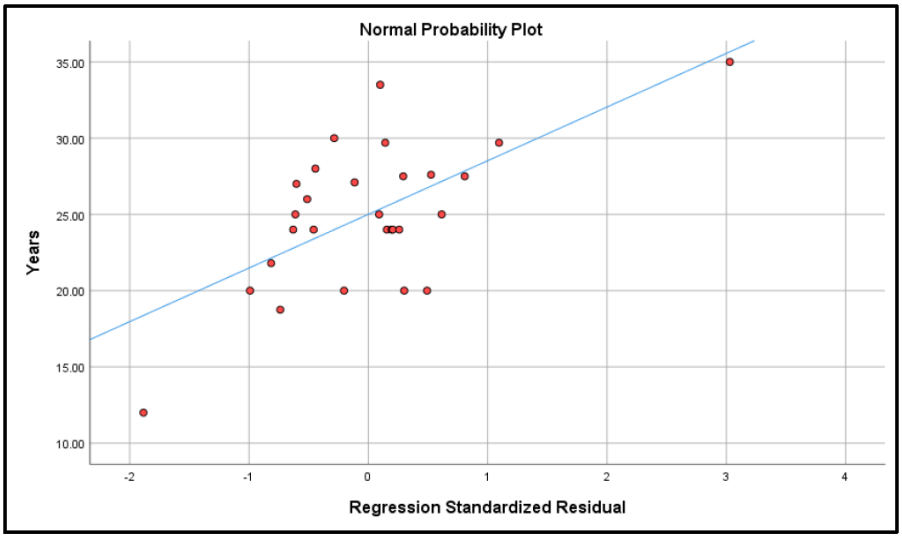

Figure 2: Normal probability plot of residuals

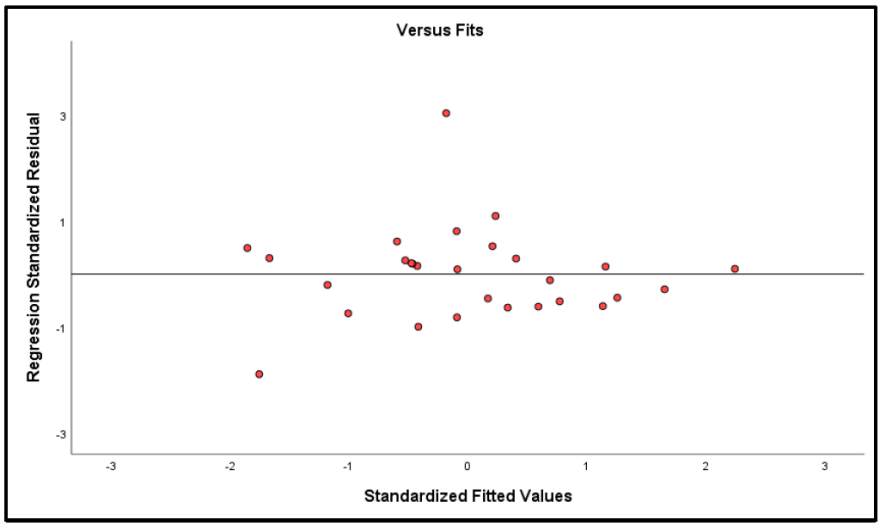

Figure 3: Residuals versus fits

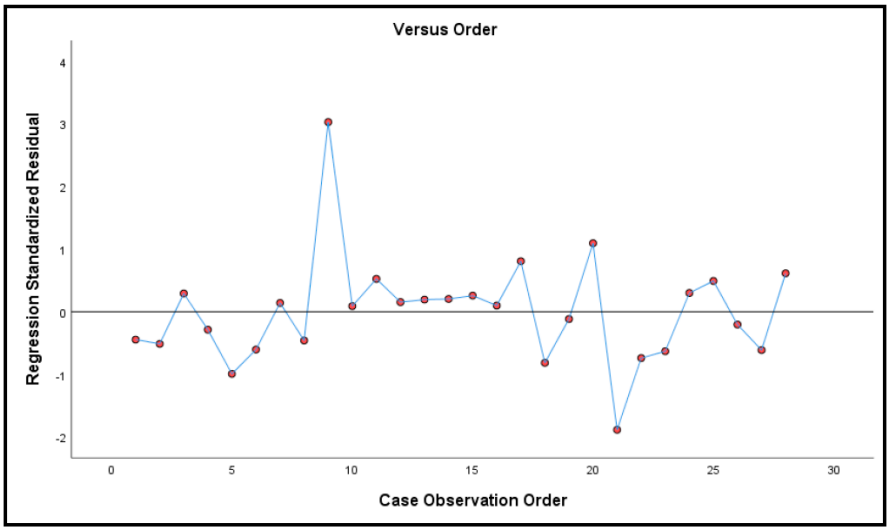

Figure 4: Residuals versus order plot

7. Discussion

Results indicate that certain factors, namely, Investment Size (InS), Public Share (PSh), Year of Contract Award (YCA), Number of Equity Holders (NoEH), and Catchment Population (CPop), significantly influence the Concession Period granted to the SPVs by the public sector. Conversely, the Construction Period (CoP) and Hospital Capacity (HoC) were found to have no significant impact on the Concession Period.

Two parameters were found to have no significant relationship with the concession period. Interestingly, both factors were recognized as significant parameters for the concession period in the extant literature as follows.

Firstly, the Construction Period (CoP) is not a significant parameter for the concession period of healthcare projects. Interestingly, the construction period has been extensively incorporated to determine optimal concession periods in general PPPs [17], and has been specifically applied to estimate this period in toll road PPPs [38]. There are suitable reasons that may explain why our findings contrast with previous literature. Firstly, healthcare PPP projects may possess distinct characteristics compared to other types of PPPs, such as toll roads or general PPP projects, such

as complex services and specialized equipment that may not be related to the construction period, which could differ significantly from the construction of other buildings or infrastructure. Unlike traditional infrastructure projects that primarily focus on building physical structures, healthcare PPPs require the integration of medical technologies, clinical expertise, and patient care protocols into the operational model. This complexity extends beyond construction and requires careful consideration during project planning, procurement, and implementation. Additionally, the financial viability and risk allocation in healthcare PPPs may rely on long-term revenue streams from government payments or insurance reimbursements, which might not be directly influenced by the duration of the construction period. These revenue streams typically come from government payments for healthcare services or insurance reimbursements for patient care. Since these revenue sources are expected to continue over the concession period, the duration of the construction phase may not directly impact the project's revenue generation capacity. Moreover, a higher proportion of private financing generates strong incentives to complete the construction quickly regardless of the project size, resulting in relatively homogeneous construction periods. In PPPs where a higher proportion of financing comes from the private sector, private investors have a significant financial stake in the project's success. These investors seek to minimize construction timelines to start generating returns on their investments as soon as possible. Completing construction quickly allows private investors to mitigate financial risks and maximize returns on their capital.

Secondly, the lack of significant impact of Hospital Capacity (HoC) on the project concession period also contrasts with previous studies. In previous research, hospital capacity was found to be influential in determining the public share of PPPs [39]. However, this study presents contrasting results in this regard, indicating that hospital capacity does not exert a similar influence on the concession period. These findings suggest that the link between hospital capacity and the concession period might be more context dependent. For example, PPPs with higher hospital capacity may result in higher public subsidies and a lower proportion of private capital provision, which could shorten the concession period. With higher public subsidies allocated to the project, the proportion of private capital provision may decrease. Public subsidies help cover a significant portion of the project costs, reducing the reliance on private financing. As a result, the private sector partner may need to invest less equity or secure smaller loans to finance the project, leading to a lower proportion of private capital provision. A lower proportion of private capital provision and higher public subsidies can contribute to a shorter concession period. With reduced financial

risks and lower debt obligations, the private sector partner may achieve financial viability more quickly, allowing for shorter concession periods. Alternatively, even in higher hospital capacity PPPs with a higher proportion of private capital, there may be mechanisms in place to ensure increasing yearly revenues, thus preventing the need for an extended concession period. PPP agreements can include provisions for demand-side management, which involves strategies to increase patient volume and utilization of hospital services over time. These strategies may include targeted marketing campaigns, community outreach programs, and partnerships with healthcare providers to attract patients and expand the hospital's customer base. By stimulating demand for healthcare services, the hospital can experience increasing yearly revenues without the need for an extended concession period.

Complementary, the analysis also uncovered a positive relation between the Number of Equity Holders (NoEH) in the SPV and the concession period. This suggests that when the market notices a bidding process with a relatively long concession period, the private companies interested in the project tend to form SPVs shared by more equity holders to enhance their capabilities and risk sharing. As previously mentioned, PPPs with longer concession periods are more susceptible to potential financial, contractual, or legal risks. Having an increased number of equity holders may indicate a more robust and capable SPV, better equipped to deal with project risks and ensure lenders' timely debt repayments. Having a larger number of equity holders broadens the pool of expertise and resources available within the SPV. Each equity holder may bring unique skills, experiences, and networks to the table, enabling the SPV to access a wider range of capabilities to address project risks effectively. Diversification of expertise enhances the SPV's resilience and adaptability in navigating complex challenges across different project phases, and it is particularly as such in the case of prolonged concession periods. It is worth mentioning that extant literature previously explored the effect of the number of partners in the SPV in reducing project risk, however, they only considered its effect on public finance [46,49,50]. This paper complements this perspective by extending the analysis to consider the influence of shareholders in the concession period.

Surprisingly, the Catchment Population (CPop) was found to have a counterintuitive effect, positively influencing the concession period. This contradicts the initial hypothesis, which assumed that a higher population of end users would result in increased revenues or higher

availability payment, thereby shortening the concession period. A higher CPop might lead to increased market demand for the services provided by the PPP project, such as healthcare, transportation, or utilities. While this increased demand could potentially result in higher revenues or availability payments, it may also necessitate expanded infrastructure, facilities, or service provisions to accommodate the larger population adequately. This expansion process could extend the overall project timeline, including construction, operational ramp-up, and optimization phases, consequently lengthening the concession period. Moreover, the complexity of facilities and services offered by healthcare PPPs catering to large populations along with the fiscal constraints faced by the public sector concerning yearly payments contribute to the decision to opt for longer concession periods. This finding contrasts with previous studies that disregarded catchment population as a significant influencing factor in PPP projects [40] and Build-Operate-Transfer toll road projects [12]. This analysis demonstrates that this factor indeed plays a significant relationship with the concession period. In summary, this implies that as the number of potential users increases, there is a corresponding need for more extensive maintenance and operational interventions. This heightened demand for OPEX may, in turn, extend the concession period. While the connection between OPEX and concession period has been examined in prior studies [51,52], it is worth noting that the specific role of catchment population as a mediator in this relationship has not been thoroughly explored in previous research. As a final factor, it is not without merit to note that PPP projects for larger populations must deal with complex regulations, get permits, and secure approvals from various government bodies. This bureaucracy can cause delays and administrative challenges, making the project take longer.

Findings indicate a significant and positive relation between Investment Size (InS) and the concession period. This relationship can be attributed to the high risk and complexity associated with larger projects, prompting the public sector to offer a longer concession in order to incentivize private sector participation in those projects. This finding complements the previous hypotheses that larger project initial investments lead to extended concession periods, mainly due to the higher expected returns sought by the investors to justify the larger upfront investment [16]. Essentially, they need more time to recoup their initial capital and generate sufficient profits from the project. So, the longer concession period allows investors to spread out their returns over a more extended period, making the investment more financially viable and attractive. This dynamic aligns the interests of both the public and private sectors by ensuring that investors have adequate time to

realize their expected returns while also meeting the project's financial goals and obligations. The finding further aligns with claims that larger projects bear greater risk for private investors, necessitating longer concession periods to mitigate the perceived risks [13]. In other words, it could be stated that longer concession periods offer investors greater stability and predictability, enabling them to implement risk management strategies, adapt to changing circumstances, and make necessary adjustments to ensure the project's long-term success. By spreading the investment over a more extended period, investors can mitigate the impact of short-term challenges and position themselves for sustained profitability over the project's lifecycle.

Furthermore, results show a significant negative relationship between the Public Share of capital expenditure (PSh) and the concession period. This could be explained by the reasoning that as the share of public funding in the initial investment decreases, the private sector is expected to contribute more to the initial investment. With a larger share of private funding, private investors may require a longer concession period to spread out revenue generation and achieve financial sustainability. This longer timeframe enables them to cover costs, service debt, and realize profits while maintaining project viability. Consequently, when the SPV receives fewer subsidies from the public sector, it may require a longer concession period in order to generate sufficient revenues over time to ensure the desired profitability and project internal rate of return. PPP literature considered the effect of public financing and concession periods on the project NPV [44]. This paper’s findings emphasize the relevance of understanding the negative relationship between public share and concession period to strike a balance between public and private sector interests. These results are consistent with other studies, which also found that government subsidies shorten the concession period [39] and help governments secure earlier operational revenues [4]. Governments often use subsidies strategically to promote economic development, stimulate private sector investment, and address critical infrastructure needs. By offering subsidies, governments can attract private investment in key sectors, such as transportation, healthcare, and utilities, and expedite the delivery of essential public services. Shorter concession periods enable governments to realize the benefits of PPP projects sooner and address pressing societal needs more effectively, as well as transfer the revenue generation capabilities of the infrastructure back to the government, so that the additional funds can contribute to other public spendings instead of going to the private partners.

Furthermore, the analysis reveals a negative relationship between the Year of Contract Award (YCA) and the concession period. This suggests that PPPs awarded more recently, tend to have reduced concession periods. One suitable explanation for this trend is that over the years, the public sector has gained more experience and expertise in contract management of PPP projects, particularly in the context of healthcare facilities. As the PPP market matures, both public authorities and private investors gain more experience and expertise in structuring and managing PPP projects. This increased familiarity with PPPs allows stakeholders to streamline processes, negotiate more efficient contracts, and optimize project timelines. Over time, lessons learned from past projects enable stakeholders to identify opportunities for concession period reduction without compromising project quality or financial viability. In addition to that and as a result of the aforementioned experience gain, governments have become more prone to procure shorter concession periods in order to avoid burdening public budgets with excessive long-term costs. They are becoming increasingly cautious about committing to long-term financial obligations that could strain public budgets. Shorter concession periods would allow governments to limit their financial exposure and manage budgetary constraints more effectively. By opting for shorter concession periods, governments can allocate resources judiciously, minimize fiscal risks, and maintain fiscal sustainability over the project lifecycle. Moreover, as a result of their experience gain, governments opt for shorter concession periods that would better enable them to reassess project priorities, renegotiate terms, or explore alternative investment options in response to evolving needs and priorities. The adjustments made in 2016 to the PPP Italian legislation also serve as an indicator of the public sector's commitment to regulating and improving the efficiency of PPP contracts, while ensuring the preservation of the benefits for the public.

8. Implications and Limitations

This study helps in understanding the factors that influence the length of the concession period in PPP projects, particularly in the context of healthcare facilities in developed countries. The findings shed light on the importance of understanding the driving factors behind concession periods to effectively regulate PPP contracts. The results show that investment size, public share,

year of contract award, number of equity holders in the SPV, and catchment population significantly influence the concession period, while the construction duration and the hospital capacity do not show a significant impact.

The findings of this study have practical implications for both the public and private sectors involved in PPP projects. Decision makers in the public sector can leverage the understanding of the negative relationship between the public share and concession period to strategically plan concession periods according to short-term fiscal constraints, and further enables them to engage in strategic planning and procurement practices. Prioritizing higher short-term public shares can help reduce the need for private capital investment, leading to shorter concession periods and avoiding long-term financial burdens. Furthermore, by aligning concession periods with short-term fiscal constraints, decision makers can prioritize projects that offer maximum value for money, address critical infrastructure gaps, and deliver tangible benefits to communities within limited budgetary resources. Strategic planning allows decision makers to balance competing priorities, evaluate trade-offs, and optimize resource allocation to achieve optimal project outcomes. Finally, decision makers can leverage their understanding of concession period dynamics to engage stakeholders effectively and build consensus around project objectives and timelines. By communicating the rationale behind concession period decisions, decision makers can foster transparency, accountability, and public trust in PPP procurement processes. Stakeholder engagement facilitates collaboration, enhances project legitimacy, and ensures that concession periods align short to long-term development goals.

For the private sector, the positive relationship between the number of equity holders in the SPV and the concession period offers valuable insights for structuring SPVs during the procurement phase. Recognizing the correlation between concession period and uncertainty, private sector stakeholders can consciously shape SPV compositions to optimize risk management strategies. A higher number of partners in the SPV can better manage project risks by leveraging diverse technical knowledge, experiences, and strengths. In addition, A higher number of equity holders in the SPV would mean a diversified ownership structure, spreading investment risk across multiple parties. This diversification enhances the resilience of the SPV against financial shocks, operational challenges, and market uncertainties which almost certainly come along with PPP projects with longer concession periods.

The findings of this study further offer valuable insights that can be strategically utilized by decision makers to purposely plan the concession period and related strategies.

Firstly, the understanding of the significant negative relationship between the public share and concession period can be leveraged by public sector decision makers to purposefully determine the concession period based on their short-term fiscal constraints. In cases where the public budget is not excessively constrained due to fiscal pressures (as seen in multiple developed countries), decision makers can prioritize increasing the short-term public share. As a result, they can reduce the need for private capital investment, leading to a shorter concession period and ultimately preventing excessive public payments and additional financial costs in the long term. Overall, this approach allows decision makers to strike a balance between meeting immediate PPP financial requirements and optimizing the long-term benefits of the project.

Furthermore, the positive relationship found between the number of equity holders in the SPV and the concession period holds practical implications for the private sector in structuring the SPV during the procurement phase and tendering process. Understanding this correlation can help private sector stakeholders in consciously shaping the SPV composition in alignment with the established concession period and optimizing risk management strategies. When the concession period is longer, it implies a higher level of uncertainty, which can be better managed by a greater number of partners in the SPV to specifically manage specific risks. This is achieved by leveraging the diverse technical knowledge, experiences, and strengths of each partner. Conversely, when there is less uncertainty associated with a shorter concession period, a lower number of partners may suffice to manage the risks effectively. With a shorter concession period, the project timeline is compressed, leading to more streamlined decision-making processes. A lower number of partners in the SPV reduces the complexity of decision-making structures, facilitating faster consensus-building and agility in responding to project challenges and opportunities. Simplified decision-making enhances the SPV's ability to adapt to changing circumstances and optimize project outcomes within the constrained timeframe of a shorter concession period. Moreover, a smaller number of partners in the SPV fosters closer coordination and communication among project stakeholders. With fewer decision-makers involved, communication channels are more direct and efficient, enabling prompt information sharing, problem-solving, and resolution of issues.

The positive impact of the catchment population on the concession period holds significant implications for the public sector. When procuring healthcare PPPs in areas with smaller catchment populations, such as local or regional public sector entities, a strategic approach should prioritize shorter concession periods. This approach is advantageous as it helps to prevent the burden of excessive long-term expenses and financial costs, particularly when the level of services required may not be as high. In addition to that, in areas with smaller catchment populations, demand for healthcare services may be less predictable compared to larger urban centers. Shorter concession periods allow public sector entities to reassess healthcare needs and adjust service delivery models more frequently in response to changing population dynamics, demographic trends, and healthcare utilization patterns. Conversely, for public institutions procuring PPPs in larger cities with substantial catchment populations, there is an opportunity to focus on enhancing the capacity and service levels through financially leveraging higher short-term capital investments. As such, they can make use of this increased short-term capital investments to develop service quality standards and user experiences across various sectors. By investing in state-of-the-art facilities, modern technology solutions, and innovative service delivery models, public institutions can elevate service standards, improve efficiency, and foster innovation in urban service provision.

Despite its contributions, this study has certain limitations that should be acknowledged. Firstly, the analysis relies on a linear regression model, which assumes a linear relationship between independent and dependent variables. This simplification may not capture more complex, non-linear interactions that could exist in the data. Secondly, while the analysis identifies relationships between factors and the concession period, it cannot definitively establish causative links, given that linear regression establishes correlations between variables but does not prove causation. Thirdly, given the data available from the 28 projects studied, the analysis focuses on the selected independent variables and does not consider other potentially influential factors that may affect the concession period.

To further enhance the understanding of concession periods in PPP projects, future research could also explore additional factors that might influence the concession period such as political and institutional factors. By delving into these factors, policymakers and stakeholders can gain a more comprehensive view of the determinants of concession periods, enabling better decision making and project planning.

9. Paper II: Driving Factors for the Concession Period in Social Public Private Partnerships in Western Europe

The second paper mostly follows a similar theme to that of the first paper in the sense that it analyzes the effects of potential influencing factors on the length of concession periods in Public Private Partnerships (Private Financing Initiatives), with the main difference that the second paper focuses on a much broader scale of projects, encompassing all types of social PPPs that have taken place in Western European countries, largely within the past two decades. At the time of this thesis being prepared, the paper has yielded the results of its analysis and is currently in the initial drafting stage. The thesis will proceed to include the statistical analysis results as well as some initial conclusions and implications.

The paper outlines an examination of the multitude of factors impacting the concession period in PPP projects. Initially, it identifies a range of potential variables that may influence the model. Following this, a statistical analysis technique is utilized to assess the impact of these selected factors and their correlation with the concession period.

The analytical process progresses through several clear stages. Firstly, there is a thorough identification of a set of potential variables that could act as significant factors within the model. These variables are selected meticulously to cover a wide range of potential influences on the concession period, considering previous research and practical aspects. Subsequently, data from real cases are collected after the potential variables have been identified. To collect data on social PPP cases, a triangulation approach was utilized, getting information from various sources including scientific literature, public databases, European newsletters, or access to the business cases of some PPP projects. In the second paper, a total of 110 social PPPs initiated in 2002, with a total value of EUR 10.97 billion, were considered for analysis.

Finally, a statistical regression analysis was selected and executed to pinpoint notable drivers of PPP outcomes. This statistical method allows for the assessment of the impact of independent variables on the selected dependent variable, namely, the concession period. It is important to

highlight that the correlation among the independent variables is thoroughly scrutinized to detect any collinearities among them.

9.1. Driving Factors for the Model

This section presents the potential driving factors that may significantly influence the concession period of PPP contracts. The chosen variables include direct public contribution, project investment size, project size, public share, SPV size, public experience, project construction scale, as well as variables associated with the level of development in the project country of origin, namely GDP and GDP per Capita. Table 4 provides an overview of these factors.

Table 4: Potential factors influencing the Concession Period

Independent Variables	**Quantifiable Parameter**	**Acronym**
Direct Public Contribution	(Amount of contribution in €m)	DPC
Project Investment Size	(Total Investment in €m)	InS
Project Size	(Project total area in sqm)	PrArea
Public Share	(Share of the investment)	PSh
SPV Size	(No. of equity holders in the SPV)	NoEH
Public Experience	(year of contract award)	YCA
Project Construction Scale	(Construction period in years)	CoP
GDP	(Average Gross Domestic Product)	GDP
GDP per Capita	(GDP divided by average population)	GDPperCap

The first variable considered is direct public contribution (DPC), which constitutes the overall amount of governmental subsidies designated by the public authorities to the PPP project. This amount only includes direct payments carried out to the SPV to compensate partially for the capital expenses born by the project, and does not include any sorts of loans, guarantee of revenues, or guarantee of private debt service coverage. The direct amount of monetary contribution by the public entity have shown to potentially influence the length of the concession period when drafting the business case and is the contracting stage of the PPP project. On one hand, the DPC represents the financial commitment made by the public sector to support the PPP project. A higher public contribution generally indicates greater financial support from the public sector, which can enhance the financial viability of the project. With sufficient funding from the public sector, the SPV may be able to achieve its objectives within a shorter concession period. Furthermore, in some social PPP projects, the revenue generated from user fees, tariffs, or other sources may not be sufficient to cover the project costs. A higher direct public contribution can supplement the project's revenue streams, reducing the reliance on user fees and potentially shortening the concession period by ensuring adequate financial resources for project implementation. On the other hand, the amount of direct government contribution can also influence the scope and scale of the PPP project. A higher DPC may allow for larger-scale projects with more extensive services or infrastructure. Depending on the complexity of the project, a longer concession period may be necessary to accommodate the planning, construction, and operation phases effectively.

The second variable being considered is the investment size of PPP projects, which encompasses the total capital investment needed for constructing and upgrading social infrastructures. This includes the sum of public financing, private debt, and equity contributed by the SPV overseeing the project. Several factors may explain the potential impact of the overall initial investment on the concession period. Firstly, the duration of the concession period often corresponds with the time needed for the private sector partner to recover its initial investment and generate profits. A larger investment in the project may require a longer concession period to allow sufficient time for cost recovery, profit generation, and achieving the desired return on investment (ROI). Additionally, a higher project investment might necessitate higher levels of debt financing for project development and construction. Longer concession periods provide flexibility for debt servicing and repayment, spreading financial obligations over an extended period and reducing annual debt service requirements for the private sector partner. Moreover, the concession period's

duration typically aligns with the expected lifespan and amortization period of the infrastructure asset. Projects with substantial initial investments, such as transportation networks or utility systems, may require longer concession periods to amortize capital costs and address ongoing maintenance, renewal, and replacement expenses throughout the asset's lifecycle. Finally, the total initial investment influences revenue generation and cash flow projections for the project. Projects with significant upfront investments may require longer concession periods to achieve financial sustainability and meet revenue targets, especially if revenue streams depend on gradual sources like user fees, government payments, or other income sources.

The project overall size, as in the total area of the public infrastructure, in the other possible factor whose influence on the concession period is analyzed. The project total area is chosen as the uniform way to represent the project overall size to the different nature of the various social PPP projects that were analyzed in the project. Considering the data contained PPPs that are related to healthcare, administration, accommodation, education, recreation and entertainment, as well as security and military, other possible parameters like the capacity of these facilities would have been an inaccurate estimate of the size of these PPP cases. Moving on, the effect of the size of social infrastructure PPPs on their concession period may be justified as follows; larger facilities typically require more time for construction and development compared to smaller ones. Consequently, PPP agreements for larger facilities may include longer concession periods to allow sufficient time for the construction phase, regulatory approvals, and other necessary processes. In addition to that, larger facilities may entail more complex operations and management requirements. They may have larger staff requirements, more extensive maintenance needs, and higher operational costs. An extended concession period can provide the SPV with adequate time to address these operational complexities and ensure the efficient and sustainable operation of the facility.

Furthermore, the public share, indicating the percentage of the initial project investment funded through public subsidies, is another critical factor. Striking a balance between government subsidies and risks assumed by the private sector is vital for determining the concession period. On one hand, a greater public share can alleviate perceived risks for the SPV. With increased public funding, private investors may accept shorter concession periods, feeling more assured about the project's financial stability and profitability. This confidence can lead to more favorable concession

terms and shorter durations. Additionally, a higher public share of the project investment amount lessens the financial burden on the private sector. When the public sector supplies a significant portion of the upfront investment, private investors may seek shorter concession periods, reducing the time required to generate returns. Conversely, despite seeming counterintuitive, a higher public investment share in PPP projects may result in longer concession periods. A greater public share often indicates lower risk tolerance among private investors. Consequently, they may request longer concession periods to spread investment risks over a longer period, facilitating gradual revenue generation and allowing more time to recoup initial investments. Moreover, private investors typically require assurances of long-term financial viability before committing substantial capital to PPP projects. A higher public investment share may suggest doubts about the project's revenue potential or profitability. To address perceived financial risks, private investors may demand extended concession periods to ensure adequate time for desired returns on investments. It must be noted that this factor is closely related also to direct contribution variable, and thus the collinearity between the two should be checked during the analysis.

In addition, the size of the Special Purpose Vehicle involved in PPP projects is another significant factor that may impact the concession period. A higher number of companies and stakeholders within the SPV suggests greater capacity to handle project tasks. With a diverse range of entities in the SPV, there's potential for varied expertise, resources, and capabilities, enhancing the collective ability to manage project tasks effectively. This diverse pool of talent and resources strengthens the SPV's capacity to address challenges, mitigate risks, and optimize outcomes. Additionally, a larger SPV enables broader risk-sharing and mitigation strategies by distributing responsibilities and liabilities across multiple entities. This diversification enhances resilience and reduces the likelihood of delays or failures that could affect the concession period. However, a large number of partners in the SPV may indicate a perception of higher risk and project complexity. Such projects often demand comprehensive risk mitigation strategies, and involving more partners allows for risk diversification and resource pooling. By spreading risks across multiple entities, the SPV aims to enhance resilience and manage uncertainties, potentially leading to a longer concession period to accommodate risk management efforts. Furthermore, projects perceived as complex or high-risk may face challenges in attracting investment and securing financing. Demonstrating a robust partnership structure with a diverse array of reputable companies and institutions can instill confidence among stakeholders and investors. The

involvement of multiple partners signals a collective commitment to project success and may support financing arrangements that allow for a longer concession period. Nevertheless, managing a large number of partners poses governance and coordination challenges, such as aligning interests, communication, decision-making, and dispute resolution. Addressing these challenges may require additional time and effort, potentially prolonging the concession period to accommodate the complexities associated with managing a diverse partnership network.

The year of contract award acts as a gauge of the public sector's evolving expertise in managing PPP projects. Initially, less developed regulatory frameworks often result in longer concession periods to navigate uncertainties and adapt to regulatory changes. As authorities refine their processes and accumulate experience, concession periods may shorten, indicating increased efficiency and confidence in project execution. Moreover, the public entity's proficiency in risk management and securing project financing influences concession period lengths. Inexperienced authorities may adopt conservative risk allocation strategies, necessitating longer concession periods for project viability. However, as authorities become more adept at risk assessment and financing arrangements, concession periods may shorten, reflecting improved risk-sharing mechanisms and investor confidence. Recent studies underscore the significance of public sector experience and legislative improvements in PPPs. Early PPP initiatives often prioritized private financing over value-for-money considerations, potentially benefiting private sector profits disproportionately. Limited focus on cost-effectiveness and transparency might have skewed project planning and procurement processes. Enhanced competition and transparency mechanisms are pivotal for equitable outcomes. Overall, the anticipation is that with more recent contract awards, the public sector's expertise and capabilities in handling PPPs will improve.

The project construction scale, represented by the duration of the construction period, serves as a critical indicator of the project's scale and intricacy, thereby influencing the concession period in PPPs. Longer construction periods, often associated with larger projects, tend to correlate with extended concession periods. This linkage stems from the fact that revenue generation typically hinges on the completion of construction activities in PPP endeavors. Projects undergoing prolonged construction phases may encounter delays in revenue commencement, placing strains on the private partner's financial stability. To navigate these challenges effectively, longer concession periods are often warranted to manage cash flow dynamics and ensure debt servicing

obligations are met. Moreover, extended construction timelines inherently harbor risks such as delays, cost escalations, and regulatory compliance hurdles, all of which can undermine project feasibility and operational efficacy. Extending the concession period provides the private partner with leeway to address these risks, implement robust risk mitigation strategies, and ensure timely project delivery. Conversely, empirical evidence suggests that larger public projects can capitalize on economies of scale, potentially resulting in abbreviated concession periods. The magnitude of such projects facilitates cost efficiencies through resource consolidation and streamlined operational processes, thereby driving down per-unit costs for construction and ongoing operations. Furthermore, larger projects often attract higher user volumes and demand, thereby fostering augmented revenue streams and hastening profitability milestones. Consequently, larger-scale projects may achieve financial equilibrium and shorter concession periods concurrently, reflecting their enhanced economic viability and operational efficiency.

As for potential influencing factors on a national scale, the first variable is the average GDP of the country in which the social PPP project in taking place, which is an indicator of the overall economy size of the country in question. A higher GDP generally indicates a stronger and more stable economy with greater financial resources available for investment in infrastructure projects. Countries with bigger GDPs typically have more financial resources available for investment in infrastructure projects. This can allow the government to provide greater financial support for PPP projects, reducing the need for longer concession periods to attract private investment. Furthermore, A higher GDP often correlates with greater investor confidence and stability in the economy. This can attract more private investors to participate in PPP projects, leading to increased competition and potentially shorter concession periods as investors are willing to accept lower returns due to reduced perceived risks. Moreover, A country with a higher GDP may have a larger market size and higher consumer purchasing power, which can translate into increased demand for services provided by social PPP projects. This increased demand can enhance the revenue generation potential of the project, making it more financially viable and potentially shortening the concession period. Finally, countries with higher GDPs often have more developed regulatory frameworks and institutions governing PPP projects. A well-established regulatory environment can streamline project approvals, reduce bureaucratic delays, and provide greater legal certainty for investors. As a result, PPP projects in countries with higher GDPs may experience shorter concession periods due to more efficient regulatory processes.

The other country related variable would be the average amount of GDP per Capita, which could potentially influence the length of the concession period. This variable is an indication of an economy's prosperity level on an individual scale, and can roughly point out at the financial capabilities of individuals, enterprises, or private partners. First of all, countries with higher GDP per capita generally have more financial resources available at the individual level. This can indicate a stronger economy and greater capacity for both public and private investment in infrastructure projects. As a result, governments may be able to offer more favorable terms to private partners, potentially leading to shorter concession periods. In addition, higher GDP per capita suggests a population with higher purchasing power and greater affordability for services provided by social PPP projects. This can lead to increased demand for such services and a potentially shorter period required for the project to become financially sustainable. In turn, this may influence the duration of the concession period as private partners may be more inclined to invest in projects with quicker returns. As another justification, in countries with higher GDP per capita, the cost of living and labor expenses are typically higher. This may influence the financial viability of PPP projects and affect the negotiation of concession terms, including the duration of the concession period. Higher labor costs may incentivize private partners to seek shorter concession periods to optimize project economics and minimize operating expenses. Conversely, the same higher amount of costs could lead to more costly projects and higher amounts of initial project investment and also increase the operational expenses, thus requiring an extended concession period to enable the reimbursement of this heightened expenditure.

Before proceeding with the statistical analysis, it is necessary to transform the aforementioned independent variables into measurable parameters. A summary of these parameters is provided in Table 4.

The direct public contribution encompasses the primary budgetary support provided by the public authority at the project's outset. It excludes ongoing or periodic contributions intended for operational expenses post-construction, as well as indirect support like profit guarantees or assurances for the SPV's Debt Service Cover Ratio (DSCR) concerning private debts. In relation to the project investment size, the analysis includes the total initial investment required for the realization of the project. As previously mentioned, this investment encompasses all initial expenses, including procurement, land acquisition, resources, construction, and other related

miscellaneous costs, but excludes other operational expenses that follow the completion of the construction work. For the project size, the total area of the social facility is considered and measured in square meters. To assess the public share, the analysis considers the proportion of project investment funded by the public sector. The size of the SPV is determined by the number of equity holders involved, as suggested by prior studies. Project construction scale is gauged by the construction period, which spans from financial closure to the start of operations. Public experience is denoted by the year of contract award, signifying when the PPP project was granted to the SPV. This variable was chosen over others like year of procurement or commencing of construction due to its reflection of the evolution of public authorities' knowledge and proficiency in managing PPPs over time. The selection of "year of contract award" as a measure of public experience is based on the assumption that public entities' capabilities in PPP management have advanced over the years. As for the country related parameters, the country GDP was calculated as the average annual GDP of the country in question throughout the years since the year that the first PPP project was awarded up to the present day. Similarly, the GDP per capita was calculated based on the average GDP as previously mentioned, divided by the average population of that nation throughout the same time period.

9.2. Data Collection

To gather data regarding healthcare PPP cases, multiple sources were utilized. The information regarding the business case of social PPP projects was complemented and refined through the analysis and comparison of multiple sources. These sources included scientific literature, public databases, European newsletters, and access to the business cases of some PPP projects.

110 projects were gathered through a comprehensive content analysis of public databases and scientific literature related to PPPs and concession periods. The literature search included the following keywords: PPP, Public Private Partnership, Build Operate Transfer, BOT, private finance initiative, social project, PFI, and concession period. The search was focused on papers related to European cases spanning from the year 2003 to 2023. Also the data bases mostly included publicly available sources that each held the critical data related to social European PPPs.

For the purposes of this paper, the selected social PPP cases are a set of 110 projects initiated in the year 2002, with a total value of EUR 10.97 billion. Most of these projects are already in the operation phase, while a few are scheduled to begin construction in the year at the time of writing this paper.

Having established the model and with access to the data set of the social PPP projects, Table 5 provides a summary of the social PPP projects and the statistical distribution of the corresponding independent parameters, which are hypothesized to influence the concession period. The table includes the lower, median, and upper quartiles of the data, along with the corresponding standard deviation.

Table 5: Social PPP projects database summary table

Variables	Acronym	Lower Quartile	Median	Upper Quartile	Standard Deviation
Direct Public Contribution (EUR m)	DPC	2.4	16.5	57.5	54.80
Project Investment Size (EUR m)	InS	23.63	65.50	124.48	113.12
Project Size (Area)	PrArea	11950.5	43400	95803	70958.75
Public Share	PSh	0.2	0.38	0.61	0.26
No. of equity holders	NoEH	1	1	3	1.74
Year of contract award	YCA	2006	2009	2011	3.95
Construction period (years)	CoP	1.5	2	3	1.50
GDP	GDP	1.87E+12	3.24E+12	3.24E+12	8.04E+11
GDP per capita	GDPperCap	38000	39526	39526	3582.76
Concession Period (Dependant Variable)	CcP	26	26.9	27.5	3.13

9.3. Data Analysis

In the model, the Concession Period (CcP) is the response variable, representing the number of years during which the SPV is responsible for operating the project.

To identify significant parameters from the considered factors, a linear regression test was performed, a commonly used method in literature to determine the key drivers of PPP outcomes. Linear regression analysis allows for the statistical examination of how independent variables influence the chosen dependent variable, revealing positive or negative relationships between them. SPSS served as the analytical tool for conducting the regression test.

In this analysis, a positive correlation signifies that changes in the independent variable lead to corresponding changes in the dependent variable in the same direction. Conversely, a negative correlation indicates that alterations in the independent variable result in opposite changes in the dependent variable.

It's important to note that the correlation among independent variables must be assessed to ensure no collinearities exist. This can be achieved by calculating a Variance Inflation Factor (VIF) for each independent variable. Low VIF values indicate the absence of multicollinearity. Variables exhibiting high VIF values, suggesting unacceptable collinearity levels, should be excluded from the regression analysis.

10. Results

An exploratory analysis is first carried out in order to verify the reliability of the independent variables and to check for any multicollinearities between them. Table 6 shows the analysis results based on the mentioned database by considering all the independent variables.

For the results to be deemed valid, the significant p-value must meet a specific threshold, indicating the reliability of the independent variable under consideration. A mean value of 0.05 was selected as the standard for determining significant factors. Additionally, a multicollinearity analysis is

conducted simultaneously to ensure that the independent variables do not excessively influence each other. This is accomplished by computing the Variance Inflation Factor (VIF). Ideally, the VIF should fall between 1 and 5 to confirm the absence of multicollinearity.

Table 6: Results of Linear Regression Analysis

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-295.242	144.079		-2.049	0.0431		
DPC	-0.030	0.008	-0.525	-3.777	***0.0003****	0.309	3.234
InS	0.008	0.004	0.295	2.275	***0.0251****	0.355	2.815
PrArea	-1.082E-06	0.000	-0.018	-0.172	0.8639	0.539	1.854
PSh	1.065	1.354	0.088	0.787	0.4333	0.472	2.120
NoEH	0.332	0.149	0.183	2.223	***0.0284****	0.876	1.141
YCA	0.163	0.072	0.206	2.265	***0.0256****	0.724	1.381
CoP	0.620	0.267	0.297	2.324	***0.0221****	0.364	2.746
GDP	-9.249E-14	0.000	-0.024	-0.243	0.8083	0.623	1.604
GDPperCap	-1.86E-04	0.000	-0.213	-1.996	***0.0487****	0.526	1.902

Note: * Italic bold shows significant p-factors less than 0.05, pointing to the reliability of the variables.

The results of the analysis are given in Table 6. In essence, the regression assesses the relationships between the Concession Period (CcP) and multiple independent variables. The observations indicate that variables of DPC, InS, NoEH, YCA, CoP, and GDPperCap have shown significant p-factors that render their influence on the dependent variable a reliable one, while PrArea, PSh, and GDP do not show to have a significant influence on the PPP Concession Period. Also, there are no multicollinearities among the remaining variables, and all VIF values are under 4 as recommended, indicating that the dependent variables are not overly affecting each other. Consequently, the result of the regression analysis performed can be expressed as:

$$CcP = -295.242 - 0.03DPC + 0.008InS + 0.332NoEH + 0.163YCA + 0.62CoP - 1.86\times10^{-4} GDPperCap \quad (2)$$

In order to validate the results of the analysis, some tests on the regression residuals were conducted. The histogram of the residuals resembles a normal curve, thus demonstrating the normality of the data set (Figure 5). The normal probability plot shows that the residuals are normally distributed, and they generally follow a straight line with few significant outliers (Figure 6). In addition, the residuals versus fits test (Figure 7) does not show evidence of systematic error in the residuals of the regression. Finally, the residuals versus orders test (Figure 8) shows no indication of the presence of trends, time series, or periodicity.

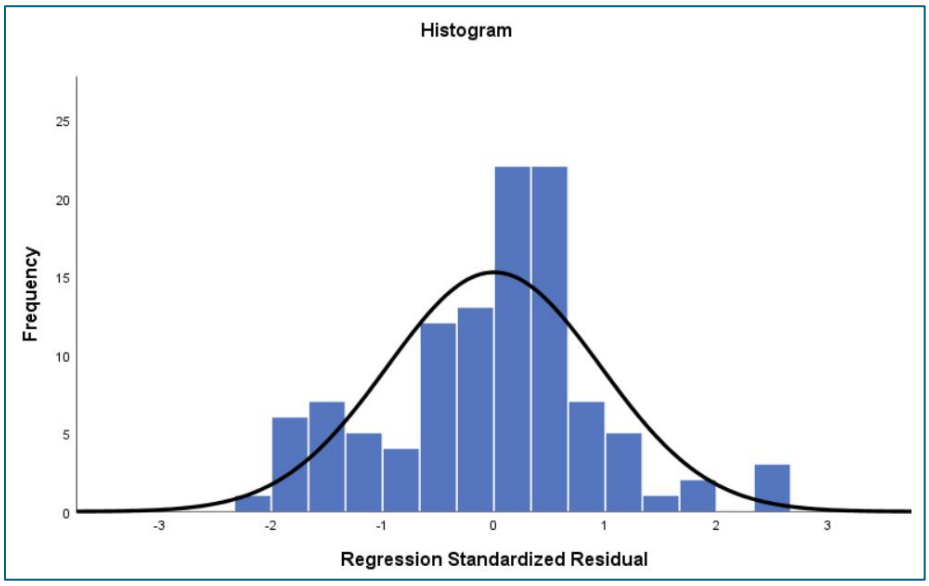

Figure 5: Histogram of residuals

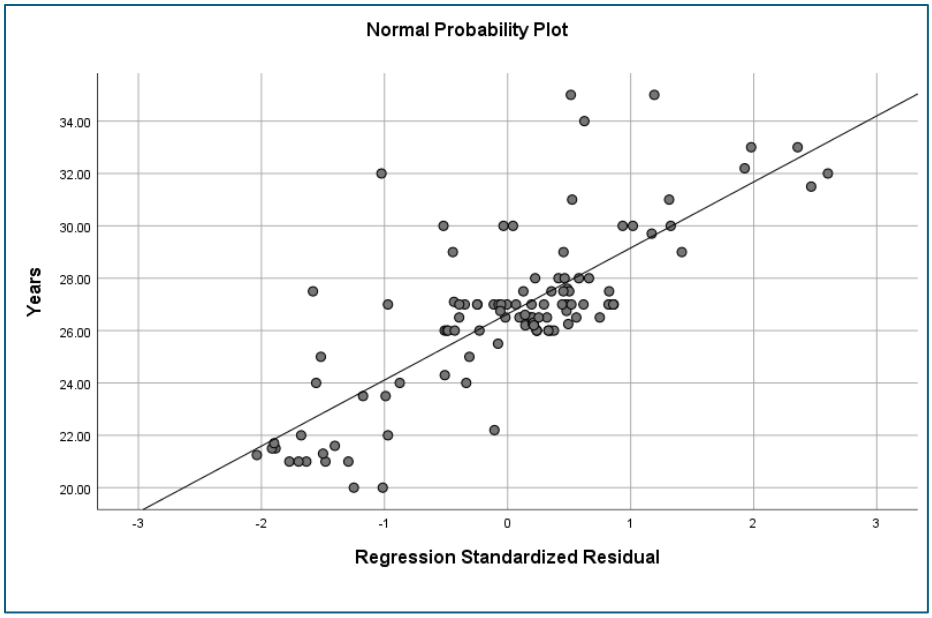

Figure 6: Normal probability plot of residuals

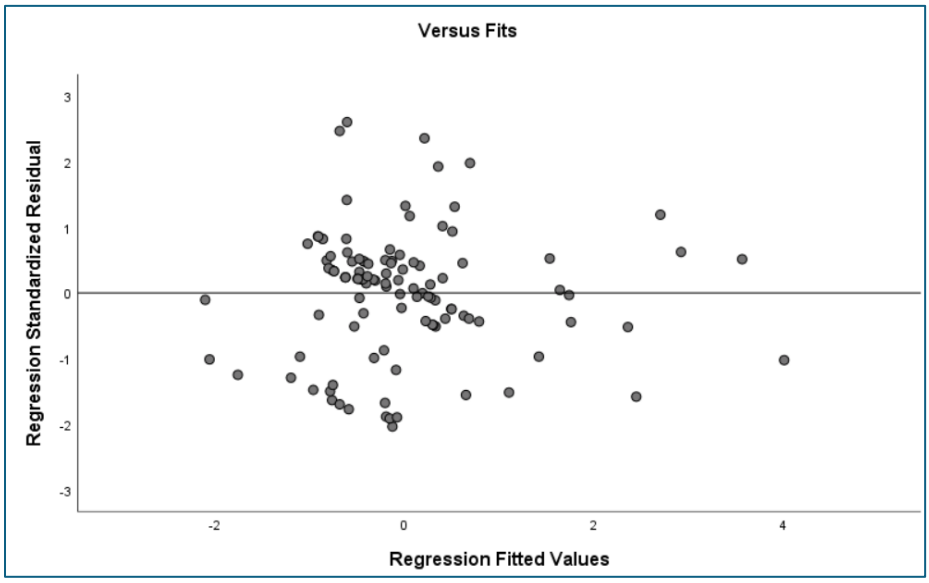

Figure 7: Residuals versus fits

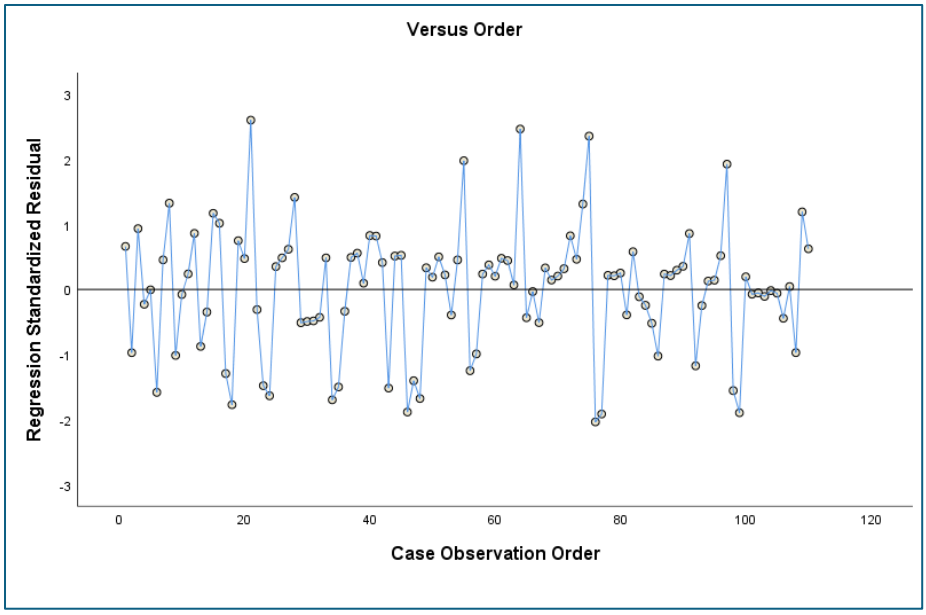

Figure 8: Residuals versus order plot

11. Discussion

Results indicate that certain factors, namely, Direct Public Contribution (DPC), Project Investment Size (InS), Number of Equity Holders (NoEH), Year of Contract Award (YCA), Construction Period (CoP), and GDP per Capita (GDPperCap) significantly influence the Concession Period granted to the SPVs by the public sector. Conversely, the Project Area (PrArea), Public Share (PSh), and GDP were found to have no significant impact on the Concession Period.

Three parameters were found to have no significant relationship with the concession period. Interestingly, most of these factors were recognized as significant parameters for the concession period in the extant literature as follows.

Firstly, the Project Area (PrArea) is not a significant parameter for the concession period of social PPP projects. There are reasons as to explain this finding. The projects analyzed across different sectors might have relatively standardized scopes or functional requirements regardless of their size. This uniformity could minimize the impact of the project area on the duration of the concession period. In addition, Western European countries often have robust regulatory

frameworks governing PPP projects. These regulations may standardize concession period durations based on project types or sectors, reducing the influence of project area variations. Finally, the financing structure and revenue generation models of social PPP projects may not be directly tied to the project area. Instead, financial viability and revenue streams might be based on service demand, population demographics, or other factors unrelated to the physical size of the project area.

Furthermore, results do not show a significant relationship between the Public Share of capital expenditure (PSh) and the concession period. This contradicts previous studies that found a negative relation between the public share percentage and the concession period. This lack of influence could be explained as the following. First of all, in Western European countries, governments often allocate funding for social PPP projects based on standardized criteria or budgetary constraints rather than the percentage of public share. Therefore, variations in the public share percentage may not significantly impact the concession period. In addition, the risk allocation framework established in social PPP projects may prioritize risk-sharing mechanisms that are independent of the public share percentage. As a result, changes in the public share percentage may not substantially alter the risk profile or concession period duration. Furthermore, social PPP projects may rely on diverse financing sources beyond the public share, such as private debt, equity, or other forms of investment. The influence of the public share percentage on the concession period may be mitigated by the flexibility and diversity of financing options available.

Similarly, GDP was found not to be an influential factor in the risk model of the concession period. One explanation for this lack of influence could be the similarity of GDP of the western European countries involved in the study, all of which are considered stable economies with high amounts of overall GDP. On another perspective, Western European countries generally exhibit stable and well-developed economies with consistent GDP growth rates. As a result, variations in GDP may not significantly impact the concession period of social PPP projects, as economic stability provides a conducive environment for project implementation regardless of fluctuations in GDP. Moreover, these countries often maintain robust regulatory frameworks governing PPP projects, which provide stability and predictability for investors and stakeholders. These regulations often establish clear guidelines for concession period durations, which may be independent of GDP fluctuations. Finally, social PPP projects typically involve long-term planning and strategic

considerations that extend beyond short-term economic indicators like GDP. Project stakeholders may prioritize social impact, service delivery, and community development goals over immediate economic fluctuations when determining concession period durations.

On the other hand, a negative correlation was observed between the amount of Direct Public Contribution and the concession period. This phenomenon can be attributed to the decrease in public funding at the project's outset, leading to a higher proportion of private sector investment. With increased private contribution, investors may demand a longer concession period to distribute revenue generation and ensure financial stability. This extended timeframe allows them to cover expenses, manage debt, and achieve profitability while sustaining the project's viability. Therefore, when the SPV receives fewer subsidies from the public sector, it may necessitate a longer concession period to generate adequate revenues over time, ensuring the desired profitability and internal rate of return. This study underscores the importance of recognizing the inverse relationship between public contribution and concession period to strike a balance between public and private sector interests. These findings align with prior research, which also indicates that government subsidies shorten concession periods and facilitate earlier operational revenues. Governments strategically employ subsidies to foster economic growth, incentivize private sector investment, and address critical infrastructure demands. By offering subsidies, governments attract private investment in vital sectors like transportation, healthcare, and utilities, expediting the delivery of essential public services. Shorter concession periods enable governments to reap the benefits of PPP projects promptly, effectively address societal needs, and reclaim infrastructure revenue generation capabilities for public use, redirecting additional funds toward other public expenditures.

The results also reveal a significant and positive correlation between Project Investment Size (InS) and the concession period. This connection can be attributed to the elevated risk and complexity associated with larger projects, prompting the public sector to extend concessions to encourage private sector involvement. This finding supports the earlier hypotheses suggesting that larger initial project investments result in prolonged concession periods, primarily due to the higher expected returns sought by investors to justify the substantial upfront investment. Essentially, investors require more time to recover their initial capital and generate satisfactory profits from the project. Therefore, the extended concession period allows investors to distribute their returns

over a longer timeframe, enhancing the financial viability and attractiveness of the investment. This dynamic aligns the interests of both the public and private sectors by ensuring investors have ample time to realize their expected returns while meeting the project's financial objectives and commitments. Moreover, this finding resonates with the notion that larger projects pose greater risks for private investors, necessitating longer concession periods to mitigate perceived risks. In essence, longer concession periods offer investors enhanced stability and predictability, enabling them to implement risk management strategies, adapt to changing circumstances, and make necessary adjustments to ensure the project's long-term success. By extending the investment over a longer duration, investors can mitigate the impact of short-term challenges and position themselves for sustained profitability throughout the project's lifecycle.

Additionally, the analysis revealed a positive correlation between the Number of Equity Holders (NoEH) in the SPV and the concession period. This indicates that in bidding processes where longer concession periods are observed, private companies interested in the project tend to establish SPVs with a higher number of equity holders to strengthen their capabilities and distribute risks. As noted earlier, PPPs with extended concession periods are more exposed to potential financial, contractual, or legal risks. A greater number of equity holders suggests a more resilient and competent SPV, better prepared to manage project risks and ensure timely debt repayments to lenders. The increased number of equity holders expands the pool of expertise and resources available within the SPV. Each equity holder brings unique skills, experiences, and networks, enabling the SPV to access a broader range of capabilities to effectively address project risks. Diversification of expertise enhances the SPV's ability to navigate complex challenges across various project phases, particularly in the case of prolonged concession periods. It is important to note that existing literature has previously explored the impact of the number of partners in the SPV on reducing project risk, albeit focusing solely on its effect on public finance. This paper extends this perspective by examining the influence of shareholders on the concession period.

Furthermore, the analysis reveals a positive relationship between the Year of Contract Award (YCA) and the concession period. This suggests that PPPs awarded more recently, tend to have increased concession periods. This contradicts the findings of another study that found out that in healthcare PPPs, projects that were awarded more recently had reduced concession periods. One

suitable explanation for this finding is that over the years, as the PPP market evolves, public authorities and private investors acquire greater proficiency in organizing and overseeing PPP projects. This enhanced familiarity enables stakeholders to craft more effective contracts and refine project schedules. Consequently, recent PPP initiatives may entail extended concession periods to facilitate thorough risk evaluations and adapt to evolving project demands. Furthermore, as governments refine and enhance their regulatory frameworks for PPP projects, they may incorporate provisions that extend concession periods to attract private investment and ensure project viability. Recent PPP contracts may therefore include longer concession periods as a means of providing greater financial security and stability for private investors. It might also be that more recent PPP projects tend to incorporate more robust risk mitigation strategies to address uncertainties and potential challenges throughout the project lifecycle. Longer concession periods provide additional time for stakeholders to implement risk management measures and adapt to changing market conditions, thereby reducing the likelihood of project disruptions and financial instability.

Complementary, the Construction Period (CoP) is shown to have a positive influence on the concession period of these social PPPs. Previously, the construction period has been extensively incorporated to determine optimal concession periods in general PPPs, and has been specifically applied to estimate this period in toll road PPPs. The findings of this paper indicate that there is indeed a significant relation between the construction period and the overall concession period. Firstly, projects with longer construction periods often involve larger-scale and more complex infrastructures, such as hospitals or educational facilities, which require extensive planning, design, and construction phases. These complex projects may encounter delays due to unforeseen challenges in procurement, land acquisition, or regulatory approvals, thus extending the overall construction timeline. Secondly, longer construction periods may also reflect the phased implementation approach adopted for certain projects. Phased construction allows for gradual development and expansion of facilities to meet evolving needs and demand over time. This incremental approach to construction may necessitate longer concession periods to align with the phased implementation strategy and ensure sufficient time for each project phase to be completed and operationalized. Moreover, the duration of the construction period can impact the revenue-generating capabilities of the project. Projects cannot start generating revenue until construction is complete and operational activities commence. Therefore, longer construction periods delay the

onset of revenue streams, requiring extended concession periods to allow private investors to recoup their initial investments and generate profits over the project lifecycle. Additionally, longer construction periods may introduce higher levels of uncertainty and risk, particularly related to construction delays, cost overruns, and supply chain disruptions. To mitigate these risks, stakeholders may opt for longer concession periods to provide flexibility in project implementation and allow for the resolution of unforeseen challenges without jeopardizing project viability.

Finally, GDP per Capita (GDPperCap) appears to have a negative relation with the concession period, meaning projects carried out in countries with a higher GDP per capita tend to have reduced periods of concession. In nations with a higher GDP per capita, we often observe enhanced economic stability, fortified institutional frameworks, and more resilient financial markets. These elements collectively foster an environment ripe for private investment and PPP endeavors. Firstly, a higher GDP per capita signals increased financial prowess within the country's economy. Consequently, governments in such countries may find themselves with greater resources to allocate toward infrastructure development, including social PPP projects. This could potentially diminish the reliance on extended concession periods to entice private investment or distribute financial obligations over an extended duration. Secondly, countries with elevated GDP per capita frequently boast more sophisticated legal and regulatory frameworks governing PPPs. Clarity in regulatory frameworks and expedited approval processes may streamline project timelines and mitigate risks tied to prolonged concession periods. Moreover, robust legal safeguards for investors might bolster confidence levels, potentially reducing the necessity for extended concession periods as a risk management strategy. Additionally, higher GDP per capita often correlates with heightened efficiency and efficacy in project execution and oversight. Strengthened project management capabilities and improved access to skilled labor could lead to swifter project completion, thereby mitigating the need for prolonged concession periods to accommodate delays or inefficiencies. Furthermore, this increased GDP per capita also brings about additional arrays of financing options for infrastructure projects, both public and private. This expanded range of financing sources, including both domestic and international capital markets, venture capital, and institutional investors, can streamline project financing, potentially alleviating the need for protracted concession periods to attract private investment.

12. Conclusion

This thesis endeavored to shed more light upon the nature of Public Private Partnerships, its potential benefits in public infrastructure projects, and the various factors and complications that can take place in a PPP's lifecycle; from financing to construction, operation, maintenance, and finally the return of the infrastructure. Firstly, they allow governments to leverage private sector expertise, resources, and innovation for project development and delivery. PPPs can also provide access to additional funding sources, reducing the burden on public budgets. Moreover, PPPs often involve risk-sharing arrangements, transferring certain project risks to the private sector, thus minimizing the government's financial exposure. Additionally, PPPs can enhance project efficiency and accountability through performance-based contracts and incentivized delivery models. Lastly, PPPs can accelerate project delivery timelines by leveraging private sector efficiency and expertise, ultimately resulting in the timely delivery of essential public infrastructure.

Public Private Partnership contracts are made up of several important elements that determine the quality, efficiency, and the profitability of the project for both the public and private sectors. Thus, it is important to take note of these elements and analyze the various factors that can potentially influence them. One such element of PPP contracts is the Concession Period, which has been the main focus of this thesis work, formed by the combination of two scientific papers focusing on the same subject. The concession period in PPP projects refers to the duration of time during which the private sector partner builds, operates, and manages the project infrastructure. It represents the length of the contractual agreement between the public authority and the private entity. This duration is of particular importance as it determines the time available for the private partner to recoup its initial investment and earn profits from the project. Furthermore, the concession period influences the allocation of risks between the public and private sectors. It affects the distribution of financial responsibilities, operational risks, and performance obligations throughout the project lifecycle. Finally, the concession period impacts the overall project economics, including revenue generation, financing arrangements, and return on investment for the private partner. It also influences the level of service provision, maintenance standards, and asset management practices during the concession period.

The research work conducted as part of this thesis work strived to determine the various potential factors that can influence the duration of the concession period, and find out how they may help build a risk model. An initial journal paper, already published, analyzed the effects of these influencing factors with a focus on healthcare projects in Italy, whereas the second paper, currently in the drafting stage at the time of writing this thesis, focused on a broader scale of social projects taking place in Western European countries. Both of these papers made use of the linear regression statistical analysis method to determine the extent and nature of the influence of variables on the result variable, the concession period. As part of the results of the first study, it was found that the variables of Project Initial Investment, Number of Equity holders in the SPV, and the Catchment Population positively influenced the length of the concession period, while Public Share percentage and Year of Contract Award negatively impacted the concession period. The analysis results of the second study on the other hand, demonstrated a positive relation of the variables of Project Initial Investment, Number of Equity Holders, Year of Contract Award, and Construction Period with the concession period. Conversely, a negative relation was observed between the Direct Public Contribution amount and GDP per Capita and that of the concession period.

The results of this study could potentially help the decision makers of both the public and private sectors, as well as investors, in strategically planning their PPP contracts in order to negotiate better terms, achieve optimum profitability, and ensure fair risk distribution. As one practical implication, public authorities may opt to use the negative relation between the public contribution and the concession period to contribute more public funds in the beginning of the project in order reduce the duration of the concession, potentially reducing the long-term financial burdens and ensuring the revenues generated by the operation of infrastructures are added to the public budget sooner rather than later. Moreover, the private sectors can make use of the findings indicating a relation being the number of equity holders in the SPV and the concession period. By understanding the dynamics between the longer concessions and the risks attributed to that, SPV can consciously structure their partners in order to better distribute and manage the heightened risks associated with extended concessions. In addition to that, the findings of this study can further make way for new efforts and studies focusing on the optimization of concession period of PPPs by determining the variables that actually make up the risk model of the concession period.

Nevertheless, it is important to acknowledge certain limitations within this study. Firstly, the analysis is based on a linear regression model, which presupposes a linear connection between independent and dependent variables. This approach might oversimplify the data and overlook more intricate, non-linear relationships. Secondly, although the analysis identifies associations between factors and the concession period, it cannot conclusively determine causal relationships. Linear regression establishes correlations between variables but does not verify causation.

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Acknowledgement

I would like to take this opportunity to express my big appreciation for Professor Alberto De Marco for his guidance throughout my research work in addition to a significant part of my study path, as well as giving me the opportunity to join his research initiatives and delve deeper into the world of project management, which has been developed more and more to become my passion and outlook with which to further continue into my career path.

I would also like to express my immense gratitude to Professor Gabriel Castelblanco for his unrelenting support and assistance throughout both of our article works. His guidance in the stages of data collection, analysis, and eventual draft preparation, as well as his ever-present availability, have simply been invaluable.

Finally, all the accomplishments throughout my masters journey would have been impossible without the support of my close friends and loved ones, by whom I continue to be inspired to this day.

When I look back to the many experiences I had thanks to Politecnico di Torino, the various awards, the unforgettable ASP 18th cycle, and the often challenging and even frustrating teamwork projects, I can't help but feel grateful for every single one of those moments that have shaped me into who I am.

Cheers!

Pourya Safari