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# **A Framework to Use Public-Private Partnership for Smart City Projects**

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## **Abstract**

The concept of Smart City has been emerging as a strategic set of integrated initiatives encompassing infrastructures, technology and digital services for the purpose of enhancing the quality of life of citizens. However, the development and implementation of Smart City projects require considerable investments that are difficult to fund with traditional public finance. In this context, Public-Private-Partnerships (PPP) appear to be suitable solutions to overcome the shortage of public finance and cuts on public spending. However, the adoption of PPP forms for Smart City projects has not been fully explored and only experimentally applied so far. In order to promote the usage of PPP to finance Smart City initiatives, this paper proposes some PPP financial instruments and discusses the associated strengths and weaknesses. In particular, the use of Project Finance, Revenue Sharing and Social Impact Bonds are suggested as sound alternatives and suitable sources of financing for Smart City projects.

## **Introduction**

The Smart City (SC) has been appearing as a new paradigm of intelligent urban development and as an important factor to shape sustainable socio-economic growth in both rising economies and more developed countries. A SC can be referred to as a planned, coordinated and interconnected digital system of citizens, transports, communications, services, and utilities. The strategy of a SC might be deployed into a variety of digital infrastructures and technology-mediated services in various vertical fields of application, such as assisted living, mobility, energy, waste, etc., in order to enable new value-added user-paid businesses, government efficiency, cost savings in public utilities, social inclusion patterns, and creation of economic wealth of citizens.

To this end, the implementation of a SC agenda, via development of a series of digital project investments, usually requires significant capital. However, the current economic climate particularly in most European countries forces many cities to seeking for budget cut and setting priorities. As a consequence, cities are facing tough challenges to maintain and upgrade innovative policies and develop initiatives (Komninos et al., 2011). In this context, forms of Public-Private Partnership (PPP) and Project Finance (PF) are sought by many municipalities as ways of

leveraging limited public funding and procure desirable new SC projects with limited spending and additional borrowing (Algarni et al, 2007).

PPP/PF was introduced in many EU countries to support procurement of infrastructures, social facilities, and innovation in urban development. Due to the limits imposed on public spending and the shortage of public financing in most European countries, PPP has been appearing as an alternative and accessible financing thanks to its main features, such as bankability with infrastructures as collaterals, optimal risk allocation between the public and private sectors, off balance sheet investments. Also, PPP has often claimed for a better risk sharing between the actors involved, a limited public financial effort, more sustainable investments, a more cost-effective management of the project, and reduced development failures.

However, despite these characteristics and promises, the PF mechanism used to develop constructed facility has failed to fully meet its expectations and has been fighting to prove its advantages and applicability.

The main reasons and drawbacks that limited PPP/PF past application are due to high transaction costs for small/medium sized projects (up to 5% of the deal value), long time from project inception to physical development, political risk, low-bid environment, and financial strength of promoters (Bonetti et al., 2010). Another factor is related to the reduced self-financing ability of many PPP/PF projects, such as social facility services requiring a shadow toll or unitary charge paid by the granting public authority with little user-generated commercial revenue to self-sustain the private portion of initial investment (Hellowell and Pollock, 2009).

As a consequence, the usage of PPP to develop SC initiatives should learn from previous PPP experiences and take advantage of result analyses and lessons learnt. To this end, the purpose of this paper is to provide with an analysis of the main key success factors of PPP applications as a contribution to supporting the definition of a framework for an effective application of PPP financial and contracting mechanisms to develop SC projects.

In the next sections, we first make a review of the pertinent literature associated with the notion of PPP and related to the different existing definition of SC. Second, we analyze the state-of-the-art of current PPP applications for SC initiatives and present some case studies. Then, we explore some selected PPP financial instruments that might apply to SC projects, namely: PF, Revenue Sharing (RS), and Social Impact Bond (SIB). For each type, we present a case study analysis and show its applicability, weaknesses, and strengths. Finally, we discuss the potential of the proposed PPP

financial mechanisms to overcome the limitations inherent with traditional financing of innovation and draw conclusions.

## **Context and Literature Review**

Nowadays, cities and megacities have to solve new kinds of problems, such as difficulty in waste management, air pollution, human health, traffic congestion, deteriorating and aging infrastructures (Chourabi, et al., 2012). Moreover, in 2008 for the first time in human history, people living in cities have overcome people living in rural areas in the world, and United Nations have forecasted that 70% of people will live in an urban setting by the year 2050. As a result, cities have assumed a key role in the urbanized world of the 21st century (Dirks and Keeling, 2009). The urgency of making a city a more sustainable and livable place calls public bodies to realize innovation and transformations at the urban scale. Furthermore, the high concentration of people could be a source of cultural, political and economic strength and cities can act as talent magnets and incubators of innovation and, in turn, as main engines of economic growth (Accenture 2011).

The need of innovation is strictly related to the challenges cities are facing. Today, there is not just a clear and unique definition of SC that is universally accepted (Chourabi et al., 2012). Its main focus seems to be on the role of ICT infrastructure, but also, as much research underlines, a SC relies on key factors such as human capital, education, environmental interest, social and relational capital for urban growth (Caragliu et al., 2009). Harrison and Donnelly (2011) state that the notion of SC is not new, since it recalls the policies for urban planning and has been used since the early 2000s for the application of new systems to integrate data and operations of urban infrastructures and services as buildings, transports, public safety, water and electrical distribution. At present, the definition of a SC seems to include fairly any form of mainly technology-based innovation in the cities. Giffinger et al. (2007) define a SC as a city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living. According to Hall (2000) a city has to monitor and integrate conditions of all of its critical infrastructures to be considered as smart. The definition proposed by Harrison et al. (2010) states that a SC is a city connecting physical and IT infrastructure, social and business infrastructures to leverage the collective intelligence of the city. Washburn et al. (2010) provide with a complete list of domains of application: in particular these are city administration, education, healthcare, public safety, real estate, transportation, and intelligent, interconnected, and efficient utilities. Based on these analysis it can be stated that the offering of new type of services and processes, primary based on ICT, should be accessible, efficient, saving generating, open, sustainable. Therefore, SC is a new paradigm of doing innovation, able to bring together the characteristics associated with organizational change,

technological, economic and social development of a modern city, and to the interaction among citizens that are involved (Gonzalez and Rossi, 2011). This new paradigm of innovation marks a shift between more traditional ways of carrying out technology-push research and development, and the new approach based on user needs and bottom-up processes from citizens to IT services.

According with the growing relevance of SCs and smart communities worldwide, in 2012 the European Commission has launched the Smart Cities and Communities European Initiative. The funding initiative proposes to pool resources to support pilot demonstrations of energy, transport and information and communication technologies in urban areas. In addition, several EU member states, as part of their declined digital agendas, are promoting and coordinating SC actions and projects.

In this context, governments and municipalities are called to invest for the development of SC initiatives in a period of economic downturn and unavailability of financial resources. Public funding is no more sufficient to sustain SC projects and traditional models for financing utility and facility projects are often inadequate because of high risk profile and intangibility of SC innovation projects. In this contest, the injection of private funding becomes necessary and PPPs appear to be suitable solutions for the implementation of SC initiatives. Therefore, the design of innovative PPP financial models must become an integral part of the planning of SC projects.

PPP is a financing and contractual mechanism to establish a long-term relationship between the public and the private sectors for the purpose of developing a capital investment project and provide the associated public service.

Three are the proposed forms of PPP that are suggested for potential usage in SC projects, namely: PF, RS, and SIB. As a matter of fact, the recourse to new forms of financing for projects of public utility, as SIBs, has been advised in Italy by the “Social Innovation Agenda” launched in March 2013 by Ministry of Education, University and Research. Under the terms of a typical PF, one or more investors join a special purpose vehicle (SPV) to finance the design, the development and the operations and maintenance of a public facility for a specified concession period, at the end of which the ownership of the project is transferred back the public granting authority. During the concession period the private partner collects revenues from operating the project in order to recover the initial investment and get a profit (Schaufelberger and Wipadasut, 2003). PF puts the private sector into full play in a wide range of activities with long-term business opportunities. Therefore PFs appear to be incentives for the concessionaire to apply innovative methods and technologies and to adopt life-cycle management strategies for improved efficiency and cost effectiveness (Zhang, 2009). The success of PF is based on claims that it provides for improved

service due to private sector efficiency, reduced burden on public budgets to develop new facilities and risk reduction for the contract parts (Lattemann et al., 2009).

RS is proposed as a second form of PPP for SC projects. In the commerce language, RS is a contract obligation for the retailers to pay a royalty on their sales to their suppliers. In this sense, this type of contract is able to align incentives among the vertical supply chain and among the actors involved. In fact, many supply contracts in vertically separated industries include revenue-sharing agreements where the downstream firms make royalty payments to the upstream firm based on the downstream sales (Dana and Spier, 2000). Fee established in a RS contract must satisfy two proprieties: first, it should be Pareto efficient so that no other allocation can offer better payoff for every actor involved; second, this allocation should not depend on the scale by which the providers' profits are measured (He and Walrand, 2006).

In the SC context, revenue sharing can be applied in a “zero cost” form, also named savings sharing. This means that involved partners share savings, and not revenues, generated by the new applied solution. This model is able to foster the reduction of public expenditure and, in turn, free public funding for other socially urgent projects.

Finally, a third proposed PPP mechanism is the SIB. SIB can be defined as a contract arrangement where the public commits to pay for improved outcomes of privately-delivered social services to the private sector. Based on this contract, the necessary investment is raised from socially-motivated investors. Target outcomes can be gained also in terms of cost savings for the public authority and if they are achieved, investors will receive payments from the government that repays the initial investment plus a financial return that depends on the level of improvement of the resulting outcomes (Social Finance, 2011). If no improvement is gained on the provision of the service, no profit is remunerated to the social investors. This means that the private investors, rather than the government, bear the financial risk of paying for services (Rubin, 2011).

In the following sections some field case studies are presented to better illustrate the pioneering usage of the three proposed financing systems for SC projects and applications. The aim of the paper is the review of these financing techniques, by illustrating their potential of applicability and their added value for smart city initiatives. The case studies are first evidences of their viability. Advantages and disadvantages are given to show applicability and suitability of the methods according to the specific type and main characteristics of a SC project.

## **Project Finance**

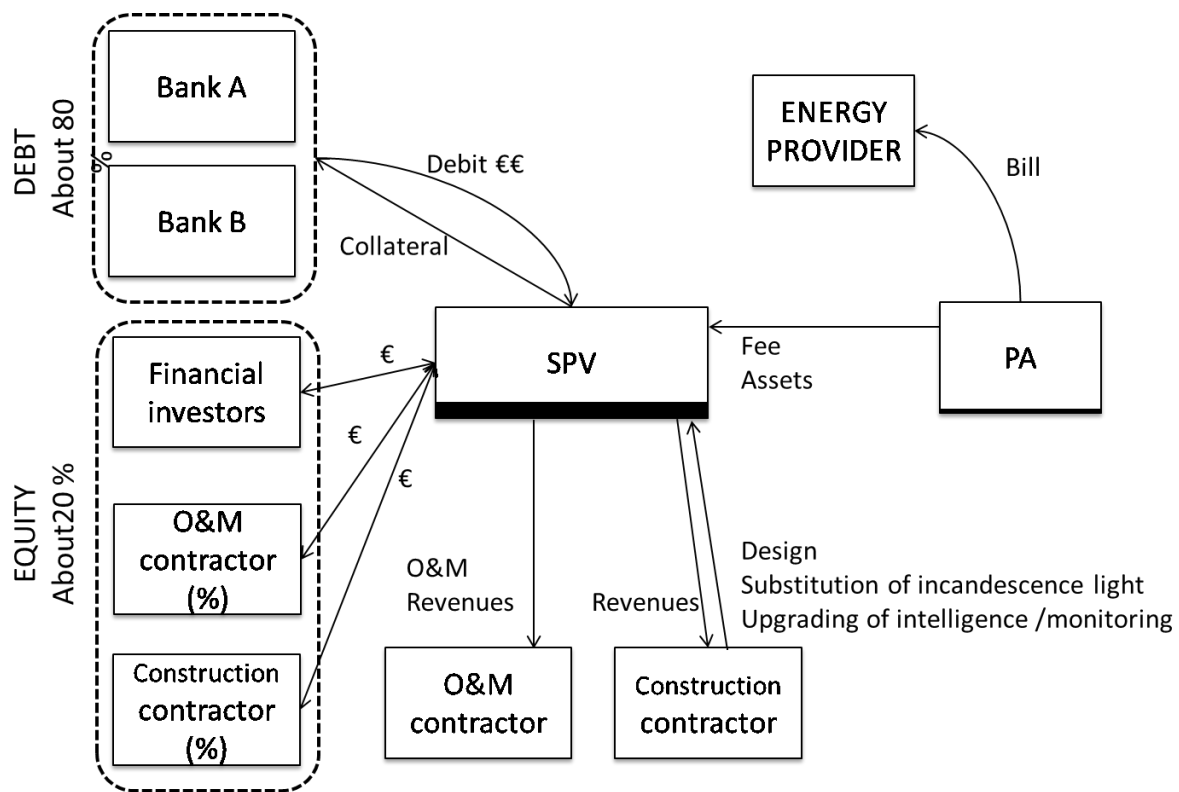
### *Case Study*

Here we present one of the first experimental applications of a PF mechanism to finance and operate an upgraded intelligent urban lighting system in a city of approximately 300 thousand residents. Nowadays the cost of electricity is more and more growing and significant savings can arise not only from an environmental point of view, but also for economic reasons because of constraints imposed on public spending. Moreover, energy savings are easy to be measured and are able to sustain PPP initiatives. Furthermore, street lamps could become the end point of a communicational network that can include internet wi-fi hot-spots, electrical recharge points, security cameras, and variable message signs. New street lamps use LED technology that illuminates based on the intensity that is needed. Therefore, a significant optimization of power consumption can be achieved. The project also includes a platform for analytics and decision-making support, able to manage maintenance interventions and the planning of supply. Finally, the remote control system allows the detection and management of system failures and the application of policies for lighting intensity regulation.

Benefits associated with the project are the efficiency of energy consumption, savings for Public Administration, and in turn the reduction of cost for ordinary maintenance. The total amount of saving equals about 55% considering both the energy and the maintenance cost.

The form of PPP proposed is a PF, with the creation of a SPV. The investment, equals about 10 million €, is financed with debt by a pool of banks, while private investors inject the equity portion of financing into the SPV. The Public Authority, thanks to savings obtained after the project, pays a fee to the SPV considering operations costs, debt rate and revenues for investors. Finally, extra cash flows come from additionally services offered through the new street lamp enabled functionalities.

The scheme of the financial model is represented in Figure 1.



**Figure 1 - Scheme of the intelligent lighting PF case model**

### *Applicability, Strengths, and Weaknesses*

PF is more applicable in the case of projects with tangible assets, such as street lamps, since it is based on the assignment of a tangible asset on which it is possible setting real rights. The main strengths of the project are:

- a clear separation between cash flows of the SPV and cash flows of investors. This represents an incentive to investors because the balance sheets of promoters are separated from the activities of the SPV;
- a better risk allocation between the public and private parts in the sense that the risk is assigned to the part more able to bear it. This reduces the probability of failure of the initiative;
- SPV as an unique center of responsibility for the execution of all the activities of the project;
- Savings of public resources, because of the involvement of private investors in the project;
- Fulfillment of the gap in terms of know-how and technology competences of the public part. As a matter of fact, private investors contribute not only economically, but also with project management capabilities.

On the other hand, PF has the following weaknesses:

- it requires more costs related to due diligence, contracting, transactional costs;
- debt is charged greater interest rates, because of the risk segregated to the project and the complexity of the relationship between the public and the private parts;
- contracts are often inadequate to the project, because the governance and relations management in a multi-stakeholders contest are more difficult. It causes greater amount of disputes and increases the risk of failure of the initiative.

Based on these arguments, PF can be considered as effective for funding smart city initiatives because it is supported by digital instruments of aggregation for the participation and transparency and by systems of accountability and management.

## **Revenue Sharing**

### ***Case Study***

New solutions offered by ICT allow the achievement of efficiency, the improvement of financial results and the release of public finance. ICT and the application of a revenue sharing model between public actor and vendors, permit the realization of improvements without the inscription of new costs on the public balances sheet. As a matter of fact, Public Administration repays his supplier, by means of a part of savings generated by the new solution, for a certain period of time that is required for the payback period in addition to revenues for the vendor. So that, implementing a revenue sharing model in the form of savings sharing allows local authorities to implement a smart project at zero additional costs. After this period, the public authority takes cost savings benefits. An international vendor of technologies for smart city has presented a model in three fields of application: fiscal elusion, management of public assets and improvement of use of ICT resources for new services for citizens. The use of instruments of intelligence in these field increases the speed and the efficiency of process of detection, inspection and recovery of lost resources.

The project achieves the reduction of fiscal evasion by the improvement of cadastral folders, guaranteeing not only the recovery of lost revenues, but also extra cash in. The improvement of the management of public assets through the development of competences of urban facility management allows the assets to generate more revenues. The improvement of the use of ICT resources, such as the dematerialization of papers or the supply of new services thanks to the application of sensors in the city, increases savings and efficiency.

### ***Applicability, Strengths, and Weaknesses***

RS is a paradigm well applicable where all the actors of supply chain are clearly identified and revenues are easy to be shared. Lastly, RS is applicable in those cases wherein sharing revenues or savings allows the alignment of the objectives of the different involved stakeholders (Dana, 2000), maximizing the overall profit, even if the single profit of each actor is not maximized. The main advantages of RS are the following:

- RS allows the implementation of smart projects without any additional costs on public balance. As matter of fact, the project is repaid through savings which it generates by itself;
- RS aligns the objectives of stakeholders involved in the project, because the aim is the maximization of the total revenues of the project.

After all, a Revenue Sharing model has several weaknesses:

- it requires a precise and detailed assessment of all costs of administration, implementation and of the entire lifecycle of the innovation, including potential costs of the future;
- for the success of RS, it is necessary the exact definition about the moment of payment in the sense that the public institution can correspond the shared savings when the inefficiency is identified or when the saving is actually accrued. It is fundamental to establish when the supplier acquires the right of obtaining his payments, in the light of savings generated by his solution;

### **Social Impact Bond**

An important case of SIB application is in Great Britain, where there was the first case of SIB emission. It was implemented in Peterborough in 2012 aiming at the reduction of recidivism rate of offenders serving short prison sentences, less than one year. SIB were funded for an amount of about £5 million mainly by foundations and charities, but also by private individuals, through the finance intermediary. If members of Peterborough are reconvicted less than offenders in a comparison group not subjected to SIB intervention and taken as a target, in the year following the release, the Ministry of Justice and the society will have less crime and less costs of policing, court cases, prison places. If reoffending has reduced by at least 10% for each cohort, compared with the target group, the Ministry of Justice and the Big Lottery Fund would have paid a return on investment to SIB investors. Stakeholders involved in SIB launch were Ministry of Justice, the Big Lottery Fund, prisoners, Social Impact Partnership, Investors, Providers (St Giles Trust), Peterborough Prison (Disley et al., 2011).

### **Applicability, *Strengths*, and *Weaknesses***

SIBs are applicable in contests where the government aims to prevent social crisis with a project involving a clearly identifiable target group of people. Applicability requires adequate measurement system that is robust, objective and comparable with target values, and sufficient revenues or savings to repay interest rates to investors. SIB application fields are reduction of recidivism, rehabilitation of disadvantage people, health, disability, assisted living. The main strength of the application of SIB is the ability to overcome limits of innovation development for social issue, because it is strictly oriented to outputs and prevents that not successful projects with little social impact persist year by year.

Moreover, with SIB application, the public sector has more incentive to invest thanks to risk transfer to the private part.

On the other hand, SIB requires more costs for assessment and contracting among involved parts, an accurate analysis to calculate the rate of return for investors, the creation of a robust system of monitoring and control of both social and economic KPIs and, finally, the definition of a target group clearly identified with respect to social variables such as age, gender, district, conditions of life.

### **Critical Review**

The analysis of these financial instruments originates some considerations about the applicability and usage for SC projects. Research, development and innovation are typically difficult to be financed through traditional instruments such as corporate debt. Empirical studies demonstrate that fundraising is the main constrain for the development of innovation (Pencarelli and Menghi, 2004). The main reason is that the return of these kinds of initiatives cannot be always precisely foreseen. In particular, in a period of bad economy, the uncertainty of return is a risk that cannot be always born. One of the difficulties of raising funds is the asymmetric information. Firms are reluctant to invest because the inventor has frequently better information about the success and the nature of the innovation compared with the potential investors (Hall, 2002). Therefore the risk for investors is higher than in case of an ordinary investment and, as a consequence, the cost of the debt is greater. The issues of asymmetrical information arise with investment in intangible assets. In fact, the knowledge asset created by innovation is intangible and in part intrinsic in the human capital, while lenders and banks prefer physical assets as collaterals to secure loans. In addition, servicing debt usually requires a stable source of cash flow, which is more difficult in the case of a R&D investment (Hall, 2002). Often, innovative firms are in the beginning phase, when it is difficult realizing the risk assessment because of scarcity of data about past experiences. Furthermore, the absence of a secondary market for intangibles makes the investment an irreversible decision and

increases the risk of financing (Pencarelli et al., 2004). In this sense, the marginal cost for obtaining debts for innovative firms increases (Bugamelli et al, 2011). The different forms of PPP could be a solution for financing these initiatives. They allow a more efficient risk sharing among parts, and there are not extra costs for the public institutions. However, the complexity of these financial instruments and the nature of developed projects foster the stakeholder to write down very precise contracts in order to avoid any kind of disputes that could jeopardize the output. Therefore, the development of contracts can be expensive, and the institutions have to evaluate these costs before to undertake PPP initiatives, in particular in case of projects of small size in terms of investment when the weight of assessment costs is higher.

However in this period of financing shortage, organizations are either unable or reluctant to use debt or traditional finance for innovative investments (Hall, 2002), limiting their capacity of fundraising. For innovative firms new forms of financing that are appropriate to the characteristic of intangibility appear to be the main way to sustain innovation (Bugamelli et al, 2011).

## **Conclusions**

This paper analyzes three PPP financial instruments for supporting innovative projects for SC initiatives. PPP allows the exchange of know-how from private actors to public ones, usually with fewer competences in the field of design and build of innovation. In this sense, the public sector takes advantage from innovations, capabilities and technologies of private firms. These forms of financing consist of partnership between the public and the private actors to implement a new type of risk sharing among parts. PPP brings to a higher level of success since it is based on the idea that risks are assigned to the part more able to manage and support them. SC initiatives can be associated with different domains of application and for each one there is a proper financial mechanism. For this reason different forms of PPP have been studied. Out of the various forms of PPP, the PF mechanism appears to be suitable in case of tangible asset that represents a warranty for the private investor and it brings to an efficient risk allocation. An example about the public lighting is provided. The expected savings account for about 55% considering both the operation and maintenance cost.

On the contrary, RS might be used for more intangible SC projects and is typically applied when the objectives of the parts are aligned and there are no extra costs for the public authority. A very promising application is associated to controls on fiscal elusion. The burden of the system is related to the contractual scheme that has to be very precise in order to prevent any kind of disagreements.

Finally, SIBs fit social projects that can be constantly monitored. In this way there is a continuous control of the outcomes and in turn of the expenditure. On the other hand extra costs for the contract assessment can be high. The implementation of SIB in Peterborough about the reduction of the recidivism appears to be very challenging, but at the same time it brings positive externalities for the community. New forms of PPP represent an alternative source of financing for innovation that usually is difficult to be sustained because of its intangibility characteristics. After all, there are some limitations for their applicability in Italy. In particular, structured regulation for these instruments is still missed, as in the case of SIB. Moreover, the time of realization of the project is often longer compared with the timing of developing smart projects. Future research streams are addressed to the collection of quantitative data about pilots projects just launched and that now are in the initial phase, to analyze the concrete applicability of these financial instruments to SC initiatives.

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