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Post-print version of the following publication: | Versione post-print della seguente pubblicazione:

Original Citation/Citazione:
Lucia, Marchegiani; Maria Elena, Nenni; Peruffo, Enzo; Pirolo, Luca. (2012). Linking Value Assessment to the Business ModelFramework in High Innovative Services of PublicUtility. INTERNATIONAL JOURNAL OF ECONOMICS AND MANAGEMENT ENGINEERING, (ISSN: 2225-742X), 2:3, 98-103.

Availability/Disponibilità:
This version is available at: 11385/48055 since: - Questa versione è disponibile alla pagina: 11385/48055 dal:

Publisher/Casa editrice:
World Academic Publishing

Published version/Pubblicato:

License/Licenza:
DRM (Digital rights management) non definiti

Availability/Termini d'uso:

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09 September 2026

Linking Value Assessment to the Business Model Framework in High Innovative Services of Public Utility

— A Simulation from the Aerospace Industry

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Abstract- **This paper is focused on the highly innovative R&D activities involving both private and public partners. The public goals pursued by these projects make them substantially different from the most common profit driven R&D ventures usually analyzed by the literature. In many cases, socio-political issues determine the decision to fund such projects within a specific initiative or sector. The lack of analytical tools to address this multiple stakeholders' often-conflicting ventures is noticeable observing big ongoing projects where the risk of conflicts among public and private stakeholders may arise. We have validated the PPBM to the satellite services industry on the Emergency Response Core Services (ERCS).**

Keywords*- *Business Model; Economic Sustainability; Value; Organization and Risk Management; Satellite Services

I. INTRODUCTION

Public investments in highly innovative industries are deemed fundamental to drive the competitiveness of countries, the overall economic development and the effective response to global crisis [1]. This tendency exacerbates the rise of public-private ventures. Over the last decade, a vast amount of Private Public Partnerships has been signed in the European Union, accounting for an estimated capital value of more than €250 billion [2]. Yet, despite such evidence and a growing body of knowledge about Public-Private Initiatives, still analytical tools are lacking to address multiple stakeholders in highly innovative industries.

Differences in public vs. private organizations can be traced back to Blau and Scott's typology [3], which designates a category of commonweal organizations whose prime beneficiaries are the public in general, as distinguished from business organizations whose prime beneficiaries are their owners. As far as highly innovative industries are concerned, public interests are of evidence. This requires adapting managerial tools to ensure sustainability of these ventures, in economic terms as well as with respect to the public interests.

Moreover, highly innovative industries are often project-based, which requires adopting specific managerial tools and accounts for new theoretical insights.

This work is focused on the highly innovative R&D activities involving both private and public partners who are substantially different from the most common profit driven R&D ventures as they pursue public goals. In many cases, socio-political issues determine the decision to fund such projects within a specific initiative or sector (e.g. the GMES and GALILEO projects inside the aerospace EU initiatives). As underlined by the European Commission, a Space Policy is pursued within the Europe 2020 strategy, developed in collaboration with the European Space Agency and Member States.

In order to deeply investigate the management of such projects, it is possible to ideally break them up into three main phases: i) the idea generation (decision phase), ii) the realization (design phase), iii) the distribution of the related services (execution phase). To the best of our knowledge, most of the works that addressed this topic take into account either the earlier stage of this process (decision), or the execution phase (e.g. [4]). So far, little progresses have been made in managing the design phase that is topical just now when discontinuous innovation and open innovation require more and more new systems and tools for idea management [5]. Yet, conflicts among private and public values appear more relevant in this stage [6], due to the opposite interests of public institutions and private stakeholders. Public partners pursue goals such as economic development, safety, reliability and accessibility (e.g. [7]). Profit-driven partners instead focus on the design of the service infrastructure to assure at least the economic and financial equilibrium in the execution phase.

Prior works focused on: i) how to assess the goodness of business arrangements [8], [9]; ii) the relevance of social costs and benefits [10]. Nevertheless, none of them has combined these two perspectives in a single model to assess the sustainability of the initiatives after the decision phase. Combining public and private values is even more relevant in highly innovative industries, due to the high amount of investment required and uncertainty of its returns.

We think that the business model framework can be emended to accommodate such diverse (if not diverging) goals. We apply this new framework to t he GMES (Global Monitoring for Environment and Security) initiative as a case study. The overall contribution of the business model conceptualization lays in the opportunity to frame an integrated view of all the actors involved in a specific business. This is particularly relevant in high technological context in which the business model framework can be useful to define the organizational arrangements among firms, partners and costumers [11] and an approach that links

business and technology can support the decision-making process and indirectly reduce business risks [12]. In this paper we extend the traditional framework of business model to include public actors and their perspectives, within innovative public infrastructure projects. The traditional business model components must be adapted through what we define the Public Private Business Model (PPBM) in order to obtain a pervasive approach to public investments. The PPBM adopts a comprehensive view of the whole value system that sustains the provision of public services and products, merging the profit-driven-actors view with the social and public issues.

Moreover, effective analytical frameworks are needed to overcome the market failures that can result from the participation on the public private sector infrastructure. In fact, rent-seeking or opportunistic behaviours by both public and private parties may result in drawbacks, such as: a) monopolistic service provision, b) overexploitation and misallocation of resources, c) production of social and environmental externalities, d) under provision of basic needs [13]. The traditional instruments used to manage public private partnerships fall short in facing these problems, as they only focus on specific aspects of the partnership. Indeed, since the business model framework is more comprehensive and offers a broader picture, it may be useful in the design phase of the public investment.

We test the PPBM model into the satellite services industry. The provision of satellite services is actually not attractive for fully private investments because of a low or even negative expected rate of return. Nevertheless, the social profile of this kind of projects generally justifies the public funding, almost regardless of any cost-benefit analysis [6]. The proposed PPBM is useful to analyse how the value is created and how the economic sustainability within the public services domain is pursued.

II. THE BUSINESS MODEL FRAMEWORK

Although business models have been conceptualized in various ways, the dominant stance is that it is a way of articulating the underlying business logic. There are four distinctive building blocks that constitute the business logic [14], such as:

- Infrastructure management: this block defines the structure of the value chain within the firm, is required to create and distribute the offering, and determines the complementary assets needed to support the primary activities. It also describes the value network in which the firm is embedded and identifies its position in the value network, linking suppliers and customers, and potential competitors.
- Offer: this block articulates the value created for the users.
- Customers: this block identifies the users to whom the offerings is useful and for what purpose.
- Finance: this block estimates the cost structure and revenue potential of producing the offering.

Currently technological innovation creates new opportunities for the definition of organizational arrangements among firms, lowering the information and cost barriers to set up business models among firms, partners, and customers [15]. Within this frame, all the participants are drawn, as well as the relations among them, and the transactions. Technological innovations have allowed the development of new ways to create and deliver value, as well as the emergence of new exchange mechanisms and transaction architectures [16]. This has increasingly attracted the attention of scholars and business strategists, who are keen to adopt the business model as an explanatory framework for firms' value creation, performance, and competitive advantage [17].

According to these considerations, Amit and Zott [18] propose a relational view of business model, which are considered as "the structure, content, and governance of transactions". From this perspective, it is interesting; from a conceptual point of view, to stretch the idea of business model to include public actors. In fact, if business models are useful to determine the value proposition and value determinants of a firm's strategy, it may also be effective to describe the dynamics of value creation in public contexts. This analogy is grounded on the view of public management as opposed to public administration.

Combining the business model and the public management tool poses questions about the measurability of effectiveness in public business model. In fact, traditionally the public private partnership (PPP) research shows that the sustainability of projects must be assessed in three different ways [6], such as:

- Social sustainability, which refers to equity of access to key public services by poorer groups within urban society [19].
- Environmental sustainability, which refers to the impact of service delivery by public infrastructures on the environment (air quality, water quality, depletion or maintenance of resources, impacts on downstream rural communities as a result of water pollution, etc.).
- Financial sustainability, which refers to the capability of service cash flow to pay back the investments in infrastructures, both in the short and in the long run.

Nonetheless, when it comes to specific industries where infrastructure investments are required and social impacts are straightforward, it is crucial that public as well as private actors jointly collaborate in effective ways.

The relationship between private sector participation in public initiative and sustainability of the project from an economic and financial point of view is complex. Perfect market conditions in infrastructure based service delivery, widely presumed to be essential to viable private involvement, are generally lacking. Because ownership of infrastructures creates entry barriers for newcomers, this kind of service delivery has the characteristics of a natural monopoly. Furthermore, local regulations and contracts may create legal monopolies by giving private firms exclusive rights to construct and operate urban infrastructure during long-term concession periods. Thus, private sector participation in public infrastructure may result in market failures. Market failures lead to rent-seeking or opportunistic behaviour on the part of both public and private parties. These may result in drawbacks, such as: i) monopolistic service provision, ii) overexploitation and misallocation of resources, iii) production of social and environmental externalities, iv) under provision of basic needs [13].

These restrictions are even more important in highly innovative industries, where a pool of interconnected actors jointly collaborate to realize highly valuable results in terms of new services and products. Those are very complex contexts, in which several level of uncertainty is intertwined. In fact, a first level refers to the potential uncertainty of an economic result, which is typical of R&D activities. Second, the public nature of the products and services causes uncertainty in the willingness to pay of end users, and makes the demand relatively unclear. Third, public run companies can be unaware of the exact figures of costs related to the production phase. In fact, often there are no reliable data when estimating cost items.

Focusing our analysis on the satellite services industry, we are able to verify if business model approach may be adapted to private public projects. In fact, as the strategic importance of the aerospace industry has constantly been proven during the last decades [20], several streams of discussion have emerged that go beyond the technical aspects of aerospace components, which indeed integrate economic concepts. The spread of contributions on these topics shows how the aerospace industry is one of the most important examples of integrating public and private efforts to deliver services and products of strategic importance.

A. The Public Private Business Model Framework

The proposed Private Public Business Model can be conceptualized as described in Fig. 1.

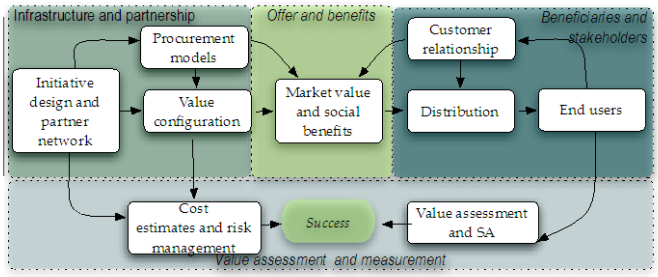

Fig. 1 PPBM framework

In particular, we define the four pillars of the PPBM as:

- Infrastructure and partnership: value configuration can be seen as the context in which a network of interconnected actors competes and solves end users' problems. The infrastructure comprises also the initiative design and the partner network as the provision of products or services may stem from the integration of different actors. This requires a detailed outline of the linkages and interrelations between each partner, being it a private firm or a public institution. Indeed, when social implications are foreseen, it is also necessary to clarify the procurement models that sustain the infrastructure. This is consistent with Christensen and Rosenbloom's view of value definition [21], as well as with the main characteristics of Public Private collaboration [22].
- Offer and benefits: this is the reason why users consume a particular good or service. From the value network perspective, it is important to understand which the attributes of goods or services are mostly appreciated by customers. If in the traditional business model the offer is analysed through a pure market approach, in contexts where public goods are traded it will be necessary to adopt a different perspective, encompassing the social benefits as well as the potential market value.
- Beneficiaries and stakeholders: this specifies a group of recipients or a market segment to whom the value proposition is appealing and from whom resources will be received. It may be not possible to talk about proper customers, as it is not possible to trade such services, but it is necessary to distinguish between the stakeholders who pay for the services and the group of beneficiaries who actually benefit from their availability.
- Value assessing and measurement: the most common methods for assessing the value creation are the average accounting rate of return, the payback period, the net present value (NPV), and the internal rate of return (IRR) (e.g. [23]). These methods are all based on cash flow forecasts, but revenues of new product/service are often affected by indeterminacy because the resulting services or markets could be not completely developed or well known. On the contrary, cost estimates usually contain just an intrinsic degree of uncertainty because at least the source of costs is almost always well known and often a large amount of historical data are available to evaluate similar cost items. Value assessment through cost analysis is thus a more reliable practice even if not exhaustive. Focusing on the cost analysis lets to better appreciate some issues such as the impact of costs uncertainty on business budget and it gauges an accurate measure of the risk project. Moreover the cost analysis is very helpful in the case of public services, assuming that investment decisions are mainly political by nature and that revenues maximization becomes secondary to social benefits.

All the pillars make up the narrative articulating the underlying logic of the provision. This logic is very different from a pure private business model, as several components of the pillars must be shaped to meet the public stakes.

Particularly for the fourth pillar, the most common methods for assessing value creation are the average accounting rate of return, payback period, net present value (NPV) and internal rate of return (IRR). Although these methods have very different characteristics, they are all based on cash flow forecasts, considering expected revenues. Unfortunately, forecasts for new product/service are more difficult because of the market indeterminacy, long lead times, various stakeholders, etc.. This is why in this paper we move the focus from the cash flow to the economic risk evaluation, agreeing with the extensive literature on the matter [24], [25].

This approach provides a lot of advantages as just experienced for private investment projects and, appropriately developed, it is very suitable even for public ones. The Arrow-Lind theorem [10] concerning the risk-neutrality for public sector is therefore outdated because actually it is increasingly frequent to deal with public-private partnership and a private investor can't be ever risk-neutral.

Our proposal is to go deep the economic-financial analysis investigating in a separate way positive cash flows (revenues or public funding) and negative ones (costs). In fact, in business models for new product/service revenues are affected by epistemic uncertainty or indeterminacy because the resulting services or markets could be not completely

developed or well known. The social welfare evaluation is often used but it isn't without problems and in any case without uncertainty. On the contrary, cost estimates usually contain an intrinsic degree of uncertainty because at least the source of costs is almost always well known and often a large amount of historical data are available to evaluate similar cost items.

Appreciating the diversity between uncertainty and indeterminacy, between costs and revenues, brings us to face them through different methodologies and to develop even two different sets of indicators: the first oriented to positive cash flow forecasts and the other based on the impact from costs uncertainty on business budget. In this paper, the aim is to deepen indicators for the second area.

The choice to deal specifically with costs in a business model this work as suitable in a specific phase of the new product/service development process, particularly after that the sponsor has approved the business. In fact, revenues or benefits analysis is certainly essential for the decision of funding a program, but that goes into background in all successive stages, in which the budget monitoring is instead necessary [26]. Particularly we want to focus on the business design, in which uncertainty but simultaneously capacity to influence results is very high [27], [28]. Budget analysis is here basically responding to the interest of the sponsor to know exactly the amount of funding or the risk to exceed with costs. It also becomes a fundamental step for developing a contingent approach to minimize the damage caused by variability [29].

III. EMPIRICAL EVIDENCES FROM THE GMES CASE

To test the general framework of the PPBM, we focused on the aerospace industry and specifically on the GMES initiative [30]. The aerospace industry is one of the most important examples of integrating public and private efforts [20] to deliver services and products characterized by a greater social relevance [31]. Moreover, in this industry the design phase is crucial because all stakeholder categories are involved to promote the satellite services provision in the light of economic and social sustainability.

GMES is the European Programme for the establishment of a European capacity for Earth Observation. GMES consists in a complex set of systems, which collects data from multiple sources (earth observation satellites and in situ sensors such as ground stations, airborne and sea-borne sensors), processes these data and provides users with reliable and up-to-date information through the services dedicated to a systematic monitoring and forecasting of the state of the Earth's subsystems.

We decided to test our model in this context to provide the European Institutions with tools useful to avoid any lack of coordination and management of the GMES initiatives. In fact, if the European Commission has funded several projects over the past years with the mandate of developing a pan-European GMES infrastructure, these were extremely focused on the technical aspects. There was a general need for the emergence of an integrated analytical framework that could comprise the technical as well as the commercial aspects of the infrastructure. More in details, we focused on the Emergency Response Core Services (ERCS), whose aim is to reinforce the European capacity to respond to emergency situations. The following sections provide further details of the PPBM application to this context.

A. *Infrastructure and Partnership:*

Our analysis on the context of the GMES initiative shows that the value configuration has been hardly shared among partners, and this has led to some lags in the operationalization of GMES services. Moreover, the interplay among different layers of public actors (European, national, local levels) and private firms has made it difficult to set up effective procurement models. Within the GMES initiative, the main source of value is the provision of satellite services for Earth observation, which can be then operationalized into a wide range of products and services. This aspect is discussed in the next paragraph.

B. *Offer and Benefits:*

The second pillar is strictly related to the value configuration, as this articulates the value that is created for the user by the offerings based on a certain technology. In the GMES context, no market value could be found, as the specific services related to Earth Observation are not traded in a pure market context. Nevertheless, it is possible to analyse the benefits related to the provision of such services, such as Risk and Emergency management, Climate Change enquiries, Land monitoring, Ocean monitoring [31].

C. *Beneficiaries and Stakeholders:*

In the GMES context, the picture is extremely complex as payers and users may be public, non-profit, or for-profit organizations. Some of them may as well be users of some services and providers of other services. In terms of stakeholders, the analysis shows that:

- The European Commission plays key roles in the operational network of ERCS: Procurement, Coordination, Planning, Control, Decision Making and Tendering.
- The European Commission leads the Governance as neither the User DGs nor the Member States play leading roles in any of the activities. Service Providers will be assuming the leading role in three activities (Delivery, Production and Customer Care) whilst offering contributory participation in further roles.

D. *Value Assessing and Measurement:*

We propose to measure the business model value through a set of not traditional indicators in order to point out the relevance of not exceeding the estimated budget and to know the estimation reliability. Indicators used in the ERCS case have been calculated using simulation and statistical tools as Monte Carlo simulation and factorial ANOVA in order to calculate the indicators (Table 1). Application of such methodologies is already widespread in literature for similar purposes [32].

TABLE I INDICATORS OF ERCS BUSINESS MODEL VALUE

Indicator	Description	Value
Basic cost estimation	The budget initially estimated	25.554.739 €/y
Risk of overrunning the basic cost	Probability of exceeding the basic cost	30%
Contingency allowance estimation	An amount kept in reserve to guard against risk of exceeding the basic cost	1.990.773 €/y
Contribution to the cost by model parameters	Contribution percentage of each parameter to the business model cost	Rapid Mapping Events per year contributes most to the determination of the cost (55.3%).

IV. CONCLUSIONS

Although we focused on a specific business domain, namely the satellite GMES services, our piece of research contributes to the understanding of the private public intersection in different ways.

First of all, when public investments are addressed to sustain specific initiatives, the public actors should adopt a process-driven orientation, which means focusing on the management of the initiative in the design phase and on its value generation.

Secondly, as far as the management of the initiative is concerned, our analysis highlights that in public domain, such as the aerospace industry, it is crucial to investigate the nature and the value of the business model, rather than considering only the financial ratios of a single investment project. In fact, the PPBM approach provides a broader view of the value chain and interaction between private and public actors. This is consistent with the literature referred to the business model approach, but gives more hints of the potential use of the business model framework in public domains. That is why we propose to adopt the PPBM terminology.

All considered, the PPBM stakeholders could benefit from the framework that we propose in the paper, since it allows identifying the key variable that drive the value of the model itself.

ACKNOWLEDGMENT

The GMES data used to develop the case study come from a research project supported by the European Commission under the 6th Framework Programme. Contract No.: BOSSA4GMES SIP5-CT-2006-030966.

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