Water Domiciliary Distribution Telemanagement Value Model

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Abstract: The Internet of Things (IoT) represents a technical innovation that is already starting to play an important role in smarter water management, when a wide variety of sensors are incorporated into intelligent metering equipment and connected through wireless networks throughout the domiciliary water distribution network, being able to measure volume, flow, temperature, pressure, levels of chlorine, salinity and more. Water scarcity, aging or inadequate water distribution infrastructure, population variation, pollution, more intense and frequent droughts and floods, generate pressures that converge on the need to increase global investment in water infrastructures and to develop solutions for the conservation and management of water. The main stakeholders in the water distribution sector are the ones that can benefit most from the use of telemanagement. However, the results of adopting this innovation are contrary to expectations, with a slow change in traditional business models. The objective of this research is the construction of a value model that allows the identification of actors and value markets and the exchange of value related to the adoption of telemanagement in Portugal, having a solid theoretical basis and a real practical validation.

1 INTRODUCTION

Water distribution telemanagement is the "integrated and innovative management system that allows monitoring, managing and controlling reservoirs, stations and their respective distribution networks, through central supervision with adequate graphical representation, associated to automatic processes of alarms generated by control devices which detect and transmit occurrences, such as levels, flows, ruptures, leaks, among others", according to site of ESTEC (2018).

The adoption of intelligent water management platforms is a strategy that is gaining more and more acceptance but has been slowly evolving, although the results obtained justify its application. Thus, in order for the introduction and development of telemanagement potential within the water distribution sector to be carried out efficiently, it is essential to have a solid understanding of the technology as well as the business and management issues underlying or adjacent to the subject. The question of whether or not to change the way business is developed today to a paradigm centered, totally or partially, on telemanagement must be seriously considered. Thus, it is important to find the answer to the following question: How does the adoption of telemanagement in Portugal show efficiency gains?

Efficiency results from the relationship between goods produced or services provided and the resources used. Value modeling is a strategic tool to identify new business opportunities and how the company can position itself strategically to maximize emerging opportunities that may or may not require a substantial redefinition of the company's infrastructure (Glova et al., 2014, pp. 1125).

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Hevner et al., (2004, p.78) argue that organizations and their information systems (IS) are intentionally designed to achieve a goal, being composed of people, structures, technologies and work processes, therefore, IS professionals and managers in general use design to achieve the essential alignments between business strategy and IT strategy and, on the other hand, to achieve alignment between the organizational infrastructure and the information system infrastructure, as studied by Henderson and Venkatraman (1993, p. 477).

The definition of the value model for telemanagement of domiciliary water distribution sector will contribute to the answer to the main question based on the reality of the existing market in Portugal, so that decision makers understand that this new paradigm is based on the transformation of the traditional value chain into a network of value, characterized by the support of the activities of the water sector in information systems.

The purpose of this paper is to describe this emerging ecosystem with the various actors and value markets and their value exchange relationships. To achieve this, the research was driven by the following derived questions:

- Who are the actors and value markets that can be identified in the telemanagement of domiciliary water distribution sector?
- How are value exchanges in the ecosystem formed by actors and value markets?

Having determined the overall goal, we may need to restrict the guidelines of the study, therefore, the specific objectives will be as follows:

- Diagnose the state of art of water distribution managing entities (MEs), identifying the main problems that are pressing towards the transformation;
- Indicate the main factors that condition the efficient implementation of the telemanagement of the domiciliary water distribution.

In this research, accordingly with the methodology and methods chosen, it was considered useful to adapt the diagram proposed by Laudon and Laudon (2016, p.25) to represent the problem of the efficiency of the information system of telemanagement of domiciliary water distribution sector, because it illustrates the relationship between management and organization to use information technologies (IT) as a solution to the challenges created by the business environment, as shown in figure 1.

The diagram summarizes how the management, technology and organization elements work together to create the systems and illustrates how the telemanagement system can solve the problem presented by the need for efficiency and cost reduction in the domiciliary water distribution sector, increase the quality of services for the consumer, among others. However, even if a system project supports an entity's strategic objectives and responds to user information requirements, the system needs to be a good investment for the organization.

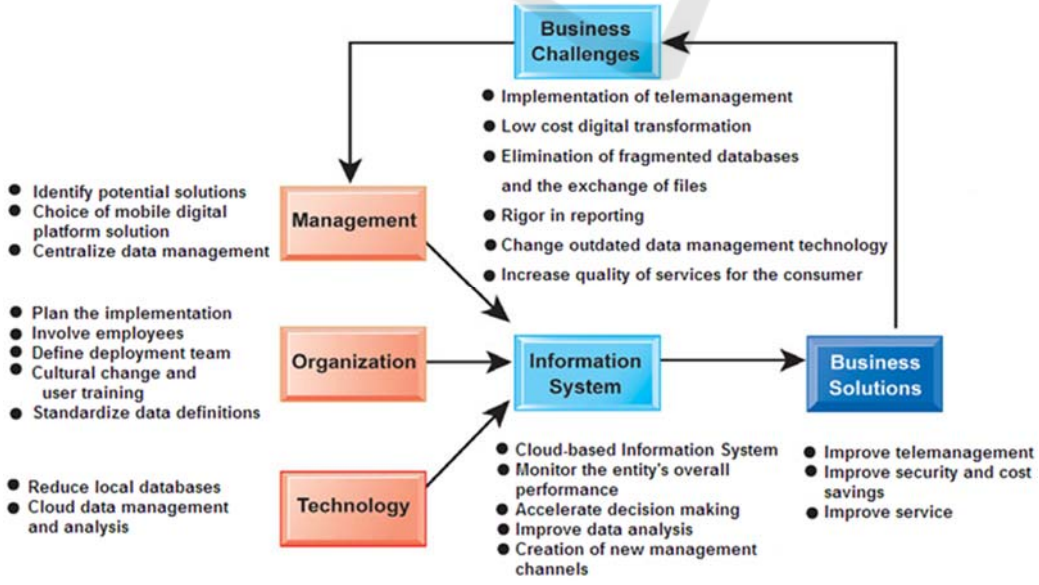

Figure 1: Diagram of the challenges and solutions in telemanagement, adapted from (Laudon and Laudon, 2016, p.25).

2 RESEARCH METHODOLOGY

The methodology selected for structuring this study is the design science research methodology (DSRM). Blessing and Chakrabarti (2009, p.12) define that design is the process by which a need is identified and a solution or product developed to respond to the need. The authors understand that design research has two related objectives: the formulation and validation of models and theories about the phenomenon of design considering all facets and, on the other hand, the development and validation of support based on these models and theories, to improve practice and results. Blessing and Chakrabarti (2009, p.20) refer that models are used in science to create conceptual organization, are a resemblance of something that exists in reality but restricted to some particular aspects of that reality. Value modeling focuses on value creation, how value is created, by whom and for whom (Glova et al., 2014, p. 1125). Thus, initially, we will construct the reference value model that in design will represent the existing situation, constituting the reference against which the desired improvements are compared. The reference model represents the level of understanding of the existing situation, then will be constructed the impact model that represents the desired situation and shows the impact of the support to be developed.

DSRM is a research methodology that provides specific guidelines for iteration in research and evaluation when the academic research objectives are in pragmatic nature. Hevner *et al.* (2004, p.76) state that the main purpose of design science research (DSR) is to achieve knowledge and understanding of a problem domain through the construction and application of an artifact design, based on results. DSR has been considered as an appropriate methodology for the conduction of research focused on technology and information systems, being an approach that, when well applied, produces real scientific rigor.

Hevner (2007, p. 2) understands that knowledge resulting from the DSR survey must be returned to the environment in the field of application for study and evaluation. The field study and evaluation of the artefact can be performed by methods appropriate to the implementation of technology, as is the case of the action investigation method, case study, simulation, among others.

After presenting DSRM as a research methodology, we turn to the method Case Study, considering that part of the research is supported in telemanagement projects developed by companies in operation, therefore it is pertinent that there is a focus on this method. Martins and Belfo (2011, p.44) define that the case study is a research method that examines a social phenomenon in its natural environment, through the collection and analysis of empirical material from specific social sites, as is the case of real organizations, with the fundamental objectives of broadening or deepening knowledge about certain social phenomena, being able to construct a theory or test theoretical concepts and relations between them.

The following research techniques are pertinent to be used: bibliographic review, direct observation and interviews. In order to know the current context of telemanagement, to know how MEs of water distribution and companies have dealt with the transformation, to find out what are the greatest difficulties faced and the solutions found for these problems, it was necessary to consult documents, but also by direct observation and interviews with stakeholders in real institutions (Martins and Belfo, 2011, p.57). The direct observation is based on the personal contact that the researcher established with the people in charge of several information systems companies and with the Water and Sanitation Municipal Services of Caldas da Rainha (SMASCR), which included a study visit to ME to deepen knowledge. Considering that in this context it is practically impossible to make a survey of the whole, it has resulted in the possibility of interviewing only a part of the population, namely those responsible for the telemanagement projects known in SMASCR.

Glova et al., (2014, p.1126) present the e^3-value technique designed to model value creation and value exchange within an e-business network with multiple business actors. With this approach, commercial activity can be reduced to its main elements, which, in the simplest case, make up the value proposition, the distribution channels and the company's customers, explaining how a multi-actor network creates, distributes and consumes value by producing a good or providing a service, so this tool was selected for the development of this study.

3 RESULTS AND DISCUSSION

Westerlund et al., (2014, p. 5) state that the Internet of Things (IoT), has become the new network paradigm that aims to link all objects around us, allowing anyone access to information at any place and time. IoT describes the interconnection of objects or "things" for various purposes including identification,

communication, sensors, and data collection. IoT includes the widespread use and distribution of sensors, and several industries are exploring how to create smart cities through the extensive use of remote sensing and cloud computing.

The digital transformation of an organization depends on two main dimensions: technology (digital capabilities) and how to lead change (leadership skills), which are two very distinct dimensions and each one plays its own role, resulting in that none of the dimensions is sufficient by itself, but only by joining the components is it possible to create advantage for the business as presented by Westerman et al., (2014, p.13).

A continuous stream of information technologies (IT) innovations is transforming the traditional business world. At the level of the water distribution sector, this transformation depends on the articulation between the business strategy, the IT strategy and the IT itself that is introduced and used to create an infrastructure and IT services adequate to the operation of the sector and that meets the needs of the various stakeholders, namely, the State and entities of the Central Administration, users, MEs, partners, among others.

From the point of view of market structure, the water sector is a typical case of natural monopoly infrastructure management, for technological reasons, with a single entity providing the service in each geographical area, with no possibility of choosing an alternative by users (ERSAR, 2017, p. 17).

In Portugal, downstream water supply is a fragmented sector, marked by the large number of management entities, 319, mostly with an intervention area equal to or less than municipal, which is explained in part by the majority of the service being assured by municipal services, but also by the existence of micro-entities that are composed of parish councils (ERSAR, 2017, p.51).

The Government is committed to the strategy of consolidating the downstream MEs, since a number of relevant studies show that this is where the significant margin of improvement of the sector is concentrated, as the capture of these improvements presupposes the creation of the basic conditions for the introduction of greater efficiency in the operation and management of services, which is essential to meet the sector's main challenges (GAG, 2017, p. 17). The promotion of regional managing entities with scale is a great bet, and is part of the PENSAAR 2020 strategy through the "anchor projects".

At the level of telemanagement, the responsibility matrix of the PENSAAR 2020 measures states that the Ministry of the Environment and the Operational Programme for Sustainability and Efficient Use of Resources (PO SEUR) are the entities that drive telemanagement and that the monitoring of the implementation of the measure is the responsibility of the Water and Waste Services Regulatory Entity (ERSAR), between the period from 2016 to 2020. Since this separation of responsibilities between the various entities in the implementation of PENSAAR 2020 results, no executive function is attributed to the Central Public Entities and, on the other hand, the MEs execute almost all measures or actions, and more, have no responsibility to promote or ensure them. Considering that MEs have the enforceable responsibility of telemanagement and that Government and central services play a role in boosting and promoting, this means that MEs are investing to the extent of internal capacities in IT infrastructure and own information systems that are provided by business partners.

The implementation of telemanagement by the MEs involves the conclusion of contracts with several market partners, namely with the companies installing and maintaining IoT things or sensors, telecommunications infrastructure and computing infrastructure, resulting in exchanges of value between the parties. Considering the knowledge acquired in the case study of SMASCR and based on all the conceptual organization on the roles and the value exchanges between the various actors and value markets, it was possible to construct the reference value model of the telemanagement of the water domiciliary distribution, using the graphic editor of the e^3-value method, as shown in figure 2.

As can be seen from the analysis of the model, the costs resulting from the implementation of remote management are supported by the 3 T: State / Community support, tariffs and taxes. The value path established for this scenario has the initial stimulus in the user and ends up in the central entities representing the sector in the State. Contract costs for the provision of IoT sensors and other IT infrastructure and services for telemanagement or telemetry are normally supported indirectly by the end-user who pays the tariffs for the water distribution service, even if the amounts involved may be alleviated by State or Community support that is granted directly to managing entities, or by reducing the costs of such services resulting from the tax benefits and subsidized credit lines granted to business partners who market and maintain the technology. The literature review and the interviews conducted throughout this research have confirmed the identified roles and their value-exchange relationships for what we consider to be a valid value model.

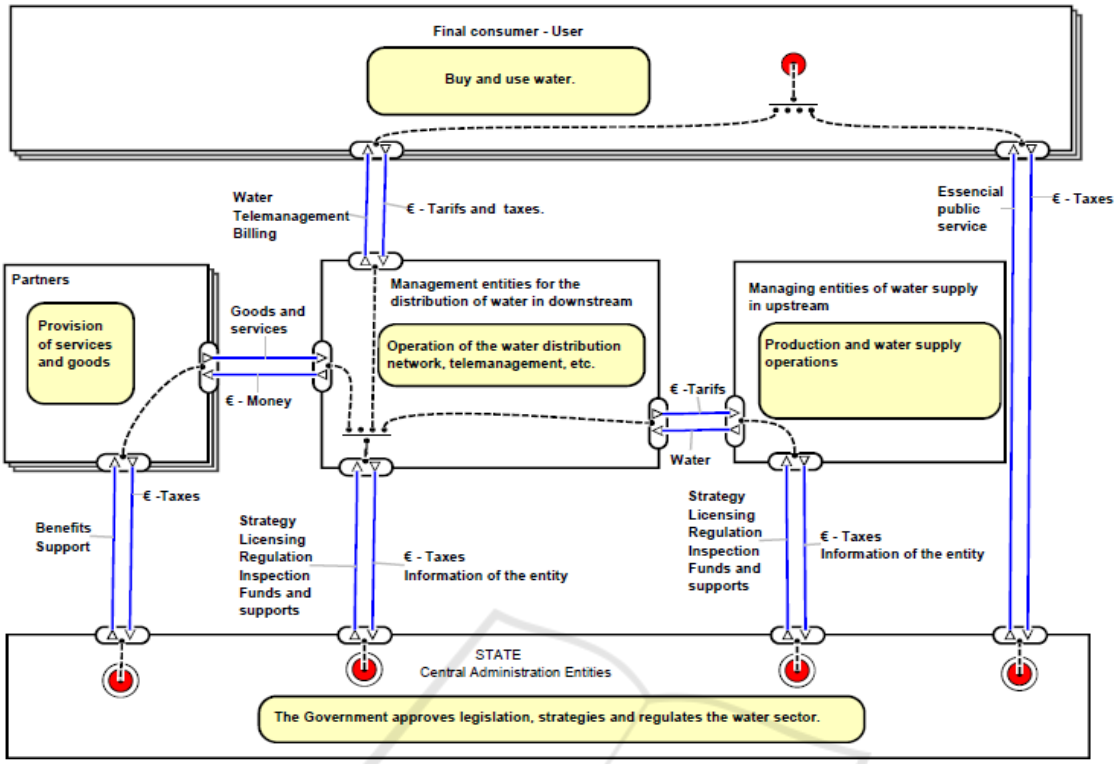

Figure 2: Reference value model of the domiciliary water management.

In order to ensure success in digital transformation, the Government has been adopting strategies in the field of Information and Communication Technologies (ICT) in Public Administration (PA) which aims to rationalize investments, reduce costs with systems duplication and provide information sharing between several institutions. In 2017, the Council of Ministers approved the ICT Strategy 2020, called the Strategy for Digital Transformation in Public Administration, the respective Plan of Action and the Sectorial Plans which are grounded in several strategic principles like the creation of security, resilience and data privacy, in order to ensure the safeguarding of the information held by the PA and strengthening the digital skills of PA employees and sharing of resources, to achieve greater efficiency in their use, adopting measures like the use of cloud computation and telecommunications.

Laudon and Laudon (2016, p.39) report that, currently, the success of organizations depends on the ability to align business strategies and objectives with available IT, specifying that there are three interrelated changes in technology: the growth of cloud computing, the mobile computing platform, and the growing use of the big data and online software business as service. These authors noted that cloud computing is more attractive to small and medium-sized businesses that can´t afford to buy and own their own hardware and software. Considering that organizations that use public clouds do not have the infrastructure, they do not have to invest heavily in their own hardware and software. Instead, they buy the computing services from remote vendors and pay only for the amount of computing power they actually use or contract on a monthly or yearly subscription basis.

The water distribution business depends on the accuracy and reliability of the data in real time. The strategic options refer water distribution managing entities to extend business along the urban water cycle, but both at the level of decision making and operational management, the MEs are limited by the data stored in legacy systems. Currently, it is found that parts of this data are stored in many legacy systems that make retrieval and correct unification extremely difficult for them to be used in decision making, concluding data is often redundant and inconsistent, limiting its usefulness (SMASCR, 2017). The distributed nature of MEs means that storing and analyzing accurate sets of operational data and monitoring the various types of equipment installed along the water network has become increasingly challenging and resource consuming, notably for producing production reports.

Bohm et al., (2010) refer that the most established value chain approach was presented by Porter (1985), who created an extended value chain, termed value system, to account for the collaboration between companies, representing an interconnected system of value chains. Thus, the value chain of an organization can be linked to the value chains of its suppliers, distributors and customers by forming a value network that is more customer oriented and operates less linearly than the traditional value chain. The technology of the Internet has made it possible to create highly synchronized value chains, called web-value networks.

In the digital economy, platform ecosystems are the basis for creating new value. Success is based on two key elements: platforms (technology) that are built to support the business and the business model that these platforms allow (Accenture, 2018). The platform-based business model fundamentally changes how businesses operate, resulting in many industry sectors accelerating the adoption of digital technologies backed by cloud computing as the first crucial step in entering the platform world, according to site of Accenture (2018).

In the IoT domain, the platform will allow not only real-time knowledge of the state of the city, but also direct control of the different systems, using a user-friendly portal as well as automatic urban space management through configuration rules that are transversal to the different domains.

For example, the management entity named “Empresa Portuguesa das Águas Livres, SA (EPAL)” distributes water to domestic consumers in Lisbon and uses the system called Water Optimization for Network Efficiency (WONE®). The implementation of WONE® allowed to reduce unbilled water levels in the Lisbon distribution network from 23.5% in 2005 to around 8% in 2015, placing EPAL at the elite group of the world's most efficient management entities, as reported on EPAL's website. WONE® provides integrated, permanent and systematic analysis of data from different systems, namely telemetry, customer system, Geographic Information System (GIS), among others. The principal differentiating factors of this approach are the following: intuitive and user-friendly interface with cloud technology, simultaneous multi-user permission, responds to the needs of different areas of the MEs, with indicators and attractive graphic presentation, integrated alarms and alerts, easy to adapt and develop.

Currently, the implementation of telemanagement presents some problems, for example, the SMASCR report that there are already shared platforms for the public sector by National Communications Authority (ANACOM) that allow public entities to register infrastructures with GIS, however, this solution does not cover services of water, which is why MEs have to lonely invest and develop a similar root system to comply with the PENSAAR 2020, which implies a significant investment for each management entity in Portugal.

The SMASCR also report that there is currently few information sharing between management entities at the telemanagement level. Considering the SMASCR case study, it is concluded that the investment in the computing infrastructure is significant and high and although the ME has the financial capacity to support the investment, it does not matter that this effort is multiplied by the majority of the MEs in Portugal, considering that it is a specialized sector and there can be interoperability and sharing of resources and information as defined in the ICT 2020 strategy, increasing efficiency in the implementation and ongoing development of IT solutions.

Usually, the implementation of strategic systems has an impact on ME and requires a profound organizational change and such strategic transitions are often difficult to achieve. In addition, not all expensive to build strategic systems are profitable, and many of the strategic information systems are easily copied between the various entities, so it is not sustainable to invest simultaneously in the development and refinement of several practically identical systems. Thus, it is concluded that at the level of telemanagement, the principles defined in the ICT 2020 strategy are not being materialized, and there is scope for improving the efficiency in telemanagement implementation in Portugal, increasing the opportunities of the ME with greater difficulties, allowing greater rigor in allocating state funds and support and avoiding the increase of the tariffs applied to final consumers due to investments at PENSAAR 2020 level.

Under these conditions, beyond the leadership shown towards horizontal integration and the creation of MEs with sufficient scale to implement the actions of PENSAAR 2020 favoring the final consumers, it´s relevant that the same leadership level is given to telemanagement implementation by the integration of MEs. This is possible through the contracting of IT infrastructure and services with a sufficient level of scale that allows the increase of the technological capacities of the downstream and upstream MEs, independently of the management model, creating efficiency gains in the implementation of telemanagement according to the principles of the ICT 2020 strategy.

Thus, the Government may appoint or create a new central entity that is responsible for the contracting and management of infrastructure and IT services with support in market partners to respond to the needs of the MEs at the level of the urban water cycle. The principles foreseen in the PENSAAR 2020 and ICT 2020 strategies should be applied by the MEs and the development of a cloud computing service project is highly advisable for the telemanagement and operational tasks of the water distribution service.

Based on the new roles of telemanagement management entity and the partners that provide the cloud computing service, it was possible to construct the impact value model of the telemanagement of domiciliary water distribution, using the e^3-value method, as shown in figure 3.

The telemanagement management entity will be responsible for bridging the cloud computing system partners, the ME and entities of the Central Administration, facilitating an efficient integration of the stakeholders in the value network. The managing entity of telemanagement is an intervener that has direct access to the platform to carry out activities of management and supervision, monitoring of the system and resolution of nonconformities.

Although we can derive some principles about value creation and the flow of value within the telemanagement ecosystem through the cloud computing service, from the interviews, no valid quantitative estimate can be made yet, resulting that future research needs to investigate further on a broader empirical basis. The proposed value network can serve as a conceptual validated model for guiding future research.

In this study, we also consider important to discuss the process of management of the telemanagement business model that results from the value scenario illustrated in the telemanagement impact model and proposes the iterative alignment of business and IT strategies as well as the updating of telemanagement model and objectives, based on the interests of stakeholders, among other aspects.

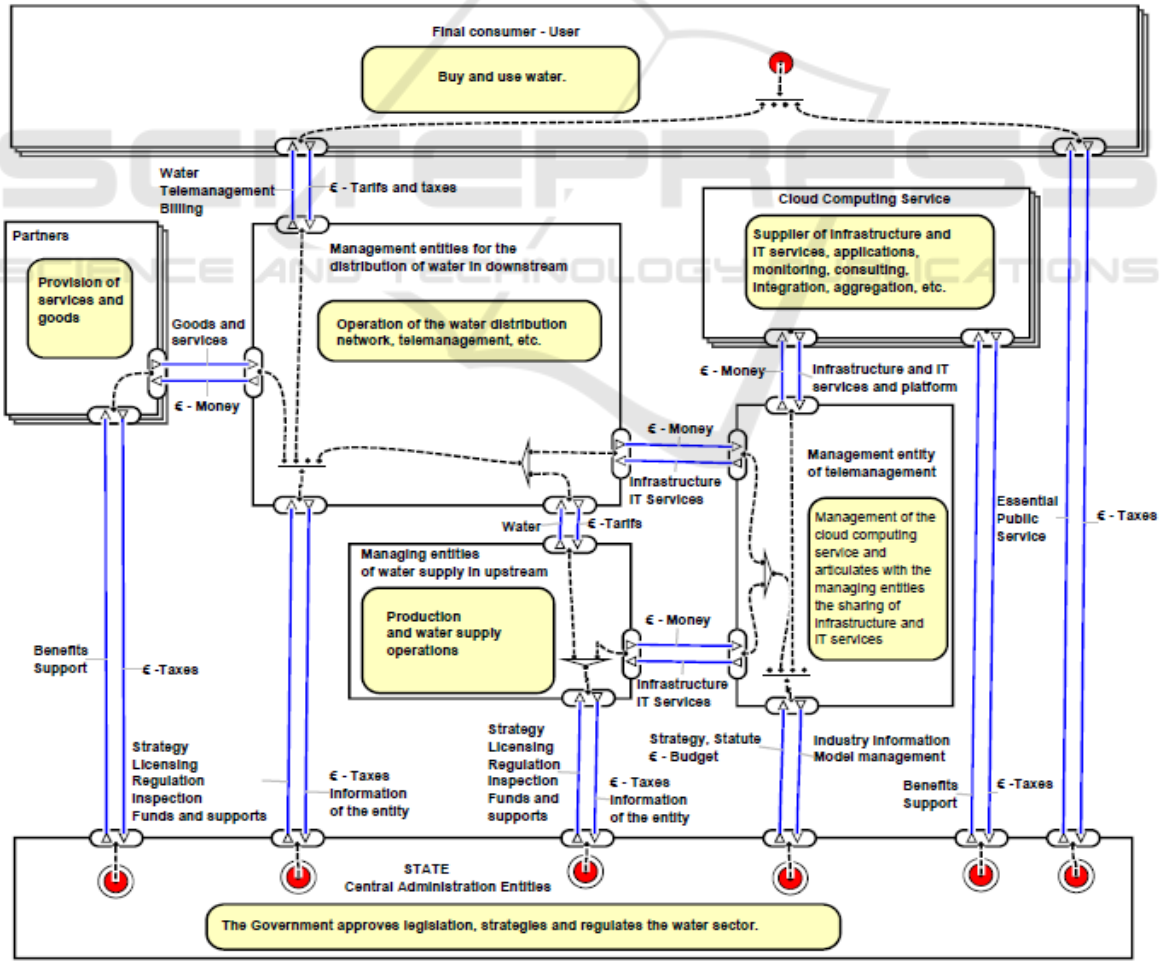

Figure 3: Impact value model of the telemanagement network of domiciliary water distribution.

4 CONCLUSIONS

The application of the methodology and methods throughout the research, based mainly on the bibliographic review and in the case study of the reality lived at SMASCR, allowed the construction of the reference value model and, subsequently, an impact value model that allows to communicate the current situation and the desired efficient situation, respectively, in terms of domiciliary water management in Portugal.

The study turned out the existing situation and presents problems considering that the various MEs are investing in telemanagement information infrastructure and systems which is more expensive than sharing a network of services with added value to the consumers, and that there should be greater leadership by the Government to achieve an alignment of the business and IT strategies. The value scenario built for the desired situation provides for the appointment of an entity responsible for telemanagement and will be responsible for the management of the cloud computing system, which will allow the development of a platform that replaces the business model between the traditional value chain to the value network, with significant efficiency gains.

The value impact model represents a scenario that allows greater strategic alignment along with the adequacy of the organizational and SI infrastructures, but it is considered relevant that future research focuses on the empirical validation of this model in an extended form and, on the other hand, it will be pertinent to deepen the competences of the telemanagement management entity in order to maximize efficiency gains in the sector, beyond the theme of telemanagement.

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