SMART HOSPITALS AND PATIENT-CENTERED GOVERNANCE

Roberto Moro Visconti [*], Laura Martiniello [**]

* *Corresponding author,* Università Cattolica del Sacro Cuore, Milan, Italy
Contact details: Department of Business Administration, Università Cattolica del Sacro Cuore, Largo A. Gemelli, 1 – 20123 Milan, Italy
** Universitas Mercatorum, Piazza Mattei, 00100 Rome, Italy

OPEN ACCESS

How to cite this paper: Moro Visconti, R., & Martiniello, L. (2019). Smart hospitals and patient-centered governance. *Corporate Ownership & Control, 16(2),* 83-96. http://doi.org/10.22495/cocv16i2art9

ISSN Online: 1810-3057
ISSN Print: 1727-9232

Received: 17.12.2018
Accepted: 25.02.2019

JEL Classification: I15, K12, O22, O31
DOI: 10.22495/cocv16i2art9

Abstract

This paper explores innovative governance models in the healthcare sector. Patients are a key albeit under-investigated stakeholder and smart technologies applied to public healthcare represent a trendy innovation that reshapes the value-driving proposition. This study contributes to the best practice improvement in this sector, showing how health governance can balance the interests of conflicting stakeholders (patients, staff, politicians, private providers, banks, suppliers, etc.) when technology-driven (smart) investments are realized. Characteristics of smart hospitals are critically examined, and governance solutions are considered, together with private actors' involvement and flexible forms of remuneration. Smart hospitals are so complicated that they may require sophisticated Public-Private Partnerships (PPP). Public players lack innovative skills, whereas private actors seek additional remuneration for their non-routine efforts and higher risk. PPP represents a feasible governance framework, especially if linked to Project Financing (PF) investment patterns. Results-Based Financing (RBF) softens traditional PPP criticalities as availability payment sustainability or risk transfer compensation. Waste of public money can consequently be reduced, and private bankability improved. Patient-centered smart hospitals reshape traditional healthcare governance, with savings and efficiency gains that meliorate timeliness and execution of cares. Transformation of in-patients to out-patients and then home-patients represents, whenever possible, a mighty goal.

Keywords: Public-Private Partnership (PPP), Results-Based Financing (RBF), Value Co-creation, Risk, Stakeholders, Personalized Care, Availability Payment, MedTech, Digital Platforms, E-health, Eurostat Rules

Acknowledgment: This publication has been financed with research funds from Universitas Mercatorum of Rome, Italy (2019)

1. INTRODUCTION

Healthcare investments represent a central social infrastructure with growing sustainability issues, due to the aging population, and budgetary pressures (Holzinger et al., 2015). The term sustainability is here considered mainly from an economic point of view, but it is a broader concept useful for delivering higher quality care with social, and environmental implications.

Public authorities are so pressed to find innovative solutions to foster sustainable investments (Moro Visconti & Martiniello, 2018), outreaching underserved patients that may either be cured at home or in "patient-centered" hospitals (Gabutti et al., 2017).

Smart hospitals represent the latest frontier of healthcare investments. Their technological features are however so advanced that public authorities hardly possess the know-how to conceive, build and operate them. Synergies with private players are so recommended and are naturally consistent with PPP backed by PF schemes.

PPP can be interpreted with a governance perspective that considers the stakeholders involved in this long-termed investment process. Traditional PPP stakeholders like the public or private partner and the sponsoring banks (Moro Visconti, 2014) represent the cornerstone of any infrastructural PPP backed by PF. Healthcare investments are however peculiar and particularly sensitive to their "clients", represented by patients.

A patient-centered perspective that considers sick persons the barycenter of governance issues is so worth investigating and represents the background of the research question of this study.

This paper focuses on how smart healthcare investments impact on patients, reshaping governance interactions. The study will concentrate on PPP/PF investment patterns, to determine if public and private interactions best fit risky investment patterns.

The issue of the higher public-to-private technological risk transfer will consequently be examined, showing that higher private risk needs to be compensated with more significant returns to make the investment bankable. Higher returns are however in contradiction with public budget constraints, and they may so derive from technology-driven savings.

Experience shows that unconditional availability payments to the private players may easily be transformed into undeserved rents. It will be shown that RBF can be usefully combined with smart hospitals, linking public payments to effective private performance.

This study is multidisciplinary and deals with complex networks of stakeholders that rotate around patients and are technology-driven.

We start from the assumption that in smart hospital investments preferential recourse to PPP/PF and its peculiar characteristics (Moro Visconti, 2017) can re-shape governance making it patient centered.

This paper is organized as follows: smart hospitals will be briefly described with a literature review, together with their innovative investment perimeter and patient-centered issues (paragraph 2). The methodology (paragraph 3) is represented to provide a set of general rules. These rules consist in connected propositions that are illustrated in paragraph 4. Paragraph 5 discusses the main governance implications and trends and paragraph 6 contains some concluding remarks.

2. LITERATURE REVIEW

The definition of smart hospitals and patient-centered hospital governance is preparatory to an examination of their interactions that drive governance patterns.

"A smart hospital relies on optimized and automated processes built on an ICT environment of interconnected assets, particularly based on Internet of things (IoT), to improve existing patient care procedures and introduce new capabilities" (ENISA, 2016, p. 9).

Modern and friendly hospitals, based on smart technologies and intelligent facilities, contribute to creating a better environment for patients (Bullen et al., 2017).

Being innovative technologies expensive and uneasy to conceive and manage, PPP agreements are naturally fit to overcome criticalities and PF is an original package for investment coverage. Evidence (Munksgaard et al., 2012; Meissner, 2015) shows that PPP models are increasingly used for Science, Technology, and Innovation and then for smart infrastructures.

"Patient-centered care" is healthcare that is respectful of, and responsive to, the preferences, needs, and values of patients and consumers. Some authors (Clarks et al., 2017) try to draw out elements of patient-centered care that are important markers of successful patient-centered care. They identify six factors: 1) engaging the patient as a whole person; 2) recognizing and responding to emotions; 3) fostering a therapeutic alliance; 4) promoting an exchange of information; 5) sharing decision-making; and 6) enabling continuity of care, self-management and patient navigation. This approach considers the patient as the primary stakeholder and identifies the importance of shared governance mechanisms.

A patient-centered approach improves care experience and creates public value for services (Australian Commission of Safety and Quality in Healthcare, 2010).

Universal healthcare is a public good consistent with a PPP framework. Governance of public hospitals ought to fulfill the expectations of different stakeholders, in a context where the costs and the demand for healthcare continue to rise while the fiscal resources are limited (Dixit, 2017).

Digitization of services and consequent network interaction is a powerful driver of patient-centered value co-creation (Rantala & Karjialuoto, 2016).

"Last-mile" remote patient monitoring and home nursing in constant connection with "first-mile" healthcare hubs (Larocca et al., 2018) represent a trendy pattern that reshapes healthcare strategies. Home-patients are the core stakeholders of a Patient-Centered Medical Home, a widely-implemented model for improving primary care, emphasizing care coordination, information technology, and process improvements (David et al., 2018).

The remote care system is the activity best able to reduce health costs for example through remote cardiac monitoring and remote monitoring for chronic diseases like diabetes. Remote patient monitoring is a cost-effective strategy (Crossley, 2017) that can transform in-patients into home-patients.

Value-based healthcare, which focuses on patient outcomes and the costs of delivering these outcomes, can address new challenges. MedTech applications re-engineer business models and help commissioners, clinicians, and patients to make informed decisions (Bullen et al., 2017).

Big data feed healthcare planning (Archenaa & Anita, 2015; Moro Visconti et al., 2018) with timely information, making forecasts more realistic and resilient.

The governance implications of the research question can be associated to innovative literature streams. Currently, corporate governance research follows two major routes: classical empirical corporate governance research and multidisciplinary research. The second is aimed at finding non-conventional methods to solve existing problems (Kostyuk et al., 2018). These methods also include the relationship between corporate governance and innovation (Belloc, 2012).

Patient-centered governance and its link with technological hospitals in a PPP/PF environment can be related to the following corporate governance theoretical frameworks (mentioned in Zattoni & Van Ees, 2012; Belloc, 2012), and literature streams:

– agency theory, based on the principal – agent paradigm adapted to PPP, where the public control over private management enhances corporate performance;

– transaction cost theory (Williamson, 1979), and incomplete contracting at the base of the stakeholders' approach. This theory is consistent with a PPP/PF model where the public stakeholders must decide between traditional procurement and PPP/PF (make it or buy).

Other theories (institutional, resource dependence, behavioral, etc.) could also be linked to patient-centered governance.

Saltman and Duran (2016) focus on the emergence of non-state actors with innovative procurement models. According to these authors health systems are framed within three levels of governance: Macro Level, with national level policy making functions; Meso Level, consisting of institutional level decision making functions; Micro Level, concerning operation issues. A new model of Meso-level provider governance follows three different directions:

1. The reform model/pattern 1 is based on traditional government delivery, with a strong central government role. This approach has been adopted in several countries as England, Norway, Portugal, Spain with varying structural characteristics.
2. The reform model/pattern 2 encourages the establishment of new private actors, mostly for profit. This approach has been adopted in Sweden, Norway, Denmark and Finland.
3. The reform model/pattern 3 combines reform model pattern 1 and 2 into a mixed public-private provider market. This approach has been encouraged in central Europe including Estonia and Czech Republic.

In this paper the reform model/pattern 3 is considered, and combined with a "new governance" approach with the involvement of many stakeholders and primarily patient or provider associations.

Patients can actively participate in their healthcare and assume higher levels of responsibility for their health and wellness which can facilitate the development of precision medicine and its widespread practice (Chen et al., 2017).

Chanturidze and Obermann (2016) use the framework developed by Saltman and Duran (2016), to examine challenges and suggest mitigation solutions that might ideally complement specific management techniques for effective service delivery practices. They define governance as "the structures and processes by which the health system is regulated, directed and controlled". Extending the concept of Greer et al. (2016) they define governance as "The culturally appropriate rules, processes and institutions through which decisions are made and authority is exercised in order to achieve transparency, accountability, participation, integrity, and capacity". Moreover, they extend the governance debate beyond the service provider models to health financing and funding structures. Regardless of how funds are collected and pooled, any publicly organized financing scheme faces the challenge of "prudent purchasing". Governing fund pooling, resource allocation, health service purchasing, together with health service provision are essential in achieving such critical, and, at times, conflicting aims.

This paper aims to contribute to the debate about how a governance model in the health sector might look like.

In line with cited authors we share the logic of PPP neoliberalism with its promise of more efficiency and effectiveness. A major role for market-oriented healthcare however requires strong governance arrangements.

3. METHODOLOGY

This study starts from the debate on Healthcare (optimal) Governance and the sustainability issues concerned with the need to deliver health care following a the triple bottom line i.e. with a financial, and environmental social return on investment (SROI). It includes innovative tips for delivering services, promote health, improve prevention and corporate social responsibility, and develop more sustainable models of care.

In particular, it is based on a theoretical model that describes some strategic elements to improve smart health governance. Two hypotheses are stated with consequential propositions.

H1: Patients are the ultimate beneficiaries of governance-driven healthcare value co-creation and contribute to improve governance. As a consequence, a better governance system is able to give patients or their representatives, a stronger role in the system.

H2: In the presence of growing healthcare needs and costs (that contrast with public budget constraints) technology creates monetary value (optimizing scarce resources) and improves quality of cares; but the public stakeholder may lack sufficient knowledge to autonomously procure and manage technological (smart) solutions so they must be able to identify skilled private providers.

As a consequence, a better governance system is able to ensure an optimal risk sharing and RBF mechanisms when selecting a private provider.

Figure 1 shows the interaction of the main stakeholders (patients, the public actor, the private players and their pivoting SPV, the banks, etc.).

4. ANALYSIS OF THE HYPOTESES

In this section, each hypothesis will be recalled and critically examined.

4.1. Hypothesis 1: Patient-centered governance

Patient-centered governance has been broadly defined in paragraph 2.

The idea that patients are the main target of healthcare value creation is intuitive and supported by growing evidence. The largest U.S. health insurer, the Center for Medicare and Medicaid Services (CMS), has set a triple aim, concerning better care for individuals, better health for populations, and lower costs. Simultaneously, major efforts have been launched to make care more patient-centered, i.e. respectful of and responsive to individual patient preferences, and needs.

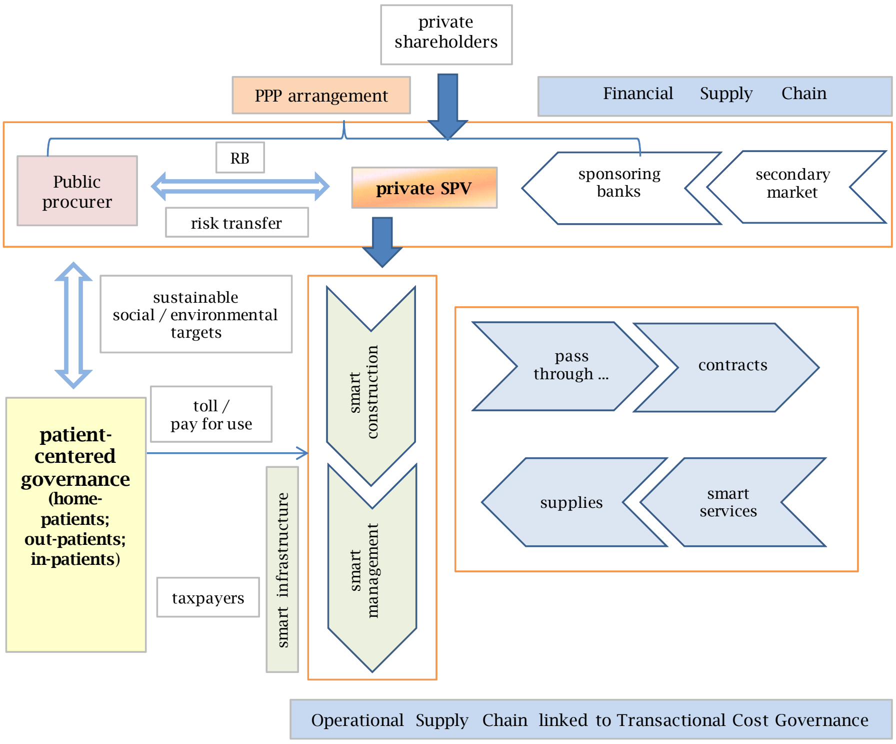
Governance implications of the hypothesis 1 concern two interacting layers of stakeholders:

– patients, which represent the fulcrum of a patient-centered value chain;

– complementary stakeholders that rotate around the smart hospital infrastructure (public and private actors linked by PPP arrangements, etc.).

Whereas the interaction of private stakeholders that pivot around the SPV in healthcare PF follows traditional corporate governance patterns, public-private relations are less investigated (Moro Visconti, 2016), and patient-centered governance issues are, to the authors' knowledge, still undebated.

Figure 1. Smart hospitals: Interaction among the PPP stakeholders along the supply and value chain



Governance concerns derive from conflicts of interests among composite stakeholders. Whereas any stakeholder looks for its value for money, patients have a peculiar target, consisting of quality of cares at affordable costs. While quality is difficult to estimate, costs are easier to detect, and they are consistent with the Williamson's transaction cost theory.

Convergence of interests among the different stakeholders represents an incentive for value co-creation. For example, in healthcare PF, the private actor has an incentive to properly build the infrastructure that has to be run for a long time. This quality target benefits the other stakeholders, from the better-treated patients to the public player or the sponsoring banks.

New governance mechanisms are also necessary to master innovative services that in the health sector, and particularly in smart hospitals, are 'co-produced' (Batalden et al., 2015).

These governance challenges must be examined within a technological – smart – environment. They concern:

1. The actors involved. The changing set of stakeholders involved in hospital service provision challenge the existing rules. Diverse types of market failure emerge and need to be managed. New operational rules and coordination procedures are required. The networks of actors significantly broaden, and governance approaches require skilled alignment of interests in a dynamic environment.

2. Data and information asymmetries. State and Public operators need to exert some form of control to avoid anti-competitive practices over the data that drive the smart transition. Data are the most valuable commodity in the smart system, and represent a public good, particularly sensitive when they concern patient information. Data sharing through digital platforms reduce information asymmetries (Moro Visconti et al., 2017) and provides value to patients but needs careful monitoring.

3. Business models and inclusion. The State must be the arbiter not only of confidentiality but also of healthcare inclusion to avoid discrimination in access to 'Smart health'.

Patient-centered governance implications are focused on targeting efficiency goals, where sick persons are adequately treated. Transformation of in-patients into out-patients (in daily hospitals) and then home-patients (with chronic but locally treatable pathologies) is, whenever possible (i.e., in the absence of acute treatments) a mighty goal.

Efficient networking among different stakeholders represents a critical strategy for proper linkage between healthcare hubs (hospitals for major surgery and excellence hotspots) and dispensaries or outpatient clinics (Larocca et al., 2018). In this healthcare re-engineering process, technology matters and needs to be fine-tuned with existing facilities.

Network theory that links geo-localized stakeholders with real spots can be adapted to the study of governance criticalities. Networks among patients soften information asymmetries and contribute to value co-creation through timely feedbacks.

The general theory of network governance (Candace et al., 1997) can be useful to explain how social mechanisms in network governance reduce transaction costs. These authors integrate social context into the Transaction Cost Economics (TCE) perspective by explaining how social mechanisms influence the costs of transacting exchanges. Specifically, they show that exchange conditions characterized by needs for high adaptation, high coordination, and high safeguarding influence the emergence of structural embeddedness, explaining how structural embeddedness arises and provides a foundation for social mechanisms to coordinate and safeguard exchanges.

In the TCE perspective three exchange conditions determine which governance form is more efficient:

1. Environmental uncertainty that triggers adaptation, which is the "central problem of economic organization," because environments are rarely stable and predictable.
2. Asset-specific (or customized) exchanges that involve unique equipment, processes, or knowledge developed by participants to complete exchanges.
3. Frequency that is important for three reasons. First, it facilitates transferring tacit knowledge in customized exchanges, especially for specialized processes or knowledge. Second, frequent interactions establish the conditions for relational and structural embeddedness, which provide the foundation for social mechanisms to adapt, coordinate, and safeguard exchanges effectively. Third, frequent interactions provide cost efficiency in using specialized governance structures (Williamson, 1985, p. 60).

In the health sector coordination and cooperation among providers and patients for customized exchanges is necessary.

Four conditions are necessary for network healthcare governance: 1) demand uncertainty with stable supply; 2) customized exchanges high in human asset specificity; 3) complex tasks under time pressure; and 4) frequent exchanges among parties within the network.

In particular, in smart health “demand uncertainty” is generated by rapid changes in knowledge or technology, which results in short product/service life cycles and makes the rapid dissemination of information critical. Understanding the sources of uncertainty is important, since they influence what governance form is used to coordinate and safeguard exchanges. Research on environmental uncertainty and governance form shows that even modest levels of supply uncertainty, combined with predictable product demand, entice firms to integrate vertically (Helfat & Teece, 1987).

In the health sector the need for “Customized exchanges” require an organizational form that enhances cooperation, proximity, and repeated exchanges to transfer effectively tacit knowledge among parties. Cooperation among exchange parties and in particular between providers and patient, is necessary to gain tacit knowledge.

Technological services supply in health is, by definition, complex and subject to time pressure. Network governance (even through innovative digital platforms) facilitates integrating complementary players to offer patient complex services.

Finally, frequent exchanges and information sharing among parties is, again according to TCE theory, an important determinant of governance.

The reduction of transaction costs in healthcare investments is driven by strategic, operational and governance choices (starting from the dichotomy between traditional procurement and PPP).

Budgeting pressures for cost-cutting in a scenario of eldering population with increasing healthcare needs constitute a further challenge that technology and smart hospitals need to front.

In this context, big data analysis of sensitive healthcare information represents an asset that can be usefully employed for the improvement of business planning (Moro Visconti et al., 2018), a crucial component of long-termed PF.

The proposition 1 follows hypothesis 1:

Proposition 1: Stakeholders’ digital networking links healthcare hubs to patients in real time. Networks between patients and PPP players soften information asymmetries and contribute to value co-creation and reduction of transaction costs through timely interactions.

4.2. Hypothesis 2: PPP combination of public interest with private technology

PPP are based on competitive auctions where private participants have a natural incentive in proposing technological advancements. If they do, they can be rewarded with higher marks in the tender and expected savings in the management phase (Moro Visconti, 2016).

The smart hospital characteristics reshape the PF investment perimeter and its operations during the management phase. The investment perimeter represents the balance sheet structure of the private SPV that depends on the features and the physical/intangible assets of the healthcare facility. Through its innovative Build-Operate-Transfer (BOT) pattern, the SPV re-engineers its investment perimeter. Smart assets are incremental and need to be interactively combined with basic facilities since the beginning.

Smart assets reshape operations that follow the construction phase in the PF timesheet. Private constructors have a governance incentive to properly build the hospital, as they then must run it for many years.

Smart functionalities incorporated in infrastructural assets concern the e-devices, which include the ICT ecosystem for healthcare services to home-patients:

– medical equipment for telemonitoring and tele-diagnosis in the form of wearable or implantable devices, etc.;

– medical equipment for distribution of drugs (automated dosing equipment, e.g., for insulin) or to administer treatment;

– telehealth equipment, such as cameras, sensors, and telephone/internet connections; telehealth computer system for patients to self-record core health parameters (e.g., blood pressure).

Biometric or IoT-driven identification systems are used to track and authenticate patients, staff or hospital equipment such as beds, blood bags or other medical items. In smart hospitals, the scanners are networked with devices and information systems, reducing human errors and improving security.

Networking equipment provides the connectivity backbone to support smart hospitals, and mobile client devices are intelligently integrated into smart hospitals to make the right information available. This process facilitates the mobility of staff and patients as in case of mobile client applications for smartphones and tablets.

Buildings and facilities manage various functions, for example as power and climate regulation systems through temperature sensors. Table 1 exemplifies some smart functionalities.

Table 1. Smart functionalities operated by the private concessionaire

1. Reservation systems and mobile client devices	Mobile clients (e.g., laptop computers, tablets, smartphones, pagers)
	Mobile applications for smartphones and tablets
	Alarm and emergency communication applications for mobile devices.
2. Data management	Clinical and administrative patient data (e.g., health records, tests results, contact details)
	Financial, organizational and other hospital data
	Research data (e.g., clinical trial reports) and data intended for secondary use
	Staff data
	Tracking logs
	Vendor details (e.g., contact details, products used).
3. Hospital equipment maintenance	Power and climate regulation systems, including smart ventilation systems
	Temperature sensors
	Medical gas supply
	Smart patient room operation and management systems, including smart boards, patient screens, medical staff screens, etc.
	Automated door lock system including smart locks, lock management applications/tokens and safe management software
4.Interconnected clinical information systems	Hospital information systems
	Laboratory information systems
	Radiology, Pharmacy, Pathology information systems
	Blood bank system
	Picture archiving and communication systems
	Research information system.
5. Networked medical devices	Mobile devices (e.g., glucose measuring devices)
	Wearable external devices (e.g., portable insulin pumps, wireless temperature counters)
	Implantable devices (e.g., cardiac pacemakers)
	Stationary devices (e.g., computer tomography (CT) scanners, life support machines, chemotherapy dispensing stations)
	Supportive devices (e.g., assistive robots).
6. Identification systems	Tags, bracelets, labels and smart badges
	Biometric scanners
	RFID systems with location services (software components) to assess and monitor relative, movement of assets/patients/staff, etc.
	CCTV (video surveillance) with recognition/authentication capabilities
7. Networking equipment	Transmission media
	Network interface cards
	Backbone network devices (e.g., hubs, switches, routers, etc.)
	IoT Gateways which further analyze data collected by devices and send them to cloud data center
8. Remote-care system assets	Medical equipment for telemonitoring and tele-diagnosis
	Medical equipment for distribution of drugs or to administer treatment
	Telehealth equipment, such as cameras, sensors, and telephone/internet connections
	Telehealth computer system for patients to register their physiological measurements themselves

Interconnected clinical information systems are deployed jointly with medical devices and identification components to enable smart end-to-end patient care processes. Moreover, the clinical networked information systems are increasingly able to make decisions autonomously. Examples include: 1) hospital information systems (HIS); 2) laboratory information systems (LIS); 3) radiology, pharmacy, and pathology information systems; 4) Blood bank system; 5) picture archiving and communication systems (PACS); 6) research information system.

Data become an asset for decisions, supporting all the organizational processes as:

- clinical and administrative patient data (e.g., health records, tests results, contact details);
- financial, organizational and other hospital data;
- research data (e.g., clinical trial reports) and data intended for secondary use;
- staff data.

A map of the smart functionalities, operated by the private concessionaire, is necessary for new governance mechanisms that provide optimal allocation of risks. Moreover, it is useful to start rethinking services on the base of RBF, as it will be shown in paragraph 4.2.2.

The proposition 2 follows hypothesis 2:

Proposition 2: PPP represents a suitable combination of the public interest in healthcare with the technological expertise of private suppliers.

4.2.1. Technology and public-to-private risk transfer

Technological PPP consistent with proposition 2 concern additional risk that has to be shared between the public and private players.

Risk transfer is a crucial characteristic of PPP, especially if Eurostat rules apply. For public entities, the accounting framework was initially based primarily on a 'risk and reward' criterion described in the Eurostat Decision 2004 and then fully regulated by the implementation of ESA 2010 (Manual on Government Deficit and Debt (Eurostat, 2016), Chapter IV.5 Treatment of PPP).

Manual on Government Deficit and Debt and Eurostat decisions (2016) try to solve the critical question of whether a PPP should be accounted 'on balance' and when it can be considered 'off balance' for the grantor. The 'risks and rewards' criterion drives the decision of how to classify the infrastructure in the public accounts.

The assets should be considered non-governmental ('off balance') when the private partner bears the construction risk, and at least one of either the availability or the demand risk.

Traditional healthcare PF was criticized for its inability to correctly transfer risk, often producing an on-balance accounting treatment of hospital infrastructure (Shaoul et al., 2008).

For the public procurer, on-balance investments increase the public debt and are so hardly viable. This is the case especially when the public grants for constructions exceed 50% of the expenditures or when contract penalties are judged by Eurostat to be insufficient to transfer the availability risk fully.

On the contrary, construction risk is substantially transferred to the private partner when the latter has capital at risk during the construction phase and when availability risk is transferred through the provision of severe penalties in case of underperformance.

Moreover, PPP was judged, in some cases, a disaster (Acerete et al., 2012) because of substantial public costs and a government still bearing most of the risk.

We wonder how smart hospitals PF can ensure a better risk transfer providing at the same time much wanted innovation.

To stimulate innovation, each party assuming project risk should share the benefits that arise from innovation. Barlow and Kobler-Gaiser (2008) argue that under traditional PF it was difficult to achieve agreement on the introduction of innovative ideas because of a separation of responsibilities between the project consortium and clinical operations. Whereas the primary goal was a facility delivering excellent healthcare to its patients, for the private partners a hospital project was mainly seen as an investment vehicle.

This mismatch in incentives resulted in more cautious attitudes towards risk, mainly when associated with innovative solutions. Many authors (Barlow et al., 1997 and 2000; Slaughter, 2000, Leiringer, 2006) found an unwillingness of the private partner to assume any additional risk associated with innovation.

Other authors consider PF a suitable instrument for financing innovation (Chirkunova et al., 2016).

In smart healthcare, innovation is at the base of the PPP, being contractually stated from the beginning of the awarding procedure. Smart PF schemes must be designed to minimize contractual uncertainties, envisaging a clear risk transfer.

In this context, it is necessary to outline new governance mechanisms in which the role and responsibility of each subject is contractually identified, remembering that the private partner bears an additional operational risk.

In smart hospitals, the private player takes construction risk (where technology is embedded since inception) and demand risk for "hot" (commercial activities), which include smart applications. Availability risk needs to be interpreted innovatively, adapting it to the real functionality of the smart infrastructure during the operational phase.

Table 2 compares traditional PF with smart investments. Table shows how smart hospital PF allows a more intensive risk transfer (compared to traditional PF) particularly in availability risk, with the possibility, to provide additional rewards for the greater risk exposure of the private actors.

Figure 2 shows the perimeter of innovation.

In traditional PF the design is sourced from public feasibility studies that shape the tender, limiting public-private confrontation, and opportunities for innovation are limited. In smart hospitals, private involvement is anticipated in the design of the infrastructure, and innovation becomes a vital task of the private partner.

Moreover, because in smart hospitals higher risks are transferred, it is easier to demonstrate that the "majority of risks" is covered by the private partner, in compliance with Eurostat rules. Contractual agreements and penalties strictly linked to results (and consistent with the RBF approach examined in paragraph 4.2.2.) will consequently allow off-balance accounting of the assets.

The annual availability fee, recognized by the grantor to the private operator of the smart hospital, will consequently represent a current expense for the public administration recognized on the base of measurable performance, even on an RBF basis.

When caring for a patient through Smart Technologies, specialized knowledge and responsibility are needed, and this compels the industry into a networked mode of operation, with risk-reward sharing needs.

Adequate risk transfer from traditional to smart investments PPP programs needs to be properly executed since inception to avoid failures.

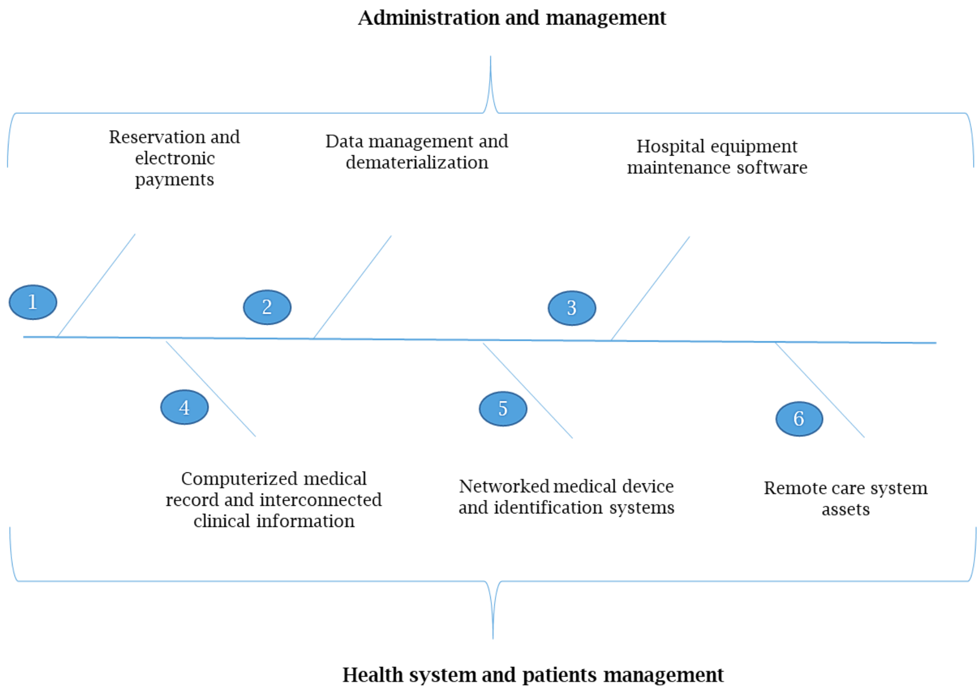
The introduction of additional risk in the model brings to a new sub-proposition:

Proposition 2a: Healthcare PPP/PF criticalities also concern insufficient public-to-private risk transfer. Technological risk exacerbates the problem, and its transfer to the private stakeholders needs to be compensated with higher returns also to properly reward the private partner and its sponsoring banks.

Table 2. Public and private risk-sharing in traditional and smart PF

Risks	*Traditional PF*	*Smart PF*
Construction risk	– The SPV is mainly a construction company. – The contract allocates construction risks on the base of a standard risk matrix.	– The SPV includes partners with an expertise in smart technologies and IoT (e.g. MedTech companies). – A public/private coordination committee ensures joint management in design and construction phases. A new risk matrix is provided.
Availability risk	Transfer of the following risks: 1. Availability of the infrastructural assets (rooms, operational rooms, etc.). 2. Maintenance costs of the buildings. 3. Maintenance costs of the equipment.	Transfer of the following additional risks: 1. Reservation services on mobile and electronic payments. This well-established technology can reduce waiting lists and ensure higher productivity with personnel cost savings. This risk can be completely transferred to the private partner. 2. Data management and dematerialization. This technology can simplify the administrative management of hospitals with significant cost savings related to paper reduction, the filing of documents, etc. This risk can be completely transferred to the private partner. 3. Hospital equipment maintenance. 4. Computerized management of medical records for an interconnected Clinical Information Systems. This is a shared activity because only the technical risk can be transferred to a private partner. 5. Hospital equipment maintenance software to optimize technical control. This software allows tracking history for all the inventory items. Tracking is used to pinpoint general trends in resource allocation within a specific department. It is so possible to catch unnecessary activities and expenditures on idle equipment and cut down costs. This action will make possible to save time as well as maintenance expenses spent on handling the hospital equipment. This risk can be completely transferred to the private partner. 6. Networked medical devices. This technology allows the implant an IT control of external and implantable devices (e.g., cardiac pacemakers). This is a shared risk activity because only the technical risk can be transferred to the private partner. 7. Remote care system management. These technologies can lower health costs for example in case of chronical cases. This is a shared risk activity because only the technical risk can be transferred to a private partner. 8. Cybersecurity.
Demand risk/ commercial services	Management by one or more traditional operators.	Integrated and automated management of newsstands, vending machines for drinks and food, advertising inside the hospital, rental of televisions and other devices for patients, supplementary services to improve the hospitality.

Figure 2. Innovative flow-charts in smart hospitals



4.2.2. Technological risk and returns: Making the availability payment sustainable with RBF

The general issue indicated in proposition 2a – higher private remuneration due to higher technological risk – can be incorporated in a narrower question, related to the sustainability of the public-to-private availability payment during the management phase.

As anticipated in sub-paragraph 4.2.1., risk transfer is a critical issue in PF and raises the following trade-off:

– from the public side, there is a necessity to transfer a higher risk component to the private player, because of a stricter interpretation of Eurostat rules but also considering that innovative investments are riskier than standard ones;

– from the private side, a higher risk may decrease profitability and raise bankability concerns (Moro Visconti, 2014).

In PF, the availability payment remunerates the SPV with "cold" revenues that do not depend on market risk like "hot" commercial revenues.

In traditional healthcare PF, availability payments to the private actor depend on the possibility for the public player to use a well-functioning hospital. Contractual provisions link the availability payments to the meeting of binding quality standards. If they are not (entirely) met, the fee is either decreased or stopped.

Healthcare providers operate in a pay-for-service model. There is an incentive to provide more services than necessary. As treatments improve by applying innovative technologies, these incentives could be removed by changing to a pay-by-success model. RBF goes in the direction of "paying for performance" (Campbell et al., 2007), ensuring more patient-centered management, and is consistent with Value-Based healthcare delivery.

How to achieve an improved outcome at lower costs is a challenging area of study. Kaplan and Porter (2017) conclude that "we need to change the nature of competition so it would reward those who deliver the highest value for patient". Value is defined a "better outcome achieved at lower costs" and the authors propose to accelerate the outcome measurement in health by applying time driven activity-based costing along the care cycle.

In this context, the burden of the affordability of the availability payment emerges as a critical long-term consequence of PF schemes where private remuneration (also considering the public grants and the revenues from "hot" commercial operations) may become hardly sustainable.

For example, UK hospital trust annual payments to the private partner were higher than expected. Shaoul et al. (2008) estimated an additional cost of PF finance, for 12 hospitals in the UK, of about 60M £ per year, corresponding to 20-25% of the trust income. They found extremely difficult for hospitals to penalize deficient performance and effectively transfer risk. Moreover, because the demand risk was not fully transferred, and the private partner was mainly treated as a finance debtor, a minor risk was passed from the trust to the private. These criticalities led to a wave of mistrust in PF, and in Build-Operate-Transfer procedures.

The idea of remunerating smart hospital services with availability payments on the base of management results also bears unknown criticalities. Traditional criticism over availability payment affordability (Henjewele et al., 2011) may so be exacerbated or reduced.

Risk can however be softened, up to an ideal complete elimination, making it flexible, i.e., linked to performance and results. This strategy reduces private rents (free riding) but also allows for higher compensation, whenever it is deserved.

This goal is neither easy nor immediate, and satisfactory results depend upon a well-structured supply chain and a flexible agreement between the involved parties ensuring the optimal allocation of risks and fair compensation of private investments linked to concrete results.

Smart PF sustainability can be partly based on availability payments in which risks are ultimately operational, intrinsically manageable and dependent on the performance and management of the private partner. Operational performance can be monitored with a comparison with standard costs for the same task, within a transaction cost framework.

As an example, a private operator in charge of the implementation of telemedicine systems and distance monitoring of patients could be remunerated on the base of the number of patients treated with the new system, with a "shadow toll" mechanism (public to private payment without the involvement of the patients).

Smart healthcare can perform many tasks in a better way, generating public savings that can be partially assigned to private remuneration.

Managing by objectives is a strategy consistent with RBF that requires:

– defining the appropriate number of indicators that work as objectives;

– choosing a correct principle to determine which indicators should be considered as high priorities.

Savedoff (2010) focuses on the range of RBF approaches, much larger and diverse than ever before. In short, a relevant decision in RBF is based on input (pay for services), output (pay for useful results) or outcomes (pay for useful results).

This approach must be associated with payments mechanisms as:

– fee-for-service: providers are paid a fee for each service that they render to a patient;

– case-based payments: providers are paid a fee for each treated case, independently of the type or intensity of services that are required and rendered;

– capitation: providers are paid a fixed amount for each person enrolled in their care and are expected to render all the services needed by that individual during the term of enrolment.

Some of these approaches best fit with smart hospitals PPP. Typical measurable indicators are: 1) the number of reservation via mobile; 2) the number of electronic payments; 3) the number of dematerialized processes; 4) the savings in prints and paper; 5) the level of productivity per employee; 6) the cost of maintenance.

Fees for service payments can be provided and incentives recognized when specific performance targets are achieved as a certain percentage (on the total) of reservations are made through IT systems or the number of default of the equipment is reduced.

Health systems and patient management present criticalities in the coordination between technological performance and medical activities. In this field of activities, RBF should be accordingly based on specified outcomes verified for quality and only occasionally on outputs.

Typical measurable indicators are: 1) the number of medical records available online; 2) the number of doctors and staff that access systematically electronic records; 3) the number of patients using implantable devices; 4) the number of patients using a remote care system, etc.

For some of these activities "Case-Based Payments" or "Capitation" can be appropriate and incentives should be recognized when specific quality targets are achieved, or high patient satisfaction is reported. In this case, incentives should include both technical and medical staff, extending the rewarded stakeholders beyond private investors or patients.

Successful RBF programs must introduce a material incentive but also help to:

– align objectives between the grantor and the IT providers;
– collect reliable information on results;
– give both private operators and medical staff an incentive for their efforts, and higher discretion to carry out their tasks.

RBF has the potential to be usefully employed in smart PF investments, softening the sustainability issues of availability payments and transferring operational risk from the public to the private part, in compliance with Eurostat rules.

RBF can help to strengthen healthcare systems, making them more accountable and delivering higher value for money by shifting the focus from inputs to results. RBF can contribute to reinforcing PPP, aligning private providers with national health policy goals. These general statements can be applied even to the peculiar case of smart hospitals, where innovative technicalities need to be harmonized with resilient supply chains.

RBF introduces checks and balances along the delivery chain, encouraging better governance, transparency and enhanced accountability.

Linking availability payments to RBF can soften affordability issues, transferring a higher risk to the private side, in compliance with Eurostat rules.

Since RBF produces higher returns (if deserved), there is a remuneration of the private extra-risk. Proposition 2b synthetizes these findings:

Proposition 2b: Higher private remuneration for the extra-risk transferred (proposition 2a) is in contrast with public budget constraints (hypothesis 2). A solution can be given by the technology-driven extra-savings that fuel RBF-returns, to be shared between the public and the private stakeholders.

5. DISCUSSION

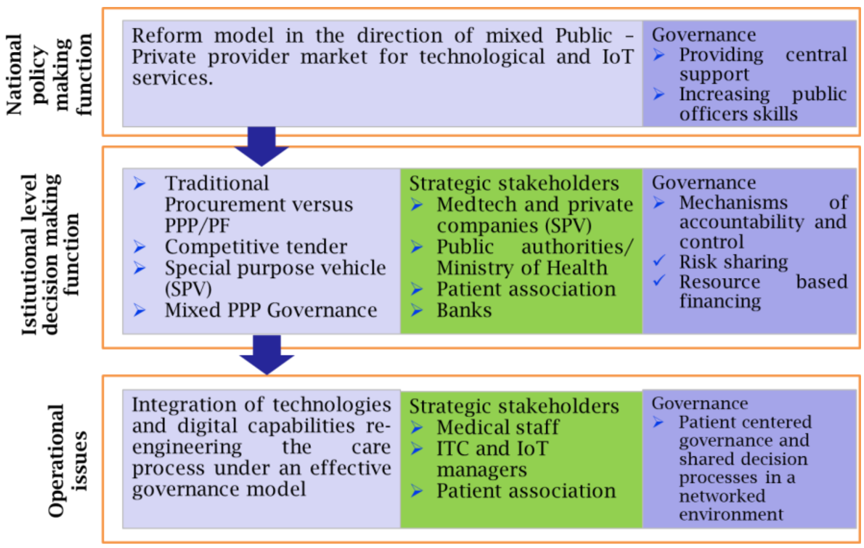
Healthcare systems throughout the world undergo significant changes driven by aging populations, budget constraints, and advances in biomedical technologies (Chen et al., 2017; Clarke et al., 2017).

With this trade-off between tightening budgets and skyrocketing costs, many countries are seeking to identify ways of using ICT and introducing new procurement models. In this context the private role is increasing and needs adequate governance rules.

This study identifies the importance of governance best practices at the three different level identified by Saltman and Duran, 2016 (Macro-Meso-Micro) and the importance of a new provider model in which public institutions negotiate PPP contracts with skilled private providers. This produces governance implications due to more complex form of shared ownership and the necessity to coordinate heterogeneous stakeholders.

Moreover, as different cities and regions have not uniform starting points in terms of healthcare systems, targets and governance, converging transition is needed. The evolution requires continuous adaptation, and, governments will continue to bear significant agency costs. These costs can be reduced by providing a governance framework with three layers, as illustrated in Figure 3.

Figure 3. Strategic governance layers



Two main hypotheses have been illustrated:

1. Healthcare needs to be patient-centred.
2. Cost-cutting technology is better managed by private actors.

The first hypothesis assumes the importance of a patient – centered healthcare examining how shared decision processes and network dynamics can improve healthcare quality and ensure joint value co-creation. Since networks of actors broaden in smart environments, governance needs to adapt to pursue alignment of interests (in operations, procedures, economic and quality targets, etc.) and value co-creation.

In this context patient associations can be usefully involved in decisional processes both at a "meso" and "micro" level. At meso level stakeholders will define the type and quality of services contractually agreed in the PPP. At micro level they will settle operational solutions for the integration of technology and digital capabilities. Proposition 1 is a consequence of this framework.

The second hypothesis assumes that technology change is better managed by private operators.

Furthermore, since value for money represents a crucial aspect of PPP/PF initiatives, its application to the patients' targets is fully consistent with smart initiatives where quality is enhanced, and costs may be reduced. From a governance perspective, this scenario is compliant with the transaction cost theory.

Smart hospital PPPs are based on competitive auctions where private participants have a natural incentive in proposing technological advancements. The combination of the public interest in healthcare with the technological expertise of private suppliers has been delineated in the proposition 2.

The public operator cannot give up with its role of control especially when additional risk must be shared between the public and private players.

Adequate risk transfer from traditional to smart investments PPP programs needs to be properly executed since inception.

The introduction of risk in the model brought to a new sub-proposition 2a.

Furthermore, risk can be softened, if linked to performance and results. This strategy reduces private rents (free riding) but also allows for higher compensation, whenever it is deserved.

Smart PF sustainability can be partly based on availability payments in which risks are ultimately operational, intrinsically manageable and dependent on the performance and management of the private partner. Operational performance can be monitored with a comparison with standard costs for the same task.

RBF introduces checks and balances along the delivery chain, encouraging better governance, transparency and enhanced accountability.

Since the 2000s, many scholars have been investigating the reasons behind failures of RBF, with a focus on the public sector (Van Thiel & Leeuw, 2002).

Linking availability payments to RBF can soften affordability issues, transferring a higher risk to the private side. RBF can contribute to reinforcing PPP, aligning private providers with national health policies to attain public health goals.

Since RBF can produce higher returns, there is a possible remuneration of the private extra-risk as stated in proposition 2b.

Innovation involves administrative processes as reservation systems, IT data management, dematerialization of "paperless" archives and software for equipment maintenance. Product and process innovation are to be combined and synchronized, re-engineering the supply and value chain where healthcare ICT is the converging digital platform. Innovation becomes a driver of cost-cutting policies and "smart" long-term savings. The impact of technology on health expenses is controversial. Technology may increase costs, but it dramatically improves quality of care and life expectancy. In many applications, technology can however contribute to savings (Kumar, 2018), especially for chronic patients that are remotely monitored.

To the extent that these savings are measurable, they can be partially converted by National Health Service or other Healthcare bodies into RBF resources that back PF initiatives.

Savings are obtained by rethinking the core function of hospitals:

- increasing labor productivity and process efficiency;
- reducing several categories of costs;
- reducing the duration of hospital stays while preserving the occupancy rate and the quality of health services.

A smart hospital needs significant investments in both tangible and intangible assets (servers, IoT-driven devices, software, information security, etc.) together with the new and effective governance of the IT and other internal processes.

These investments can drive to the following economic and non-economic results:

- optimization of admissions, scheduling, and other processes, resulting in a seamless patient flow. The new, more automated processes increase labor productivity and reduce personnel and management costs;
- optimization of assets maintenance (with warning IoT sensors) that diminishes yearly assets costs with quantifiable savings and reduced errors;
- computerized medical record and interconnected clinical information, which ensures a more efficient healthcare thanks to the availability of patient information. Together with networked medical devices, these systems increase the quality of medical treatments reducing the duration of hospital stays, with an impact on daily cost for the patient.

Building a smart hospital is more than bringing together connected devices on a high-speed networking infrastructure. It means rethinking and fully re-engineering the care process, management system, and governance. Technology and digital capabilities need to be fully integrated into day-to-day functioning. This is challenging to implement across a fast-moving, complex organization like a hospital, in a highly networked healthcare system.

In this context it is essential to identify an applicable operational framework and an innovative and effective governance model.

Health systems in many countries are moving away from traditional procurement, which is based on clinical preference and price, and towards a more holistic perspective that factors in quality and total costs across the product life-cycle. This shift is opening doors for new partnerships with private providers and Medical technology (MedTech) companies.

MedTech corporations are growing fast because of the pressure to reduce healthcare costs, the increasing power of economic stakeholders in purchasing decisions and the ubiquity of information.

Despite consistent investments in the short run for startup technology, long term savings can be enormous, regarding the lower mobility of patients, instantaneity of care at home, decreased hospital infections, time savings converted in work activities, etc. The width of the worldwide healthcare market is a further propellant for economies of scale and experience.

6. CONCLUSION

The inevitable transition to smart technologies will have a significant impact on healthcare processes and their governance in all countries. New actors, networks, and innovation are already challenging consolidated health governance practices.

This study provides some tips to detect and soften governance criticalities and increase sustainability of smart healthcare investments. Much attention begins to be dedicated to a "Sustainable Healthcare" also through the creation in some countries as UK of "Sustainable Development Units" to help healthcare organisations think about the medium- and long-term future, and understand and prepare for their changing role.

Evidence shows that healthcare systems of the developed economies find it difficult to cope with ageing population in the presence of budget constraints driven by the public debt burden.

A partial solution to this vital issue is represented by technology that is revolutionizing medicine and healthcare. Smart hospitals are the infrastructural cornerstone of this trend, but they raise many unconventional governance concerns.

Healthcare is undergoing a paradigm shift, and governance issues mainly rotate around patients, who are painfully becoming the pivoting stakeholder.

The thesis of this paper is that whereas the public player maintains a vital role in safeguarding health as a primary "public good", it may lack the expertise to promote and run technological – smart – investments. This assumption is valid worldwide as PPP and RBF are well-known and increasingly used instruments.

Hence the growing importance of PPP, where public actors interact with private players. Healthcare PPP investments, backed by PF patterns, are consolidated in many developed and catching up economies (Moro Visconti et al., 2017), although they preserve some criticalities. Among them, insufficient public-to-private risk transfer can exacerbate public budget concerns.

Smart investments imply higher operational risk, aggravating public-private sharing issues. Public players are so forced to transfer more standard and technological risk to the private actors, whereas the latter need to compensate it with extra-returns, even to soften bankability issues. But extra public payments face the budget pressures.

A solution can be represented by the savings and efficiency gains that technology produces, reshaping consolidated business models. Some countries are more advanced than others but all need to settle the risk-reward transfer issues, by sharing it between the public and the private stakeholders. RBF is routinely applied in healthcare to link remuneration to performance, minimizing opportunistic rents. It may so represent a partial solution to these intricate problems and to their related governance concerns.

Limitations of this study concern the lack of data and empirical evidence able to test the described model at several levels. At macro-level by investigating the new skills needed by health professionals. At meso-level by investigating already existing accountability and risk sharing practices in more advanced countries. At micro-level by looking for examples of already working smart hospitals.

Further investigation over the theory of the "healthcare" firm and its peculiar stakeholders is also needed, considering the impact of telemedicine and e-health on the supply and value chain. Digital platforms where connected stakeholders interact and co-create value should reduce information asymmetries and soften risk. This is however another under-investigated area.

Future research avenues should address the governance shift promoted by the use of private providers for technological innovation. "Evidence based health policy" should accordingly be brought into the governance debate (Chanturidze & Obermann, 2016). Customization to specific country issues – backed by emerging empirical evidence – remains a practical target for on-site implementation.

Furthermore, new research should address the government culture and purchasing methods shift necessary to promote technological innovation.

REFERENCES

1. Acerete, B., Stafford, A. & Stapleton, P. (2012). New development: New global health care PPP developments – a critique of the success story. *Public Money and Management, 32(4),* 311-314. https://doi.org/10.1080/09540962.2012.691315
2. Anand, A., & Fosso Wamba, S. (2013). Business value of RFID-enabled healthcare transformation projects. *Business Process Management Journal, 19(1),* 111-145. https://doi.org/10.1108/14637151311294895
3. Archenaa, J., & Anita, E. A. M. (2015). A survey of big data analytics in healthcare and government. *Procedia Computer Science, 50, 408*-413. https://doi.org/10.1016/j.procs.2015.04.021
4. Australian Commission of Safety and Quality in Healthcare. (2010). *Patient-centered care: Improving quality and safety by focusing care on patients and consumers.* Retrieved from the World Wide Web: https://www.safetyandquality.gov.au/wp-content/uploads/2012/01/PCCC-DiscussPaper.pdf

5. Barlow, J., & Köberle-Gaiser, M. (2008) Delivering innovation in hospital construction: Contracts and collaboration in the UK's private finance initiative hospitals program. *California Management Review, 51(2),* 126-143. https://doi.org/10.2307/41166483
6. Batalden, M., Batalden, P., Margolis, P., Seid, M., Armstrong, G., Opipari-Arrigan, L., & Hartung H. (2015). Coproduction of healthcare service. *BMJ Quality & Safety Online First, 25,* 509-517. https://doi.org/10.1136/bmjqs-2015-004315.
7. Beck, M. (2016). *How telemedicine is transforming healthcare.* Retrieved from the World Wide Web: https://www.wsj.com/articles/how-telemedicine-is-transforming-health-care-1466993402
8. Belloc, F. (2012). Corporate governance and innovation: A survey. *Journal of Economic Surveys, 26(5),* 835-864. https://doi.org/10.1111/j.1467-6419.2011.00681.x
9. Bertolini, M., Bevilacqua, M., Ciarapica, F. E., & Giacchetta, G. (2011). Business process re-engineering in healthcare management: A case study. *Business Process Management Journal, 17(1),* 42-66. https://doi.org/10.1108/14637151111105571
10. Bullen, M., Hughes, T., & Marshall, J. D. (2017). The evolution of nice medtech innovation briefings and their associated technologies. *Value in Health, 20(9),* A595-A595. https://doi.org/10.1016/j.jval.2017.08.1114
11. Campbell, S., Reeves, D., Kontopantelis, E., Middleton, E., Sibbald, B., & Roland, M. (2007). Quality of primary care in England with the introduction of pay for performance. *New England Journal of Medicine, 357(2),* 181-190. https://doi.org/10.1056/NEJMsr065990
12. Chan, M., Campo, E., Brulin, D., & Est'eve, D. (2017). Biomedical monitoring technologies and future healthcare systems. *Journal of Science and Technology, March, 3(1),* 59-75. Retrieved from the World Wide Web: http://jst.udn.vn/ict/index.php/jst/article/view/39
13. Chanturidze, T., & Obermann, K. (2016). Governance in health – The need for exchange and evidence. *International Journal Health Policy Management, 5(8),* 507-510. https://doi.org/10.15171/ijhpm.2016.60
14. Chen, Y., Yang, L., Hu, H., Chen, J., & Shen, B. (2017). How to become a smart patient in the era of precision medicine? In B. Shen (Ed.), *Healthcare and big data management. Advances in experimental medicine and biology, vol. 1028* (pp. 1-16). Singapore: Springer. https://doi.org/10.1007/978-981-10-6041-0_1
15. Chirkunova, E. K., Kireev, E. E., Kornilova, D. A., & Pschenichnikova, J. S. (2016). Research of instruments for financing of innovation and investment construction projects. *Procedia Engineering, 153,* 112-117. https://doi.org/10.1016/j.proeng.2016.08.089
16. Clarke, S., Ells, C., Thombs, B. D., & Clarke, D. (2017). Defining elements of patient-centered care for therapeutic relationships: A literature review of common themes. *European journal for person centered healthcare, 5(3),* 362-372. https://doi.org/10.5750/ejpch.v5i3.1337
17. Crossley, G. H. (2017). Further evidence that remote monitoring is cost-effective: It's time for all to adopt. *Heart Rhythm Society, 14(1),* 362-372. https://doi.org/10.1016/j.hrthm.2016.09.023
18. David, G., Saynisch, P. A., & Smith-McLallen, A. (2018). The economics of patient-centered care. Journal of Health Economics, 59, 60-77. https://doi.org/10.1016/j.jhealeco.2018.02.012
19. Deloitte. (2018). *2018 Global health care outlook. The evolution of smart health care.* Retrieved from the World Wide Web: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-hc-outlook-2018.pdf
20. Dixit, S. K. (2017). A new multiperspective emphasis on the public hospital governance. *International Journal of Healthcare Management, November.* https://doi.org/10.1080/20479700.2017.1403761
21. European Union Agency for Network and Information Security (ENISA). (2016). *Smart hospitals: Security and resilience for smart health service and infrastructures.* Retrieved from the World Wide Web: www.enisa.europa.eu/publications/cyber-security-and-resilience-for-smart-hospitals
22. Eurostat. (2016). *Manual on government deficit and debt. Implementation of ESA 2010.* Luxembourg: Publications Office of the European Union. Retrieved from the World Wide Web: http://ec.europa.eu/eurostat/documents/3859598/7203647/KS-GQ-16-001-EN-N.pdf/5cfae6dd-29d8-4487-80ac-37f76cd1f012
23. Gabutti, I., Mascia D., & Cicchetti, A. (2017). Exploring "patient-centered" hospitals: A systematic review to understand change. *BMC Health Services Research, 17(1),* 364-380. https://doi.org/10.1186/s12913-017-2306-0
24. Greer, S. L., Wismar, M., Figueras, J., & McKee, C. (2016). Governance: A framework. In S. L. Greer, M. Wismar, & J. Figueras (Eds.), *Strengthening health system governance. Better policies, stronger performance* (pp. 27-56). Maidenhead, UK: Open University Press.
25. Helfat, C. E., & Teece, D. E. (1987). Vertical integration and risk reduction. *Journal of Law, Economics and Organization, 3(1),* 47-67.
26. Henjewele, C., Sun, M., & Fewings, P. (2011). Critical parameters influencing value for money variations in PFI projects in the healthcare and transport sectors. *Construction Management and Economics, 29(8),* 825-839. https://doi.org/10.1080/01446193.2011.592204
27. Holzinger, A., Röcker, C., & Ziefle, M. (2015). From smart health to smart hospitals. In A. Holzinger, C. Röcker, & M. Ziefle (Eds.), *Smart health. Lecture notes in computer science* (pp. 1-20). Cham, Germany: Springer. https://doi.org/10.1007/978-3-319-16226-3_1
28. Jones, C., Hesterly, W. S., & Borgatti, S. P. (1997). A general theory of network governance: Exchange conditions and social mechanisms. *Academy of Management Review, 22(4),* 911-945. https://doi.org/10.2307/259249
29. Kaplan, R. S., Porter, M. E., & Frigo, M. L. (2017). Managing healthcare costs and value. *Strategic Finance, 98(7),* 24-33. Retrieved from the World Wide Web: https://www.hbs.edu/faculty/Pages/item.aspx?num=52117
30. Kostyuk, A., Mozghovyi, Y., & Govorun, D. (2018). Corporate governance, ownership and control: A review of recent scholarly research. *Corporate Board. Role, Duties and Composition, 14(1),* 50-56. https://doi.org/10.22495/cbv14i1art4
31. Kumar, R. K. (2011). Technology and healthcare costs. *Annals of Pediatric Cardiology, 4(1),* 84-86. Retrieved from the World Wide Web: http://www.annalspc.com/text.asp?2011/4/1/84/79634
32. Larocca, A., Moro Visconti, R., & Marconi, M. (2018). *First-mile accessibility to health services: A m-health model for Rural Uganda* (Working paper, Milan, Italy).
33. Marshall, D. A., Burgos-Liz, L., Pasupathy, K. S., Padula, W. V., IJzerman, M. J., Wong, P. K., … Osgood, N. D. (2016). Transforming healthcare delivery: Integrating dynamic simulation modelling and big data in health economics and outcomes research. *Pharmaco Economics, 34(2),* 115-126. https://doi.org/10.1007/s40273-015-0330-7

34. Meissner, D. (2015). Public-private partenerships models for science, technology and innovation cooperation. *Journal of Knowledge Economy, September,* 1-21. https://doi.org/10.1007/s13132-015-0310-3
35. Moro Visconti, R. (2014). Multidimensional principal–agent value for money in healthcare project financing. *Public Money & Management, 34(4),* 259-264. https://doi.org/10.1080/09540962.2014.920198
36. Moro Visconti, R. (2016). Healthcare public-private partnerships in Italy: Assessing risk sharing and governance issues with PESTLE and SWOT analysis. *Corporate Ownership & Control, 13(4),* 122-131. https://doi.org/10.22495/cocv13i4p12
37. Moro Visconti, R. (2017). Public private partnerships, big data networks and mitigation of information asymmetries. *Corporate Ownership & Control, 14(4-1),* 205-215. https://doi.org/10.22495/cocv14i4c1art3
38. Moro Visconti, R., & Martiniello, L. (2018). Public-private partnerships for sustainable investments in smart hospitals. Paper presented at the *2nd Social Impact Investments International Conference,* Rome, Italy.
39. Moro Visconti, R., Doś, A., & Pelin Gurgun, A. (2017). Public-private partnerships for sustainable healthcare in emerging economies. In J. Leitão, E. M. Sarmento, & J. Aleluia (Eds.), *The Emerald handbook public–private partnerships in developing and emerging economies* (pp. 407-437). Bingley, UK: Emerald Group Publishing. https://doi.org/10.1108/978-1-78714-493-420171015
40. Moro Visconti, R., Larocca, A., & Marconi, M. (2017). Big data-driven value chains and digital platforms: From value co-creation to monetization. In A. K. Somani, & G. C. Deka (Eds.), *Bigdata analytics: Tools, technology for effective planning* (pp. 355-372). Boca Raton, USA: Chapman and Hall/CRC Press. https://doi.org/10.1201/b21822-16
41. Moro Visconti, R., Montesi, G., & Papiro, G. (2018). Big data-driven stochastic business planning and corporate valuation. *Corporate Ownership & Control, 15(3-1),* 189-204. https://doi.org/10.22495/cocv15i3c1p4
42. Munksgaard, K. B., Majbritt, R., Evald, Clarke, A. H, & Nielsen, L. S. (2012). Open innovation in public-private partnerships. *Ledelse og Erhvervsøkonomi, 77(2),* 41-52.
43. N. Nohria, & R. G. Eccles (Eds.). (1992). *Networks and organizations: Structure, form, and action.* Boston, USA: Harvard Business School Press.
44. Pramanik, M. I., Lau, R. Y. K., Demirkan, H., & Azad, Md A. K. (2017). Smart health: Big data enabled health paradigm within smart cities. *Expert Systems with Applications, 87,* 370-383. https://doi.org/10.1016/j.eswa.2017.06.027
45. Rantala, K., & Karjialuoto, H. (2016). Value co-creation in healthcare: Insights into the transformation from value creation to value co-creation through digitization. In *Academic MindTrek'16: Proceedings of the 20th International Academic Mindtrek Conference* (pp. 34-41). New York: Association for Computing Machinery (ACM). https://doi.org/10.1145/2994310.2994325
46. Saltaman, R. B., & Duran, A. (2016). Governance, government and the search for new provider models. *International Journal Health Policy Management, 5(1),* 33-42. https://doi.org/10.15171/ijhpm.2015.198
47. Savedoff, D. W. (2010). *Basic economics of results-based financing in health.* Retrieved from the World Wide Web: https://www.rbfhealth.org/sites/rbf/files/RBF%20Economics_0.pdf
48. Shaoul, J., Stafford, A., & Stapleton, P. (2008). The cost of using private finance to build finance and operate hospitals. *Public Money & Management, 28(2),* 101-108. https://doi.org/10.1111/j.1467-9302.2008.00628.x
49. Van Thiel, A., & Leeuw, F. L. (2002). The performance paradox in the public sector. *Public Performance & Management Review, 25(3),* 267-281. https://doi.org/10.2307/3381236
50. Wang, Y., & Hajli, N. (2017). Exploring the path to big data analytics success in healthcare. *Journal of Business Research, 70,* 287-299. https://doi.org/10.1016/j.jbusres.2016.08.002
51. West Health Institute. (2013). *The value of medical device interoperability: Improving patient care with more than $30 billion in annual healthcare savings.* Retrieved from the World Wide Web: https://www.westhealth.org/wp-content/uploads/2015/02/The-Value-of-Medical-Device-Interoperability.pdf
52. Williamson, 0. E. (1985). *The economic institutions of capitalism: Firms, markets and relational contracting.* New York, USA: Free Press.
53. Williamson, O. E. (1979). Transaction-cost economics: The governance of contractual relations. *Journal of Law and Economics, 22(2),* 233-261. https://doi.org/10.1086/466942
54. Zattoni, A., & Van Ees, H. (2012). How to contribute to the development of a global understanding of corporate governance? Reflections from submitted and published articles in CGIR. *Corporate Governance: An International Review, 20(1),* 106-118. https://doi.org/10.1111/j.1467-8683.2011.00866.x