



**The use of transfer pricing for smart contracts in a  
blockchain system for the National Health Service:  
A systematic literature review**

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**João Pedro Marques Ferreira**

**Dissertação de mestrado**

**Mestrado em contabilidade e finanças**

**Porto - 2019**

**INSTITUTO SUPERIOR DE CONTABILIDADE E ADMINISTRAÇÃO DO  
PORTO INSTITUTO POLITÉCNICO DO PORTO**



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**apresentada ao Instituto de Contabilidade e Administração do Porto para a  
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## **Resumo**

Este trabalho é parte de um projeto investigação-ação composto por três fases, onde o objetivo final é a criação de um modelo de blockchain que suporte smart-contracts capazes de gerir a troca de serviços de imagiologia no sistema nacional de saúde português. A primeira fase consiste na revisão da literatura sobre blockchain e no método de custeio baseado em atividade e tempo (TDABC), de forma a identificar as atuais áreas de investigação e viabilidade do modelo de custo. A segunda fase consiste na criação de um modelo de preços de transferência após análise dos custos com base no método TDABC. A terceira fase consiste na criação de um modelo de blockchain, onde o smart-contract irá operar na gestão de serviços de imagiologia dentro do sistema de saúde nacional português.

O primeiro grande objetivo deste trabalho é em perceber em que áreas de negócio pode a tecnologia de blockchain ter impacto, bem como vantagens e limitações. O segundo grande objetivo é descobrir o potencial do TDABC como metodologia de custeio nos serviços de saúde. Durante esta primeira fase do projeto concluímos que a tecnologia blockchain tem potencial para ser usada, entre outros, no setor de saúde. Fomos também capazes de identificar vantagens e desvantagens bem como limitações que têm de ser resolvidas. A revisão da literatura sobre o TDABC permite-nos concluir que a metodologia tem potencial para superar metodologias convencionais de cálculos de custo no sistema de saúde bem como na identificação e mapeamento dos processos.

**Palavras-chave:** Blockchain, Transfer-pricing, TDABC, Management

## **Abstract**

This work is part of a major action-research project with three main phases, where the final goal is the creation of a blockchain capable of supporting smart-contracts that manage the exchange of imaging services in the Portuguese National Health Service. The first phase consists of a systematic literature review of the literature on time-driven activity based costing (TDABC) and Blockchain. The second consists in the development of a transfer price system based on a TDABC methodology, designed for a bottom up approach to cost measurement. The third phase consists in creating a blockchain model, where the smart contract for imaging services exchange, would operate within the Portuguese National Health Service.

The first big objective of this work is to find out in which fields of business can blockchain have a big impact, as well as potential advantages and limitations of the technology. The second big objective is understanding the potential for TDABC to outperform traditional cost accounting methodologies in the healthcare sector. During this first phase we found that blockchain can benefit, among others, the healthcare industry and some barriers that can limit or delay its use. On the topic of TDABC we found that it showed great promise in its uses within healthcare to measure costs, identify and map procedures, which is an important goal when dealing with complex systems.

**Keywords:** Blockchain, Transfer-pricing, TDABC, Management

## **List of Abbreviations**

NPM – New Public Management

NHS – National Health Service

ABC – Activity Based Costing

TDABC – Time-driven Activity Based Costing

PoW – Proof of Work

PoS – Proof of Stake

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# Introduction

An increase in the quality of the health service provided generates a higher expectation from the community that carries an increase in demand. This in turn brings new costs and financial burden to hospitals and health care providers (Vagnoni & Oppi, 2015). Being that health services are a service provided by the state, this burden falls on everyone and the general constraints that countries have with budgeting are worsened, which affect the quality (WHO, 2010). Public hospitals have to guarantee universal coverage for their citizens which forces certain costs and financial repercussions on these institutions, that are amplified by the growing average lifespan (Harfouche, 2008). The rise in complexity of situations encountered is set to increase, which require a pro-active style of management (Neves, 2002).

Where previously it was assumed that costs were inevitable and there wasn't much attention paid to waste and efficiency, nowadays there's a big emphasis transparency for public expenditure, as well as the results and quality of service provided.

In the health sector, New Public Management (NPM) is particularly noteworthy with the reform of the English National Health Service, initiated in the 1980s. In Portugal, it was mainly in 2003, with the transformation of about half of the public hospital network into public enterprises, and later in 2011, with the Portuguese sovereign debt crisis and the Troika agreement, that the NPM imposes itself in Portuguese health sector. Since then, hospital organization have been through great changes and, nowadays, it is quite common and well accepted that public organizations, namely hospitals, adopt administrative practices and management models that were assumed to be market oriented.

In 2018, healthcare expenditure represents 9% of Gross Domestic Product, so improving hospital efficiency is an important factor in achieving global coverage. Since reduced costs means more people covered (WHO, 2010), there is a social interest in this not limited economical point of view.

Portuguese National Health Service (NHS) was created in 1979, it is a public and complex system that guarantees free, or almost free, healthcare services to all Portuguese citizens. Organizations within NHS has a complex interdependency, they share the clients, they exchange services, they depend on each other. In regard to imaging services, like X-ray, computed tomography and magnetic resonance imaging, public hospitals can provide these services on their own or buy it from private operators.

One big challenge would be to optimize the capacity of NHS and increase the efficiency of resources used. To do that, we propose the creation of an internal market of imaging services where each public hospital can offer its services to other public hospitals or family doctors. This system could be based on blockchain architecture. In this blockchain, each hospital would offer its services at a given price, defined every moment based on demand. On the other side, public hospitals and family doctors would introduce requests for imaging services for the patient. A smart contract will then match the supply and demand and make the contract between the two agents. To make it work in an efficient way, hospitals need to know their cost structures, in other words, they need to define their transfer price and in order to optimize the resource use within the NHS, each hospital should know its opportunity cost. In such a context, recent literature on cost accounting in hospitals reveal hospitals need to develop a cost accounting model. There's evidence that Time-Driven Activity Based Costing (TDABC) can work as a model for hospital costing.

This work is part of a major research project with main phases:

The first phase consists in contextualizing the problem and a literature on TDABC and Blockchain, to identify current research trends and opportunities as well as the costing methodology viability.

The second phase consist in the use of TDABC to develop a bottom-up approach to cost accounting so we can design an appropriate transfer price.

The third phase consists in creating a blockchain model, where the smart contract for imaging services exchange would operate within the Portuguese NHS.

This work represents the first phase of the project. In chapter 1 we go over the relevant literature for management accounting in hospitals related to this work. This includes public management, decentralized management systems, hospital management, transfer pricing and TDABC. In chapter 2 we present a short review and explanation of how blockchain and smart contracts work.

In chapter 3 we present the methodology chosen for this study and dchapter 4 includes a systematic literature review on blockchain where we seek to understand how blockchain can affect businesses and the possible advantages and disadvantages it can bring.

Chapter 5 presents a systematic literature review on the use of TDABC in hospitals. The goal

was to figure out if TDABC is a viable costing methodology over traditional top-down approaches.

In the final chapter we present our final remarks and conclusions about the topic and steps moving forward.

## **I – Management accounting in hospitals**

## **1.1.Public management**

It's hard to pinpoint a definition for public administration due to its close relation and resemblance to the private sector. For Greenwood, Pyper, & Wilson (2005) the public sector has a vast number of objectives and a focus on accountability, equity and legality while the private sector has fewer and more well-defined objectives and is greatly motivated by profit. Because the distinguishing lines are tenuous, the relationship between private and public administration is viewed differently by some authors. While some believe that management rules are universal and fit every scenario, others look for practical evidence to believe that private theories of management work in the public sector, while some outright reject any theory originated in the private sector (Allison, 1980; Boyne, 2002).

Some authors look to define the influencing factors for corporations behavior and look for elements that explain why certain actions work. Pollitt & Harrison (1994) found that the emphasis on accountability towards the elected politicians, the lack of consensus regarding objectives and priorities as well as the complex organizational network are traits found in the public sector. The vast majority of public services is filled with complex processes (e.g. hospitals) compared to other services and the specific legal context where it's inserted only contributes to that.

Rainey & Bozeman, (2000) looked at several studies comparing the differences between the private and public sector. Most of the studies discussed were based on questionnaires, that can be filled with response bias. Despite that, the results can't be dismissed entirely, as the convergence of findings lends strong support to their validity.

According to Rocha (2000), the public sector has a hard time measuring output and efficiency, many of its projects are not profit focused and often there is also lack of consensus on how to proceed. The evaluation process is often used to validate political actions and there is a coerciveness to rulings made in the public sector. As opposed to private corporations that operate by the market, public organizations report to political power. This political power can sustain a public entity despite suffering losses, but the same is not true for private corporations who may enter bankruptcy if the business model doesn't work (Bilhim, 2001; Pinto & Aragão, 2003).

Murray (1975) finds that different institutional approaches to management have developed



over the course of time for the public and private sector but concludes that they are not so different, more a “blurring of the lines rather than a bifurcation” (Murray, 1975, p. 370). In areas like objective setting and evaluation the differences found were minor. The differences in the way ethical issues are dealt with are only legalistic in nature but the same concerns appear in both sectors. When looking at which aspects of efficiency should be valued, the criteria is not the same. The public agent might be looking for political efficiency while the private agent economic efficiency. In summary, the authors conclude that public and private management procedures can’t be seen as totally separate.

New Public Management refers to a model for managing public service organizations. The approach was developed during the 1980s owing to concerns that public agencies and institutions were delivering poor services in comparison to private business organizations. The disparities in service delivery and operational efficiency created the need to adopt private sector management models into the public sector. One of the basic premises necessitating the emergence of NPM is that traditionally, managers in the public sector have been shielded from the pressures and incentives characterizing the private sector. The lack of such pressures has created an environment that is conducive for inefficient bureaucratic organizations and further facilitates complacency (Ferlie, Ashburner, Fitzgerald, & Pettigrew, 1996).

The NPM approach to management highly regards privatizing government functions, thus placing more emphasis on hands-on methods. This approach provides leaders with a greater degree of freedom and discretion when managing resources. In terms of performance standards, the NPM approach acknowledges the importance of maintaining clearly articulated standards and measures of performance. The use of performance measures promotes the clarification of targets, goals, and indicators of progress which results in a shift from bureaucratic procedures and input controls to the use of output controls that are evaluated using quantitative performance indicators. The use of output controls calls for the use of performance-based assessments, especially when outsourcing certain functions and operations to private firms.

The NPM model aims to create competition in the public sector, where the focus is on enhancing operational efficiency through cost reduction and constant quality improvement. The principle of private sector management places emphasis on the need to set up short term

labor contracts, establish business plans, mission statements, and performance agreements. The principle of cost reduction is closely tied with that of operational efficiency and the idea of achieving more with less. At the same time, there's an emphasis on citizens who act like customers to the public sector (Cankar & Petkovsek, 2012). NPM has been applied in a wide range of sectors and various countries, especially in Europe. However, one of the sectors that have proven challenging is the health industry.

Healthcare is a core government function and has experienced myriads of changes over the recent decades, mainly because of efforts to implement NPM. The public health sector is unique in terms of availability, structure, and political influence. One of the primary roles of public health is to ensure that the public has access to quality health care services. The implementation of NPM in public health has revealed a number of differences in terms of implementation, perception, knowledge, and use. Additionally, it has also revealed the highly competing interests of quality service delivery and financial objectives. This is mainly due to the approach being designed as an integrated management tool that is rather rigid and static and hence limited in terms of differentiating between people, thereby ending up categorizing them in a wrong way (Ferlie et al., 1996). This results in workers perceiving goals and strategies as independent and disconnected to each other. Secondly, there is the practice of choosing measures before gaining a comprehensive understanding of how they are supposed to be used (Aas, 1997; Young, 2014).

In most cases, the underlying assumption of using performance measures is that links, causes, and effects are predictable. However, in reality, people can act unintentionally, which is an aspect that is commonly overlooked by performance management. In essence, performance measures for financial and non-financial aspects fail to take into account theories organizational behavior, which is a major source of conflict in the implementation of NPM. Another source of conflict is that of the profession. The healthcare industry comprises a group of people with specialized expertise such as physicians, nurses, and laboratory technicians. People working in strong professions are normally resistant to changes and prefer the laissez-faire approach to management (Spath, 2013).

The implementation of NPM in various countries across Europe faced a high level of resistance from physicians owing to the perception that it would result in a power shift from physicians to the management. Secondly, physicians resisted the change because

performance management tends to assume their fundamental role as physicians. Basically, physicians feel that the main focus should be on qualitative results as opposed to quantitative. Thirdly, taking Denmark as a case study, research indicates that the implementation of NPM and the use of economic measurements as part of the NPM model shifted the focus from quality to financial performance, thereby challenging the fundamental philosophy of physicians since the professionals' basic objective is qualitative in nature as opposed to quantitative. Additionally, the health profession tends to value collective rewards that have a positive impact on the learning organizations in comparison to financial rewards (Ramesh, 2009).

Furthermore, healthcare professionals were not zealous in using the performance measures but only did so for compliance purposes and to fulfill their core objectives. In essence, the health practitioners used performance measures as a matter of obligation and legitimization. They strived to have a chance to work on their core objectives, which is to provide quality patient care. Therefore, although the NPM approach is well intended, especially due to its focus on operational efficiency, its application in the public health sector is problematic mainly because the performance indicators are not suitable for the field (Lægreid & Christensen, 2011). The diagnosis and treatment of health conditions and their outputs are highly complex. Therefore, the application of performance indicators is challenging.

Furthermore, owing to the level of competition in the private sector, it is rare to find two managers in the same industry collaborating, especially as far as their operations are concerned. However, in the public health sector, it is common practice for physicians to consult among themselves concerning complex medical cases to the extent of encouraging their clients to seek a second opinion from another professional (Walshe & Smith, 2011). Such practices are common because the main objective of physicians is to accomplish positive health outcomes for their patients and not necessarily to dominate the market and make more sales. Measures of performance should possibly be a combination of qualitative and quantitative methods that take into account the overall experiences of clients.

### **1.2. Decentralized management systems**

Aas (1997) defines decentralization as the delegation of power. This is in fact different from just delegating tasks to subordinates, power implies responsibility and the capacity to make decisions. Things like day-to-day budget handling, resource planning and personal hiring

can benefit from the knowledge of those who handle daily operations. Decentralization improves adaptation which in turn improves productivity. Those closer to the field have a better understanding of the day-to-day activities and can better respond to new challenges.

At higher levels, innovation requires input from different fields and having a centralized authority controlling the process may be beneficial to the endeavor. On the contrary, in a decentralized system there is no one making the connection between different thinkers and problems can surge due to unclear division of authority. It may also occur simply due to people wishing to fulfill personal ambitions, where some units will pursue goals that may not align with those of the organization.

Lack of organizational control and coordination are possible side effects of the decentralization process. To offset this, certain control mechanisms can be put in place: formulation of common goals, planning activities, budgeting, promotion of a common culture and information sharing. There's also the risk of competence deteriorating due to isolation. While top control can limit creativity, on the other hand the lack of forced interaction can lead some departments to isolate themselves. What was initially a measure taken to increase creative output by offering freedom, may end up backfiring.

According to Melumad, Mookherjee, & Reichelstein, (1992) when establishing responsibility centers, be them profit centers or cost centers, decisions should be delegated to that center's management to maximize the financial element being measured, especially during the transition period. A profit center may be preferable if the output level varies with the information held by agents in the division while a cost center may be preferable if the output is given exogenously, meaning that the target is set by an outside source, in this case the division only has control over the costs, vice-versa for the other.

As a response to loss of coordination a suitable compensation system can be constructed that will help align the division goals with those of the company. A division with a higher degree of freedom needs a higher detailed measure for each individual item, while a division that is constantly communicating with top management can be measured by the aggregated cost/profit. Because communication is limited it also plays a role in the decision to decentralize, and having people closer to the field able to make decisions can decrease those costs. Here the communication costs include not just the costs of transmission of messages,

but also time taken to write and read them. Technology reduces transmission costs, but composing and reading messages are still cognitive tasks requiring the human brain and the latter costs have not declined.

Decentralization has the advantage of putting the decision closer to where the work is performed, allowing the decision-making process to be much more efficient by reducing response time (Hammer, 1990). These measures also seem to improve working atmosphere and employees motivation. (Vera & Kuntz, 2007)

According to Alonso, Dessein, & Matouschek, (2008) division managers find themselves with an information advantage in terms of local knowledge due to their proximity with the field which makes them great for day-to-day planning. Nonetheless headquarters possesses a communication advantage and as a result work very well as aggregators and distributors of information. The key here is a balance in the trade-off between coordination and independence where the pros and cons of each will have to be evaluated. Coordination losses are lower in centralized systems and adaptation losses are lower in decentralized systems.

In decentralized systems dispersed information is better utilized, where people closer to the action have more control. On the other hand, in a centralized system some information might be lost when communicated to the decision maker, disrupting operations. When it comes to coordination decentralization has a disadvantage, a central authority will have a better time organizing between divisions, especially if the need for coordination is not to be fully internalized in a division (e.g. making decisions adapted to local conditions). The managers in one division might also not be aware of the decisions being made by managers in other divisions.

Under centralization, management will make the decision for both divisions, so the lack of coordination will be minimized. The authors also found that vertical communication is more efficient than horizontal communication. “Division managers share more information with an unbiased headquarters than they do with each other.(Alonso et al., 2008, p. 4)” Decentralization can still be an optimal strategy even if coordination is very important. If coordination starts becoming a bigger factor, the issue of communication disappears. The division managers will recognize their independence and work with each other to improve their own performance.

The hierarchical structure is a problem when designing accounting systems for hospitals due to their complex structure and the fact that patients often cross administrative boundaries when being treated which makes costs hard to distribute (Nyland & Pettersen, 2004). To help with that, it's possible to have a process-based design implemented in hospitals, where a company structure is designed to serve its purpose. Processes can be divided in core processes, which focus on strategic objectives that keep the company competitive, and support processes that target internal customers (Vera & Kuntz, 2007).

In fact, it seems that changes involving decentralized mechanisms can be done in the healthcare sector. These changes will occur by altering the general management of the hospitals or by making changes to the way financing or payment mechanisms occur (Fundação Calouste Gulbenkian, 2000). For hospitals with a centralized structure without decision making power inside the organization (i.e. residing in the state that makes the budgeting and financing decisions), the organizational reform starts by transferring that power to inside the organization. The next steps are to increase the level of autonomy the management inside the hospital has so that a system of financial accountability can start developing (Ferreira, 2004).

Management accounting change can be seen as a “change in organizational rules and routines”. Rules are harder to change and only do so at specific intervals, while routines may suffer change throughout the day-to-day activity. That is because rules are formalized procedures and routines are those procedures in effect (Burns & Scapens, 2000). It seems in fact that management accounting routines are institutionalized and taken for granted as part of the management process but they don't always follow the manual and more often than not deviate when applied (Macintosh & Scapens, 1990; Roberts & Scapens, 1985).

The purpose of measuring performance is to improve the service provided to the patient so we can raise general population health. So when implementing management tools, we need to see if this measure will work in that direction (Shawn, 2003). The performance indicators should offer more information than other financial reports, seeing as they are a good way to enforce accountability. Not only is this information used to make decisions (from activity planning to resource distribution), they serve as the base to measure how well a department/service/team is doing (Steeple & Medori, 2000).

### **1.3.Hospital management**

The medical professional has an elevated status in society, and historically has even been given the chance to operate differently from other businesses. Hospitals evolved in complexity over time, but that same status from old may have remained. While economic and financial issues have not been greatly taken into account, a culture of values has been present in hospitals since they first became a thing (Pollitt & Harrison, 1994; Smith, 1976). The increased emphasis on accounting that has been developing over time may have contributed to the elevation of economic practices. It has certainly contributed to a culture of rationality in organizations, where individuals have gained more control and responsibility on their operations, and this seems to be especially true in hospitals (Burns & Scapens, 2000; Roberts & Scapens, 1985).

If the medical personal holds a set of values and the administration another, conflict will often arise due to this clash of ideals. Bringing the medical personnel input into the other side can help solve this issue (Comerford & Abernethy, 1994). Hospital management differs greatly from that of other sectors. Information asymmetry, price irrelevance when predicting consumption and unpredictable and uncontrollable means of financing. Allied with the fact that management techniques often targeted to increase economic growth can't be applied as is, new systems have to molded to obtain long term success (Logarinho, 2012).

The differences in how the clinical and administrative side treat responsibility is also a factor in managing healthcare facilities. The clinical personnel puts a greater emphasis on professional morals and norms, while administrative responsibility is more centered on individual responsibility and adherence to rules. (Nyland & Pettersen, 2004) This approach is one of the reasons as to why implementing decentralized systems that give the clinical staff more freedom to act could lead to better performance outcomes than trying to impose a type of management nonconductive to how they perform. Macintosh & Scapens, (1990) found that managers spoke the accounting language to a great extent, even when detailing their activities, all while also possessing a great degree of financial literacy. It's not expected of every healthcare professional to have this same type of capacity.

High costs are seen as a given when talking about healthcare institutions, but it is necessary to understand why that is the case. Hospitals tend to perform a vast and diverse amount of

activities making them highly complex organizations. The employment of a large quantities of highly qualified labor is a factor that contributes to its high costs. Furthermore, hospitals also tend to use advanced technologies with large development periods that also contribute to the high costs (Quesado & Cardoso, 2017).

Young, (2014) talks about the four forces that affect healthcare costs in the industrialized world, from spending and morbidity patterns to the complexity of health care markets. As he describes, the first three forces apply pressure to the costs and the fourth limits the control mechanisms that can be put in place:

- Demographic Changes – As people grow older, the annual inpatient days per person increases, meaning that as people grow older, they tend to spend more time in the hospital. With advances in medical care and other fields, life expectancy has been increasing every year. If the trend continues, the number of inpatients will keep growing.
- Spending Patterns for the Elderly – Most of the spending is related to chronic conditions that tend to be more present in the elderly age bracket.
- Morbidity in the Nonelderly Population - many individuals still face high-cost medical conditions, such as cancer and heart disease, before reaching the later age brackets.
- Complexity of the Health Care Market – From the number of different players (patient, physician, hospitals, specialists, insurances, government, etc.) to the role each plays, all make the health care market a very complex system, as was also described previously. Even in countries where social security systems are implemented and the number of players is reduced, there is still a distinction between those who order the service, those who provide it and those who bear the cost.

Young then manages to reduce the number cost drivers for healthcare to five. Each of those drivers relate to one or more of the previously mentioned four forces: case mix, volume, resources per case, cost per resource unit and fixed costs. The drivers also have different factors affecting them and not all are controllable. Environmental factors and health habits can be adjusted but genetics leave little room for adjustment.



Demand uncertainty can also be an aspect in increased costs, as Almeida & Cima (2015) find, a higher demand uncertainty results in an increase in excess costs. Hospitals who face higher demand uncertainty have significantly higher costs. These come from managers not wanting to risk running out of capacity to satisfy the possible demand so they tend to build excess capacity, and in consequence sustain all the associated costs. Unfortunately demand is not always possible to be accounted for, especially in emergency services (Lynk, 1995).

Understanding how much something costs is relatively easy when the production is homogeneous. Unfortunately, that is not the case for hospitals as they offer different services that require different inputs. Even though there is disagreement about the veracity of full cost calculations they have its use. Nevertheless, full-cost information has its purposes. The full-cost of a product or service is useful when entering negotiations with private institutions like insurances and private hospitals. For example: a private hospital might be offering the same exams at lower prices than whatever cost a public hospital incurs, and at that point the state should negotiate to have patients redirected there. This type of decision is never possible if the full-cost of a product is unknown (Young, 2014).

A big part of hospital management is done through cost control, avoiding waste and good budget control. To achieve this, hospital managers need more information about their costs. And while they do feel that necessity, this is a difficult task, in part due to how hard implementing a system to achieve that is. Either due to lack of knowledge, certainty, strategy or sometimes professionals capable of tackling such a big task. A detailed cost accounting system would help the organization obtain a better knowledge of their activities across departments, especially given how vast and complex they tend to be. This in turn would likely result in better performance measure and planning (Quesado & Cardoso, 2017).

Clinical decisions are not only done to improve healthcare, there is a large link to the financial side which creates a tight relationship between the two worlds, clinical and administrative. It is necessary that health professionals work alongside those responsible for the administrative and managerial side of the operations to coordinate and evaluate decisions made to the processes and structure of the hospital. Through this it's possible to achieve an equilibrium between economic sustainability of resources used and the services provided. One of the biggest challenges hospitals face is in reconciling sustainable costs with the quality of services provided, the use of high-level technology increases the quality of the

service but also the cost. Reconciling this can be a potential conflict between management and clinical staff. Decentralization policies that distribute decision-making power increase responsibility. This type of governance creates a scenario where there's a need for accountability from all parts. Intermediate management structures, like responsibility centers help bridge the gap between the clinical side and the managerial side, which may increase productivity and help reduce costs and resource waste. (Logarinho, 2012)

The World Health Organization (2010) reported that the determining factors of a hospital organizational structure are found to be autonomy, accountability, social function and market exposure.

- Autonomy helps obtain better control over resource input, activity output, financial and administrative management and in coordinating market strategies.
- Accountability goes hand-in-hand with the increased level of autonomy. Tools to measure and monitor the performance of those responsible as well as financial incentives are necessary to make it work.
- Governments bailing out hospitals that have deficits, will incentivize bad performance and management. The more a revenue from a hospital is obtained from direct market exposure in a competitive way the higher its level of efficiency.
- Hospitals serve certain social functions that have a negative impact on the financial side, like providing care for people of every social-economic strata. Any changes in the organizational or managerial structure need to account for this need and make sure they keep serving the hospital values.

Congruence between a set of well-established objectives, the organizational structure and system of incentives are important to make this type of reform work. Goals give focus, a well-designed structure helps achieve those goals and the incentives help achieve coordination.

Responsible planning and management of resources is crucial to achieve better performance in health care systems. This responsibility falls on the government, to recognize and allocate people best suited to deal with the many different issues. Another important factor is that of being able to identify challenges ahead of time and the best way to deal with them and for

this, information is crucial. A better understanding of local and national risk factors leads to prevention, reduced demand uncertainty while helping maintain coordination in decentralized authority systems. The goal is a balance between control and independence in order to maintain motivation. Here textbook answers don't apply, instead a local solution needs to be found. "The role of stewardship in systems with a great deal of decentralized spending authority is to set the rules, rather than to adjudicate every decision." (WHO, 2000, p. 138)

#### **1.4.Transfer pricing**

"There is possibly no single accounting topic that consumes more management time and energy in multi-profit center companies than the business of establishing acceptable transfer prices. The expenditure of energy in this division far exceeds that expended on pricing products sold to outside customers" (Thomas quoted by Schuster, 2015, p. 45).

Schuster (2015) describes transfer pricing as the internal price used by independent divisions of a company when transacting with each other. For it to work, a decentralized organization with managers responsible for the performance of each division needs to be present. It can work alongside other performance measures like budgeting systems and profit measures. Divisional managers need to have the autonomy to run each center and in doing so they tend to maximize profits/reduce costs, depending on the performance measure of the profit/cost center.

This idea seems to fit healthcare operations in theory. Because the activities have a very technical component, a big part of the management should be done at the local level, close to where the action occurs, as only those involved directly can know the quantity and quality of the resources used (Logarinho, 2012). Transfer prices can be used to control managers during product development. It's hard for overhead management to intervene in the process because they often lack the knowledge that the involved division/management has. But by charging an overhead cost when the true cost is exceeded, they can direct the developer to be more efficient.

According to Kuntz & Vera (2005) a transfer price can be defined as the price of goods or services transferred among organizational units within the same firm. A system of transfer pricing becomes important when the organization is decentralized, each department has decision making power and financial performance is measured individually. The authors

consider that a transfer pricing system can be implemented in almost any hospital department. The company/department strategic and organizational “circumstances” shape the decision regarding which transfer pricing method is to be applied. (Spicer, 1992)

One thing to pay attention to is that transfer prices are the revenue of the supplying division while being the cost of the buying division. The profit contribution of each division becomes visible and if profit becomes a performance indicator it measures divisional success, but multiple success components can be in play and spread out through various divisions. A division might be performing badly according to the measure while being necessary if it produces an intermediary product to the next division who is successful. If one division is eliminated it might destroy the synergistic effects in play (Schuster, 2015).

#### 1.4.1. Market based transfer price

Market based transfer pricing is the theoretical preferred method. For this to work certain conditions should be met:

- The presence of an external market. This condition is often not fulfilled, and while approximations are possible, there’s never the possibility to replace the internal product without major adjustments to the production process.
- The order amount should not affect price, otherwise the play between divisions is not possible.
- The price should not be influenced by short-term decisions like cutting price to obtain a business relationship.

The better these conditions are met the “stronger” the transfer pricing system will be. A market base price is also harder to be manipulated by different divisional managers when asymmetrical information exists. This system also demonstrates the long-term profitability of a division, meaning if over a long period of time a division cannot earn a profit maybe it shouldn’t exist. A modified market price is also often considered where the costs associated with the use of the external market (sales, shipping, marketing, interest) are deduced and internal transportation costs added, corresponding to a marginal price of supply divisions.

#### 1.4.2. Cost-based transfer price

A cost-based transfer price is the method most often applied in practice. Here the price can be based on the actual cost or the standard cost. One way to solve this is to look at capacity variance, i.e. what division causes capacity variations. If the buying division decides the amount of the product or service and the supplying division has to fulfill that internal demand, the capacity variance is on the buying division and the transfer price should be based on actual costs. On the other hand, if the supplying division decides on the amount, the capacity variance is on them and the transfer price should be based on standard costs.

With standard costs the buying division can make adaptive decisions while knowing the price and that is not possible with actual costs because they are only available at the end. While settling standard costs the supplying division has an advantage because it has more information on the actual cost, head office can choose to settle the price but it will have to involve itself in the process defeating the point.

Another alternative is a marginal cost-based transfer price. This method is rarely used in practice because both sides can greatly manipulate the marginal price. For instance, the supplying division can manipulate the costs, especially if they produce more than one product, or if they have control over production capacity, since by limiting it they can increase price, because opportunity costs at limited capacity should be included in the transfer price. On the other hand, the buying division can overestimate their demand during budgeting phase to force the supplying division to have underutilized capacity. "Transfer prices based on marginal costs fulfil the coordination function for short-term decisions under certain circumstances; however, for the assessment of divisions, they are not suitable, because they typically discriminate the producing division."(Schuster, 2015, p. 61)

Lastly, there is the option of a full cost-based transfer price. The producing division is reimbursed (on average) in the amount of their total costs. They do not suffer a loss but they also do not achieve a profit. This reimbursement can be based on variable costs alone or include overhead costs. The full cost can also be limited to market price one exists. The inclusion of fixed costs suffers from the same problem seen previously, where both divisions have an incentive to influence it in order to gain an advantage. The full cost will also appear as a variable cost to the buying division even if fixed costs are included because they will increase or decrease by the transfer price for each unit, which can lead to incorrect or suboptimal decisions. This can also lead the organization cost accounting system to have a

distorted view of the cost composition, if the data provided by the buying division is distorted by that fact.

#### 1.4.3. Negotiated transfer price

Negotiated transfer prices result from the negotiation between divisions, but conflicts between managers may arise. For this to work divisions need to have the right to refuse internal business, otherwise negotiations would end with an arbitrary split of the profit. It should also be determined the level of negotiation for each transaction. If the volume of transactions is high an agreed upon set of principles expedites the process.

This system gives divisions a lot more autonomy, which carries both advantages and disadvantages. Independence often results in high motivation, and because both divisions possess more information about the situation, they could reach higher levels of efficiency. On the other hand, this could also lead to them making decisions that favor them at a cost for the company. Negotiations can also give rise to conflict between managers and are often very time consuming, and this is accentuated if the division managers don't have access to an external market.

#### **1.5. Time-Driven Activity Based Costing**

Cost accounting goal is to value all fixed and variable costs in the determination of the cost of products and services. Approaches such as activity-based costing (ABC) and time-driven activity-based costing can be used to achieve efficiency and cost reduction in its service delivery. The TDABC model is considered more efficient, and it accomplishes and addresses areas where ABC experiences limitations. It is an approach that considers estimated time taken in completing a task and then multiplying it with total work done and the hourly expenditure. TDABC is a cost mechanism metric that entails cost determination, and its application and benefits to the health sector are significant (Kaplan & Anderson, 2003). Below is a theoretical framework.

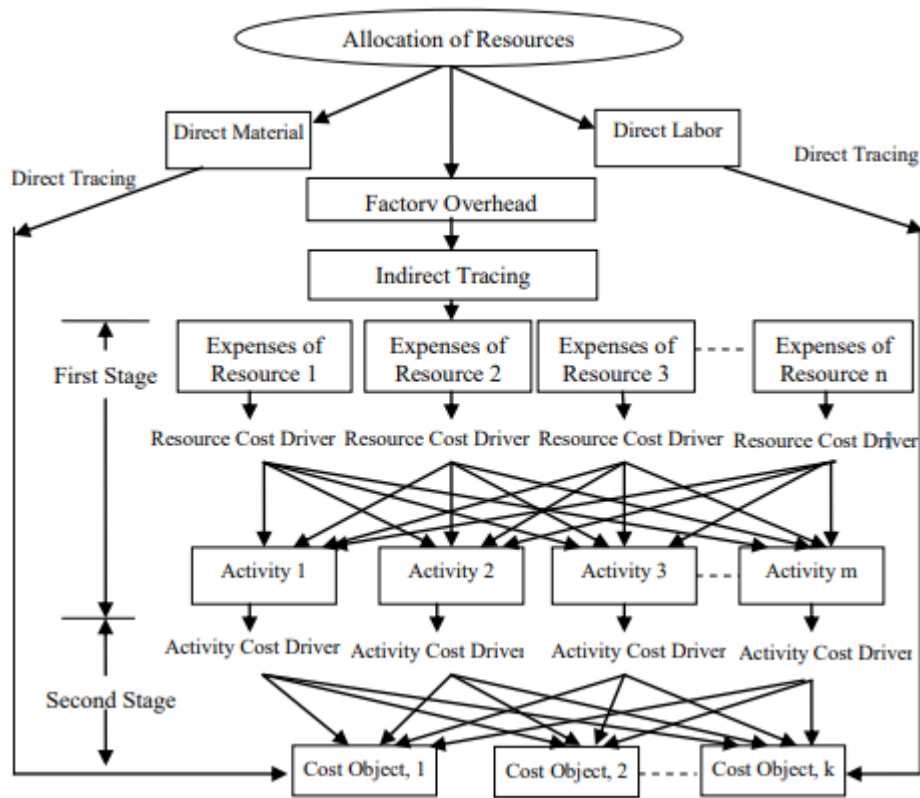


Figure 1 - TDABC theoretical framework

Source: Namazi, 2016, p. 460

TDABC plays a crucial role in simplifying the costs of transactions or activities in a company. This costing method uses time as its driver and the frequency of performance of an event as an allocator of resources to various cost centers. TDABC formulates diverse time equations that reflect time consumption of activities. Hence, it accounts for time exerted to accomplish an event of transaction in the formula (Namazi, 2016).

The methodology is easy to use since it simplifies the complex processes involved. Equivalences are the reason it is considered simple because it takes into account time as its only driver. It also does not require conducting frequent surveys when identifying work time distribution within activities. Time standards are used, which makes TDABC maintenance effective and straightforward. They eliminate the complex operations through use of time equations in determining the number of resources utilized in every resource group (Kaplan & Anderson, 2007).

While TDABC is simpler and less costly to implement than the ABC methodology, it still presents some limitations that affect its accuracy and usage. This approach is indifferent to

whether actual or standard costs are used in the determination of the unit amount of resource groups. It requires that time consumption and average cost pool consumption must remain proportionate to achieve correct results. This condition makes the model rigorous to maintain and update, since any change requires an update. Lastly, it is difficult to accurately measure time in a time-based model. For example: time in minutes results in significant overestimation of time spent when staff is requested to estimate the duration they take while completing various tasks (Gervais, Levant, & Ducrocq, 2010).

TDABC in a health care setting helps ensure that payment is equitable to the service provided at least on a time basis. The metric makes computation possible since time spent in each process is known and can be applied to determine actual cost per minute in every step. Apart from simplifying activity costs, TDABC presents considerable merits when applied in resource allocation (Demeere, Stouthuysen, & Roodhooft, 2009). Kaplan & Porter, (2011) describe a series of steps managers can take to implement TDABC:

1. Selection of a medical condition. When selecting, a manager should consider the beginning and end of the care period. For chronic diseases the duration of a care cycle is chosen.
2. Definition of the care delivery value chain. Care providers chart all activities in a care cycle for a given condition. This is the starting point to mapping out the processes that constitute each activity.
3. Development of process maps. A detailed plan is developed for a patient through timing them and recording all utilized resources. Early sessions can sometimes already identify prospects for improvement.
4. Obtaining time estimates. Approximate time details are formulated after the construction of a process map. Standard time should be used for short processes and actual times should be used for long, unpredictable procedures that involve multiple physicians.
5. Estimation of costs of supplying patient care. Direct costs can be gathered from the ledger or budget and include salaries, depreciation of equipment, supplies and other operation expenses. Indirect costs should be distributed on a time consumption basis.
6. Calculation of capacity cost rate. The amount of a resource is divided by the duration the



resource is consumed. For instance, a doctor's remuneration is divided by the period the doctor spends offering care. For a piece of equipment, its cost is divided by either the use time or the number of tests.

7. Calculation of the total cost of patient care. It is the final stage, and the total cost can be calculated. The unit cost is multiplied by the capacity cost rate to obtain the personnel's consultation. The total cost of equipment, space, and staff are aggregated to get total patient care costs. The value can be compared to reimbursement to identify whether there is a positive margin in delivery of a service.

The authors also point out that this approach bridges the gap between clinical and management teams discussed in an earlier chapter by building a common information platform built on the understanding and sharing of the information about the procedures.

## **II – Blockchain and smart contracts**

Blockchain was first introduced with the creation of Bitcoin, a peer-to-peer electronic cash system as a way to solve the double spending problem (Nakamoto, 2009). Each transaction includes the hash of the previous one strengthening the ones before it. This is also where the name “blockchain” derives. To transact an address needs to be created and with it a pair of public and private keys. These keys are a set of alphanumeric characters that allow users to secure their content. The private key works like a password and is what allows the user to access and execute transactions in the blockchain.

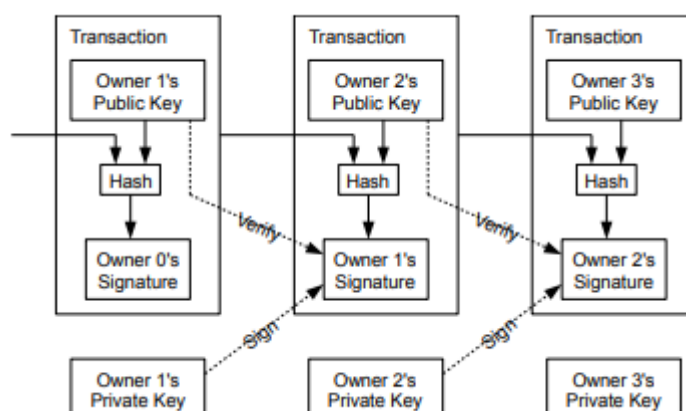


Figure 2 - Blockchain hash signature

Source: Nakamoto, 2009

Millard (2018) says that due to the unorthodox way in which blockchain was developed, it's hard to pin a decisive definition of what a blockchain is. He considers the technology to be a system that uses cryptography to record data with shared copies of the ledger maintained via an agreed upon consensus mechanism. Savelyev (2018) offers a concise definition based on definite characteristics: blockchains are digital ledgers that offer transparency, redundancy, immutability and disintermediation. Blockchains can record the information about the ownership of a specific asset, about who bought a particular product or service, who sold it and even about who has the right to make a decision, working as an evolution of the previous role ledgers fulfilled (Felin & Lakhani, 2018; Soto, 2017).

Because blockchains are distributed, the system where a blockchain operates runs on several computers controlled by individuals or organizations. Kamel Boulos, Wil-son, & Clauson (2018) explain that to validate the information there are consensus protocols built on the

system to find agreement among all the participants. The two most common type of consensus protocol are Proof-of-Work (PoW) and Proof-of-Stake (PoS).

According to Savelyev (Savelyev, 2018) in PoW, a miner (a node on the network) competes with others on the network to validate transactions by solving a complex mathematical formula and, if successful, in return receives a compensation in the form of new created coins and a fee paid by the users who sent the transaction. This is also the process by which new coins are created. It is necessary to understand that the transactions validated by the miners are grouped in what's called blocks, and what users validate is that aggregate of transactions. In PoS nodes mine a percentage of the transaction according to the ownership stake of the coins of each node (Wang & Kogan, 2018).

Over time blockchains started to be used for more than simple peer-to-peer transactions, with one case being smart contracts. Smart contracts were a concept introduced by Nick Szabo in 1994 long before the blockchain. "A smart contract is a computerized transaction protocol that executes the terms of a contract." (Szabo, 1994, p. 1). In other words, a smart contract is a program that will automatically fulfill the obligations present. With sufficient technological progress, day-to-day contractual clauses can be transferred to a smart contract system.

When combined with blockchain technology it's possible to automate complex processes in a robust, distributed peer-to-peer system with no need for intermediary actors. Nowadays there are multiple blockchain systems that already operate with smart contracts. Although smart contracts are possible in the Bitcoin blockchain, they are more commonly used with blockchains that support high level languages like Solidity on the Ethereum blockchain (Luu, Chu, Olickel, Saxena, & Hobor, 2016).

In a blockchain, smart contracts are stored in an address and trigger once a transaction is sent to it. Once this happens the smart contract will execute the clauses previously defined autonomously. As such they can be extremely useful in managing interactions between different participants of the network (Christidis & Devetsikiotis, 2016).

### **III- Methodology**

### 3.1. The overall project

As mentioned before, Imaging Services, like X-ray, Computed Tomography and Magnetic Resonance Imaging, are one of the main internal markets of Portuguese NHS. Public healthcare has several organizational structures providing these kinds of health service but each one is managed by its own institution. This can create scenarios where the NHS is buying an imaging service to a private entity while having a hospital located nearby with over capacity. So, it is important to optimize the capacity of NHS and increase the efficiency of resources used. To do that, we propose the creation of an internal market of Imaging Services where each public hospital can offer its services to other public hospital or family doctors. This system will be created on a blockchain that supports smart contracts.

In this blockchain, each hospital would offer its services at a given price, permanently updated. On the other side, public hospitals and family doctors would introduce orders of Imaging Services for a certain patient. Then a smart contract will match the supply and demand and create a transaction between the two organizations. Figure 3 summarizes the model we propose:

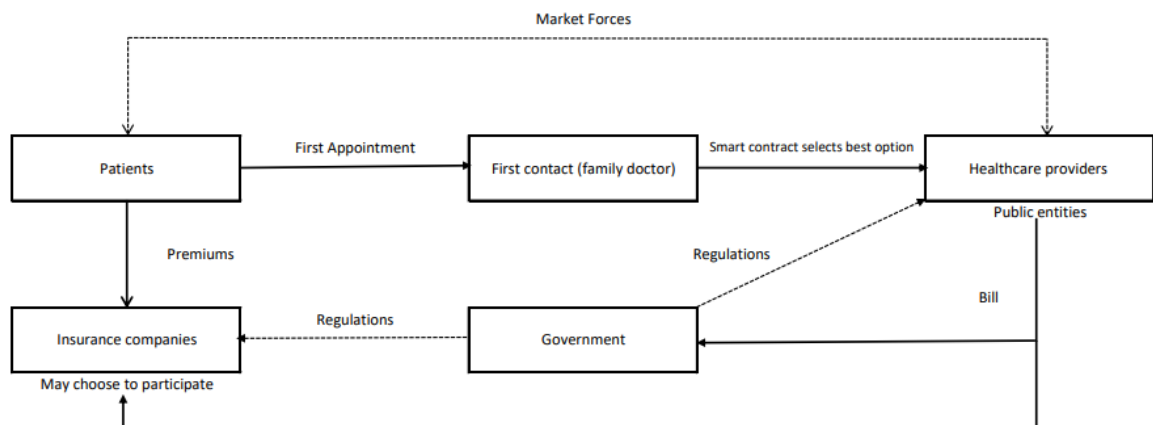


Figure 3 - Blockchain and smart contract design for imaging services within the NHS

To make it work in an efficient way, NHS should define free transfer prices for that service exchange within NHS. However, if hospitals want to optimize their resources, then they need to know their cost structures and its opportunity cost. For this it's better if hospitals use a bottom up cost accounting approach.

Recent literature on cost accounting in hospitals reveals TDABC as an appropriated model for hospital costing. All these solutions should be designed in an integrated way.

A smart contract could schedule medical exams based on the availability and cost at the time of the procedure. The automated system would save administrative costs, facilitated by blockchain's immutability, data protection and tamper detection properties. Other benefits would include the ease of transaction, auditing and cost saving for the state as a result of increased efficiency.

### **3.2. Phase one: literature review**

Our work intends to bridge two main technical issues that are typically from different knowledge schools: TDABC and Blockchain. So, we elected these two main topics as our focus in phase one. The overall project will certainly be failed if the accounting system that supports agents' decisions don't promote rational thought with impact on profitability and efficiency. On the other hand, the blockchain has to be functional and secure. So, for that phase of our research, the main research questions are:

Is TDABC the best cost accounting model for Imaging Services in public healthcare services?

What is the blockchain and what kind of opportunities can this create for business?

To answer these questions, we conduct a systematic literature review on each topic.

A systematic literature review is a research methodology that originates in the medical sciences, unsurprisingly due to the necessity to compile and gather all the evidence due to the increase emphasis on evidence-based medicine (Guyatt et al., 1992). This methodology gained traction in the social sciences with the increase number of publications due to technology advancements but it requires certain adaptations. While it's much harder to do a meta-analysis, it still gives the ability to gather a vast amount of knowledge and information about a given subject.

Following Kitchenham et al., (2009) method, in the first phase of the study we define a number of questions that we want answered with the literature review. After that, on the second phase, a protocol is defined to help evaluate which studies are relevant to the research. The last step involves the process of answering the initial questions based on the papers collected.

### **3.3. Phase two: action research**

As we mentioned before, the overall project will fail if the accounting system fails in its

aim to support the best decision making for each hospital. This is only possible if hospitals create a bottom-up cost accounting system. To do so, action research is the best methodologic approach because it crosses scientific knowledge with the knowledge of a particular reality. Indeed, the importance of empirical research in the fields of accounting has been demonstrated, and doing so “is adopting a perspective on theory, methodology and change” (Laughlin, 1995, p. 85).

Lewin (1946) was the first to define and establish the core principles of action research in the 1940s. He considered this methodological approach able to solve concrete problems that affected the social world while also contributing to the development of social theory. For Rapoport (1970), action research is able to both help solve practical definitive concerns of people while still furthering the goals of social science. Susman & Evered (1978) contribute a third goal, helping those dealing with the problem develop aptitudes to deal with it in the future.

The authors describe action research as a cyclical process with five phases:

Diagnosing – Identifying or defining a problem

Action planning – Considering alternative courses of action for solving a problem

Action taking – Selecting a course of action

Evaluating – Studying consequences of an action

Specifying learning – Identifying general findings

On the subject of action-research, Kaplan (1998) describes a process that starts with ideas formulated from practice that are then spread with researchers action as facilitators. So, during the cost measurement process we intend to apply and test the seven steps proposed by Kaplan & Porter (2011) in its pilot for estimating the total costs of treating a patient.

- Select the medical condition and/or patient population to be examined
- Define the care delivery value chain
- Develop process maps of each activity in patient care delivery; identify the resources involved and any supplies used for the patient at each process
- Obtain time estimates for each process step
- Estimate the cost of supplying each patient care resource



- Estimate the practical capacity of each resource provider, and calculate the capacity cost rate
- Compute the total costs over each patient's cycle of care

### **3.4. Phase three: design research**

Once each hospital has a cost accounting system to support decisions on at which price it is available to supply Imaging Services, the blockchain architecture needs to be studied. Key questions that need to be answered:

1. What is the best type of blockchain? (public, private or consortium)
2. How are transactions confirmed?
3. Who can own the nodes?
4. How are the smart contracts regulated?

To answer these questions, we have to develop and test the solution we propose. In this case, design research is the methodologic approach.

According to March & Smith, (1995) the main purpose of design research is to create artifacts capable of serving humans, with a focus towards technology. Hevner et al., (2004) consider it a rigorous process that generates artifacts, capable of solving problems, evaluate projects and produce results. Vaishnavi & Kuechler, (2004) define design research as a collection of techniques used to further studies in information systems. According to Manson, (2006) design research is a process that utilizes knowledge to create useful artifacts capable of being assessed through current methods and techniques, further advancing knowledge. Çağdaş & Stubkjær, (2011) consider design research a process used to create artifacts capable of solving problems, evaluate designs and share results. Anderson & Shattuck (2012) define design research as a methodology where the educational context validates correct research assures that results are ready to be used. Lacerda, Dresch, Proença, & Antunes Júnior (2012) consider knowledge developed through design research as prescriptive, meaning that the method suggests the artifact utility.

Design research is thus presented as a model to analyze and develop research projects. Wieringa (2009) presents a series of 5 steps: (1) problem investigation – in this step, contact with the problem occurs for the first time, this is where goals are defined; (2)

solution design, in this step we start to search for solutions; (3) design validation – where the artifact is created, we can look for outsider opinion in order to validate the desired effect of the design; (4) solution implementation – step where the design is implemented with the goal of solving the initial problem; and lastly (5) implementation evaluation - step where the solution is validated and where the impact of the proposed solution is evaluated. During this evaluation, the cycle may begin again if the problem persists or a new one is born.



*Figure 4 - Design research cycle*

Source: Wieringa, (2009)

## **IV – Systematic literature review on blockchain**

The initial group of questions were:

1. What are advantages and disadvantages of the technology?
2. What are current interests in research surrounding this technology?
3. Will existing business models benefit or be hurt by blockchain?

From that, 146 journals were selected from the “SCImago Journal & Country Rank” portal, from which papers would be extracted. The selection was made with the following criteria:

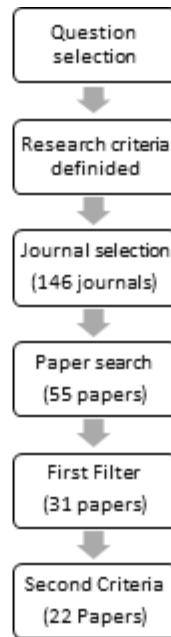
- All subject categories: Business, Management and Accounting;
- Rank indicator: Q1-Q2.

The reason for this choice was to circumvent the search tools presented by b-on, where the paper search was conducted. SCImago rankings offer a way to filter for quality not presented in the final database, from where the papers were extracted.

The search for articles was conducted in the Online Knowledge Library “b-on”, with the following string: “TX All Text: “blockchain” and ISSN: “the number corresponding to each journal””. The literature search was carried out between 29/10/2018 and 06/11/2018.

During the search, papers that did not meet the following parameters were immediately excluded:

- The paper is not in English.
- The paper is not available for viewing.

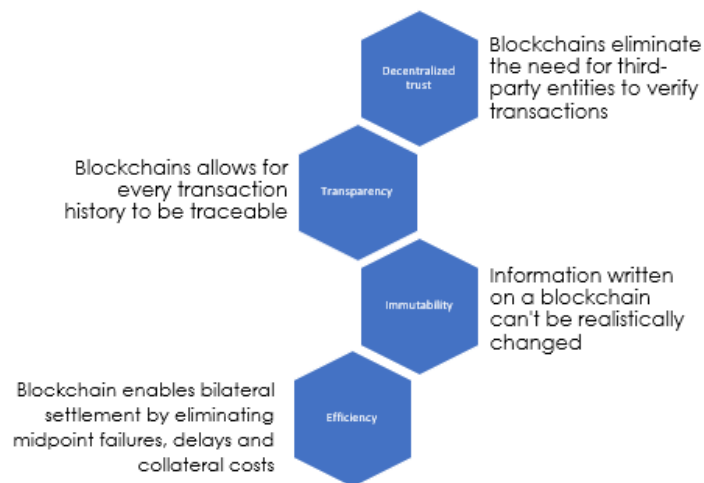


*Figure 5 - Steps Followed in the systematic review*

#### **4.1. What are the advantages and disadvantages of the technology?**

Soto (2017) considers property ledgers to be one of the most important factors in the development of civilizations and the consensus mechanisms found in blockchains, talked about in the previous chapter, provide a step forward for new developments. The difference between countries and civilizations who have harnessed ledgers in the past, versus those who didn't is highlighted and it opens speculation to what block-chains can do. Places like Africa can bypass the lack of infrastructure necessary for old business models and instead take advantage of new digital mediums that require less infrastructure due to their decentralized nature, with blockchain being one of them but not the only (Bounfour, 2018; Hain & Jurowetzki, 2018).

The biggest advantages mentioned in the papers are related to the elimination of intermediaries, data reliability, trust and transparency. The permanent keeping of transactions without the need of third-party entities, allows for faster transactions at a reduced cost (Seidel, 2018). The most prominent example presented are banks, but since blockchain technology can be used in the transfer of all sorts of information it doesn't seem to stop there, with applications in the health sector and supply chain management (Kearney, Harrington, & Kelliher, 2018). Figure 6 presents the main advantages of the blockchain architecture.



*Figure 6 - Blockchain advantages*

Dierksmeier & Seele (2018) make the case that privacy and anonymity can be both a positive and a negative when it comes to decentralized data, depending on the practices applied. This is illustrated through a list of pros and cons associated with cryptocurrencies, which are currently the biggest application of blockchain technology. This are as such:

Pros:

- Low cost of transfer;
- Low barrier of entry – in many cases only requiring internet access and phone;
- Censorship resistance – no one can be denied access based on their personal entity;
- No infrastructure or documentation needed – could be very advantageous for developing nations.

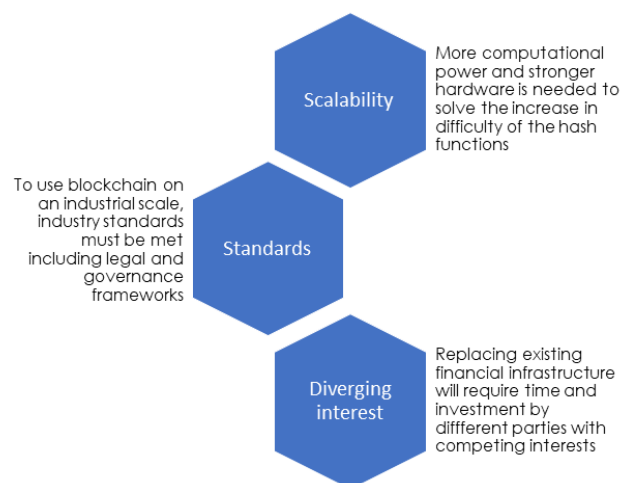
Cons:

- Allows the ease of transactions in the dark web;
- No deposit insurance – because there is no entity keeping track of your money, if you lose access to the account for some reason, you lose the money;
- High volatility – this can be dangerous from both an investment and a currency point of view.

With that said, an interesting idea modeled by Hendrickson (Hendrickson, Hogan, & Luther, 2015) is that a bitcoin ban is not sufficient to discourage its use. The model presented shows that users who prefer bitcoin simply exclude those that favor other type

of currency, making it a close system difficult to track.

One of the biggest disadvantages pointed out in the papers, has to do with the network distribution. To truly be decentralized and trustworthy a blockchain network needs to have many participants, not only so that it can keep functioning in case of attacks, but to also create trust between the participants and avoid a 51% attack (Hendrickson et al., 2015). There are other issues that bring to question the capacity for the technology as a long-term solution for maintaining trust over digital records (Bounfour, 2018; Lemieux, 2015; Millard, 2018). This is due to the possibility of having unreliable or inauthentic outside information anchored to the blockchain, which makes it hard if not impossible to verify. Radziwill (2018) also questions if the technology is ready to be implemented, with issues like network distribution, scalability and energy consumption present in its current state. Figure 7 presents the main barriers of the blockchain architecture.



*Figure 7 - Blockchain barriers*

#### **4.2. What are the current interests in research surrounding this technology?**

Fraud prevention like in the case of insurance claims is an example of the advantages in trust and auditability provided by the technology (Eling & Lehmann, 2018; Kamel Boulos et al., 2018). Despite the fact that the first blockchain applications were in cryptocurrencies, which are financial in nature, the technology can be applied to the transfer of any digital asset. Wang & Kogan (2018) take this further with the tokenization of real-world assets and resources (e.g. finished goods, raw materials, labor, etc.) in its blockchain model for accounting.

Kamel Boulos et al (2018) present a case for blockchain application in the health industry, acting on clinical data sharing, as a way to secure patient and provider identities as a way to optimize management, to run clinical trials, for public health surveillance and medical records management. The concept of monetization is also discussed, because due to patients now having control over their data it allows users to directly sell this information. Seidel (2018) presents the same concept when applied to other industries. An example of that is social media. From the moment users are in control of their data, they can now sell it directly to advertisers if they wish to do so.

O’Leary (2017) looks at the differences between different types of blockchain architecture when applied to accounting, auditing and supply chains. Blockchains can be either private or public depending on the needs of the business. Public blockchains like bitcoin allow for anyone to participate, while a private blockchains could be used in a consortium of companies like banks in order to mediate transactions between themselves. The level of information available can also be adjusted depending on what’s deemed necessary (D. E. O’Leary, 2018). There are a number of reasons as to why enterprises would not be willing to participate in open transactions with a blockchains:

Wash trading- which involves the act of an entity generating transactions with itself in order to create the illusion of market movement.

Spoofing – is the creation of false information to obtain some sort of advantage.

Off-chain transactions – blockchain only guarantees the integrity of registered information, transactions that occur outside the blockchain cannot be validated.

There are also blockchain models for accounting which would allow for continuous monitoring and fraud prevention (Wang & Kogan, 2018). This would be done through the tokenization of real-world assets and resources (e.g. finished goods, raw materials, labor, etc). The real-world transaction would be accompanied by a token in a blockchain and he would receive the token representing the cash in return. Due to the ledger nature of the blockchain, it stays registered forever. The data is always available and is distributed through all the participants. Fraud becomes more difficult in financial statements due to permanence of records.

#### **4.3. Will existing business models benefit or be hurt by blockchain?**

Blockchain technology can impact companies like UBER and Facebook. Users can own



their own data and sell it directly to advertisers instead of having companies do it for them. Or in the case of Uber, the company now acts as an intermediary between the driver and the customer, but a decentralized ledger with smart contracts can do the same thing. The same is true for stock brokers and some roles financial banks play, like custody (Akdere & Benli, 2018). Another example is the energy industry, where some users produce solar energy and instead of selling it directly to the energy company, they can sell it directly to other people on an open market (Seidel, 2018).

There is also the potential for decentralized autonomous organizations. “The DAO”, was one of these types of organization that failed due to a hack that stole \$50 million from the company. And although no new attempts at such an endeavor have been made since, it brings attention to the fact that technology limitations that caused the situation can be solved in the future and so this new type of organization needs to be studied.

Blockchain may also provide new ways of fund raising. Initial Coin Offerings (ICOs), which are a way of raising capital similar to Initial Public Offerings (IPOs), involve the transfer of a token in exchange for money. This form of capital raising allows the avoidance of third-party entities such as crowdfunding platforms and payment agents like banks (Giudici, Adhami, & Martinazzi, 2018).

Current methods of fundraising are very inefficient and localized when compared to ICOs, as the project has to be presented to many different individuals until one decides to invest while ICOs are almost global. There are some downsides, as ICOs can be tax inefficient if the amount raised is treated as revenue and it also has high risk, due to many projects not surviving the hardship of the early stages. They also face regulatory uncertainty. There are different approaches being made. For example, the USA is creating stricter regulations while other countries like Switzerland and Singapore are friendlier towards this type of crowdfunding (Chen, 2018).

Real estate crowdfunding has been gaining traction as a way for real estate developers to fund their projects in ways similar to those of the ICOs, by pooling small amounts of capital from a big group of investors (Montgomery, Squires, & Syed, 2018). This directly competes with traditional financing institutions, and the inclusion of a token in a blockchain could be a logical step in this process, due to all the benefits it provides.

Intellectual property will also be able to be tracked through blockchain (Felin & Lakhani, 2018). With blockchain it is possible to track and account for the contribution of each

member in a project. For example, in a team of coders developing a new software, each time a new member uploads a new piece of content to the network it is tracked and with the help of smart contracts he can receive a token that has some monetary value in exchange.

For this to happen a metric of value needs to be created but it may not be possible to apply in every scenario, because it could be hard to measure the value of any given contribution. The other issue has to do with the size of the data, which would be enormous and only technological innovation beyond what is currently available would solve this (Gurkaynak, Yılmaz, Yeşilaltay, & Bengi, 2018).

In short, some industries seem to benefit more from the technology (healthcare and those that depend on supply-chains like physical retail stores), while others may suffer a blow (banks, energy and other service providers).

## **V- Systematic literature review on TD-ABC**

Our research question was the following: Is TDABC a viable alternative to the other costing methodologies in healthcare?

Our intent was in finding if TDABC could outperform other costing methods, what its limitations might be when implemented in healthcare and how viable is its implementation. Following that a search was conducted to gather papers. The papers then went through three filters in order to eliminate those that do not apply. They are first selected based on the title. Following that those that remain are filtered after reading the abstract and finally the whole paper.

The data was gathered on August 15<sup>th</sup> by one researcher on the SCOPUS and Web of science platforms. The research was conducted using the following strings:

Scopus: (TITLE-ABS-KEY(hospital) and (TITLE-ABS-KEY("TD ABC") or TITLE-ABS-KEY("time driven ABC") or TITLE-ABS-KEY(time driven activity based costing)) AND ( LIMIT-TO ( DOCTYPE,"ar" ) ) )

Web of Science: TS=hospital and (TS="time driven ABC" or TS="TD ABC" or TS="time driven activity based costing"), Refined by: DOCUMENT TYPES: ( ARTICLE ), Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC Timespan=All years

We looked for mentions of TDABC in hospital settings on indexed papers with no restriction on the timespan. The initial search retrieved 87 papers on Scopus and 55 on Web of Science. Table 1 below summarizes the results of the data gathering.

Data bases	Scopus	Web of Science	Total without overlap
Initial gathering	87	55	
After first filter (Title)	50	36	
After second filter (abstract)	23	18	
After third filter	19	16	22

(Full paper)			
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*Table 1- Data gathering summary*

While reading the papers 1 was excluded because it was not in English and 2 were not available. The other 3 exclusions were because the papers did not answer the research question. During the application of the first two filters if it was not clear whether a paper should proceed to the next selection stage or not it would be included.

A big difference between the results after the first and second filter can be seen. This is because a lot of the papers happen to include a mention to TDABC on the title but the conclusion did not pertain to the costing methodology. Instead, the focus was on a specific treatment or procedure and it was merely being used as a tool for times and costs. While there's something to be said about the methodology usefulness in this type of application we do not consider this to be in line with our research purpose.

We chose to focus our discussion on three different topics: "Goals", "Conclusions" and "Research recommendations". We believe these points encapsulate the essence of the paper and give a good enough idea of the problems and benefits achieved. Furthermore, when all papers are collectively analyzed it allows us to get a better idea of the trends and problems in the field. A short summary of all three for each paper can be found on tables 1-3.

### 5.1. Research Goals

Year	Author	Goals
2009	Demeere, Nathalie; Stouthuysen, Kristof; Roodhooft, Filip	Explain the development, relevance and managerial impact of TDABC in an outpatient clinic environment and improve the understanding of the relevant cost drivers and accurate cost information on which to base strategic, pricing and management decisions.
2013	Oeker, Figen; Oezyapici, Hasan	Study the efficiency of TDABC and display how it can be applied in a health care institution.

2014	Campanale, Cristina; Cinquini, Lino; Tenucci, Andrea	Evaluate the potential of accounting tools to support transparency and resource allocation in public hospitals, by describing the implementation of TDABC.
2015	Balakrishnan, Karthik; Goico, Brian; Arjmand, Ellis M.	Demonstrate the versatility of TDABC and use it to define areas of unused capacity.
2015	Inverso, G., Lappi, M.D., Flath-Sporn, S.J., Heald, R., Kim, D.C., Meara, J.G.	Use TDABC to evaluate the high-volume, low-complexity diagnosis of a treatment to identify ways to increase value and decrease patient visit-time.
2015	Kaplan, A.L., Agarwal, N., Setlur, N.P., Tan, H.J., Niedzwiecki, D., McLaughlin, N., Burke, M.A., Steinberg, K., Chamie, K., Saigal, C.S.	Use TDABC to study and understand the costing of a treatment in order to identify areas of improvement.
2015	Chen, Alvin; Sabharwal, Sanjeev; Akhtar, Kashif; Makaram, Navnit; Gupte, Chinmay M.	Conduct a TDABC analysis of the clinical pathway for a medical procedure to determine where the major cost drivers lay.
2016	El Alaoui, Samir; Lindefors, Nils	Evaluate the cost-effectiveness of allowing psychologists to perform post-treatment assessment through TDABC.
2016	McBain, Ryan K.; Jerome, Gregory; Warsh, Jonathan; Browning, Micaela; Mistry, Bipin; Faure, Peterson Abnis I.; Pierre, Claire; Fang, Anna P.; Mugunga, Jean Claude; Rhatigan, Joseph; Leandre, Fernet; Kaplan, Robert	Understand the cost of healthcare delivery and study the advantages of TDABC through a case study in a network of hospitals in Haiti. Create a framework for policymakers to apply this approach in low-resource settings around the world.
2016	Akhavan, Sina; Ward, Lorraine; Bozic, Kevin J.	Compare the costs associated with 3 different procedures measured using TDABC versus traditional hospital accounting.
2016	Ilg, Annette M.; Laviana, Aaron A.; Kamrava, Mitchell; Veruttipong, Darlene; Steinberg, Michael; Park, Sang-June; Burke, Michael A.; Niedzwiecki, Douglas; Kupelian, Patrick A.; Saigal, Christopher	Use TDABC to determine the true cost of different treatment options and demonstrate opportunities for cost reduction.

2016	Yu, Yangyang R.; Abbas, Paulette I.; Smith, Carolyn M.; Carberry, Kathleen E.; Ren, Hui; Patel, Binita; Nuchtern, Jed G.; Lopez, Monica E.	Identify cost-reduction opportunities in a common procedure by applying TDABC methodology.
2016	Laviana, A.A., Ilg, A.M., Veruttipong, D., Tan, H.-J., Burke, M.A., Niedzwiecki, D.R., Kupelian, P.A., King, C.R., Steinberg, M.L., Kundavaram, C.R., Kamrava, M., Kaplan, A.L., Moriarity, A.K., Hsu, W., Margolis, D.J.A., Hu, J.C., Saigal, C.S.	Compare different treatment options of a low-risk cancer type using TDABC.
2017	Özyapici, H., Taniş, V.N.,	Study the differences between resource consumption accounting and TDABC systems in determining the costs of services of a healthcare setting.
2017	Yu, Yangyang R.; Abbas, Paulette I.; Smith, Carolyn M.; Carberry, Kathleen E.; Ren, Hui; Patel, Binita; Nuchtern, Jed G.; Lopez, Monica E.	Study how TDABC can be used to appraise healthcare interventions in a pediatric treatment to increase value.
2018	McCreary, Dylan L.; White, Melissa; Vang, Sandy; Plowman, Brad; Cunningham, Brian P.	Compare TDABC and our institution's traditional cost accounting method to measure true cost expenditure around a specific episode of care.
2018	Menendez, M.E., Lawler, S.M., Shaker, J., Bassoff, N.W., Warner, J.J.P., Jawa, A.	Use TDABC to explore inpatient cost of a medical procedure in order to identify preoperative characteristics of high-cost patients.
2019	Simmonds, Jonathan C.; Hollis, Russell J.; Tamberino, Ruby K.; Vecchiotti, Mark A.; Scott, Andrew R.	Measure the costs of a treatment using TDABC and explore how this differs from cost estimates using traditional forms of hospital accounting.
2019	Al Amiri, N., El Khmidi, S.,	Use TDABC methodology to calculate costs and compare its outcome to the currently implemented system.
2019	Kurt, Pinar; Saban, Metin; Cankaya, Fikret; Annac, Mehmet Cengiz	Identify why the TDABC method is applicable and how it can be efficiently applied.

2019	Khan, R.M., Albutt, K., Qureshi, M.A., Ansari, Z., Drevin, G., Mukhopadhyay, S., Khan, M.A., Chinoy, M.A., Meara, J., Hussain, H.	We conducted a time-driven activity-based costing (TDABC) analysis of TKR to identify major cost drivers and areas for process improvement
2019	Basto, J., Chahal, R., Riedel, B.	Use TDABC to model personnel costs for a high-turnover operating list to assess value.

*Table 2 – Research goals of the selected papers*

Analyzing the goal of each paper gives us not only an idea of what the authors intend to achieve but also of the problems present in the field. Most of the papers fall within two big groups. The first are the papers that use TDABC to compare the price of two treatment options and propose changes to the management field. The second are papers that compare the costs of a medical procedure or complication using TDABC against traditional accounting methods.

What we can derive is that TDABC is currently mostly used to explore cost and timing of a certain procedure, medical condition or treatment. This implies a current lack of general applicability of the costing methodology in healthcare. This could be justified by the fact that TDABC is a relatively recent costing methodology, that while easier to implement than the ABC methodology still require a big initial time investment to map out all the procedures.

With this it's no surprise that the papers choose to focus on a single process in order to garner insight into the possible advantages and viability of TDABC. This issue is then aggravated by the fact that medical procedures are highly complex in nature, making it hard to estimate times and for every possible complication and account for the resulting cost. This limiting aspect that makes studies restricted in nature makes it not possible to generalize results from such a low dataset. In fact, it shows that the application of a TABC methodology will prove to be very difficult in a general setting.

Another issue was the fact that data was not always available and estimates had to be made, that once again do not account for all the possible scenarios. Times can also vary greatly in some more complex treatments and often entire phases of care were left out which in prolonged treatments or post-operation scenarios can represent a big chunk of the time and cost.



## 5.2. Papers conclusions

Year	Author	Papers conclusions
2009	Demeere, Nathalie; Stouthuysen, Kristof; Roodhooft, Filip	TDABC introduced a healthy competition and an open communication between the different departments concerning possible operational improvements while challenging healthcare managers and department heads to identify and analyze the underlying activities that drove the overhead costs.
2013	Oeker, Figen; Oezyapici, Hasan	The study showed that TDABC is an effective, accurate and easily applicable system for the hospital, while also being easy to implement in many other businesses.
2014	Campanale, C., Cinquini, L., Tenucci, A.	The information produced may allow a higher coherence between resources and activities. TDABC may enhance transparency and support decisions toward a better organization of work and an informed allocation of resources.
2015	Balakrishnan, Karthik; Goico, Brian; Arjmand, Ellis M.	TDABC can be used to model the personnel cost effects of increasing staffing and to examine the effects of using different types of personnel for the same job. This can be used to optimize efficiency.
2015	Inverso, G., Lappi, M.D., Flath-Sporn, S.J., Heald, R., Kim, D.C., Meara, J.G.	The study demonstrates the improvements in patient education, workflow coordination, and examination room allocation.
2015	Kaplan, A.L., Agarwal, N., Setlur, N.P., Tan, H.J., Niedzwiecki, D., McLaughlin, N., Burke, M.A., Steinberg, K., Chamie, K., Saigal, C.S.	TDABC can be used to measure cost across an entire care pathway in a large academic medical center and is a useful tool to measure cost, and thereby value, in clinical care.
2015	Chen, Alvin; Sabharwal, Sanjeeve; Akhtar, Kashif; Makaram, Navnit; Gupte, Chinmay M.	Through TDABC it was possible to identify the major cost drivers and propose several approaches to reduce the overall cost of treatment.
2016	El Alaoui, Samir; Lindefors, Nils	TDABC may be a useful tool for measuring resource cost and is a potentially more accurate costing method.

2016	McBain, Ryan K.; Jerome, Gregory; Warsh, Jonathan; Browning, Micaela; Mistry, Bipin; Faure, Peterson Abnis I.; Pierre, Claire; Fang, Anna P.; Mugunga, Jean Claude; Rhatigan, Joseph; Leandre, Fernet; Kaplan, Robert	TDABC allows providers and staff to observe resource costs at the patient-level in order to inform delivery of care and can be applied in order to improve health cost estimates and resource allocation.
2016	Akhavan, Sina; Ward, Lorryne; Bozic, Kevin J.	Substantial differences between cost estimates using TDABC and traditional accounting were found. Traditional hospital cost accounting systems overestimate the costs while TDABC provides a more accurate measure of true resource use and can be used to identify high-cost/high-variability processes that can be targeted for process/quality improvement.
2016	Ilg, Annette M.; Laviana, Aaron A.; Kamrava, Mitchell; Veruttipong, Darlene; Steinberg, Michael; Park, Sang-June; Burke, Michael A.; Niedzwiecki, Douglas; Kupelian, Patrick A.; Saigal, Christopher	With TDABC, the true costs of the procedures from the health system perspective were derived. Analysis by physicians and hospital administrators regarding the cost of care afforded redesign opportunities. TDABC appears to be a feasible and powerful costing methodology that can propel value-based care redesign.
2016	Yu, Yangyang R.; Abbas, Paulette I.; Smith, Carolyn M.; Carberry, Kathleen E.; Ren, Hui; Patel, Binita; Nuchtern, Jed G.; Lopez, Monica E.	TDABC can be used to identify inefficiencies in healthcare delivery by highlighting processes that currently are redundant or lead to unnecessary wait times.
2016	Laviana, A.A., Ilg, A.M., Veruttipong, D., Tan, H.-J., Burke, M.A., Niedzwiecki, D.R., Kupelian, P.A., King, C.R., Steinberg, M.L., Kundavaram, C.R., Kamrava, M., Kaplan, A.L., Moriarity, A.K., Hsu, W., Margolis, D.J.A., Hu, J.C., Saigal, C.S.	The use of TDABC is feasible for analyzing cancer services and provides insights into cost-reduction tactics in an era focused on emphasizing value.
2017	Özyapici, H., Taniş, V.N.	The study demonstrates that traditional costing methods assign a higher cost to both procedures than TDABC.
2017	Yu, Yangyang R.; Abbas, Paulette I.; Smith, Carolyn M.; Carberry, Kathleen E.; Ren, Hui; Patel, Binita; Nuchtern, Jed G.; Lopez, Monica E.	The paper shows that TDABC can model changes in healthcare delivery as a result of process improvement. TDABC is a useful tool to optimize the delivery of value-based care and interventions analyzed using this methodology can result in significant decreases in duration of phases of care as well as total costs.

2018	McCreary, Dylan L.; White, Melissa; Vang, Sandy; Plowman, Brad; Cunningham, Brian P.	The paper claims that accurate costing will become increasingly critical to maintain a successful practice. TDABC can provide a better estimate of the cost of the resources necessary. It also shows that the difference in cost between the two methods is largely derived from how indirect cost was accounted for.
2018	Menendez, M.E., Lawler, S.M., Shaker, J., Bassoff, N.W., Warner, J.J.P., Jawa, A.	This study to identify patient characteristics associated with high cost using a TDABC methodology and was able to identify substantial cost saving practices.
2019	Simmonds, Jonathan C.; Hollis, Russell J.; Tamberino, Ruby K.; Vecchiotti, Mark A.; Scott, Andrew R.	The authors highlight how traditional hospital accounting systems apportion all overhead costs, including items such as orthopedic implants, evenly across specialties, thus increasing the perceived cost of procedures.
2019	Al Amiri, N., El Khmidi, S.	TDABC can be implemented as a solution to accurately calculate cost and allocation of human resource to different cost locations. It can also help managers make more accurate decisions regarding human resources cost management, while producing more detailed information that could benefit staff on to improve their work environment and use their time efficiently.
2019	Kurt, Pinar; Saban, Metin; Cankaya, Fikret; Annac, Mehmet Cengiz	The study showed that the TDABC method can be applied in hospital businesses to obtain accurate cost information, and it is useful in helping hospital management make strategic decisions. Hospital businesses will also be able avoid waste of resources by calculating their costs in a realistic way through TDABC method.

2019	Khan, R.M., Albutt, K., Qureshi, M.A., Ansari, Z., Drevin, G., Mukhopadhyay, S., Khan, M.A., Chinoy, M.A., Meara, J., Hussain, H.,"57209137025	The use of TDABC granted an analysis of time and cost that was subsequently used to inform quality process improvement initiative identify cost reduction areas. In low-resource settings, TDABC has the potential to be a useful tool to guide resource allocation and process improvement.
2019	Basto, J., Chahal, R., Riedel, B.,"57205730865	This paper shows that Improvements to efficiency in operating rooms with minimal investment in additional personnel resources. This is an opportunity for hospitals to optimize revenue and reduce surgical waiting lists.

*Table 3 - Conclusions of the selected papers*

In terms of results all the papers report that an improvement can at least possibly be derived from applying TDABC. Those that compare the cost between TDABC and traditional costing methods found that estimated costs tend to be higher when using the latter with claims of better utilization of resources possible. What's interesting is that for some cases the process of figuring out the time and costs of the procedures led managers to realize where improvements could be made and to a better organization of work.

Other improvements are seen on human resource management, waste reduction, better capacity utilization and transparency. The latter refers to clarity about the performed procedures and its associated costs. If for nothing else there's certainly something to be said about the need to know as much about a problem in order to fix it. Furthermore, if a hospital has a better knowledge of the procedures a better resource management can be done. There was also mention of external transparency with the citizens who pay taxes and are the main stakeholders of the public healthcare system on top of the potential for an increase in reputation.

### **5.3. Research recommendations**

<b>Year</b>	<b>Author</b>	<b>Research recommendations</b>
2009	Demeere, Nathalie; Stouthuysen, Kristof; Roodhooft, Filip	No recommendation
2013	Oeker, Figen; Oezyapici, Hasan	The researchers recommend testing the system in other sectors like banking and transportation.
2014	Campanale, Cristina; Cinquini, Lino; Tenucci, Andrea	Further studies are required to analyze decisions following the implementation of the TDABC model.

2015	Balakrishnan, Karthik; Goico, Brian; Arjmand, Ellis M.	Future studies should analyze other aspects of the care cycle, as well as additional non-staffing costs to determine and minimize overall procedural costs for the treatment. It is also important to study patient outcomes and satisfaction associated with this optimization.
2015	Inverso, G., Lappi, M.D., Flath-Sporn, S.J., Heald, R., Kim, D.C., Meara, J.G.	Further efforts toward cost measurement, coupled with outcome measurement, are needed to better define value for this treatment.
2015	Kaplan, A.L., Agarwal, N., Setlur, N.P., Tan, H.J., Niedzwiecki, D., McLaughlin, N., Burke, M.A., Steinberg, K., Chamie, K., Saigal, C.S.	Future work is needed to determine outcome discrepancy between the diagnostic and the surgical modalities.
2015	Chen, Alvin; Sabharwal, Sanjeeve; Akhtar, Kashif; Makaram, Navnit; Gupte, Chinmay M.	However, future research that adopts these methods in larger and more heterogeneous patient populations would be important in benchmarking more accurate tariffs that accommodate patient and surgical factors which may influence overall cost.
2016	El Alaoui, Samir; Lindefors, Nils	The authors recommend further studies of the use of TDABC within mental health care.
2016	McBain, Ryan K.; Jerome, Gregory; Warsh, Jonathan; Browning, Micaela; Mistry, Bipin; Faure, Peterson Abnis I.; Pierre, Claire; Fang, Anna P.; Mugunga, Jean Claude; Rhatigan, Joseph; Leandre, Fernet; Kaplan, Robert	No recommendation
2016	Akhavan, Sina; Ward, Lorryne; Bozic, Kevin J.	No recommendation
2016	Ilg, Annette M.; Laviana, Aaron A.; Kamrava, Mitchell; Veruttipong, Darlene; Steinberg, Michael; Park, Sang-June; Burke, Michael A.; Niedzwiecki, Douglas; Kupelian, Patrick A.; Saigal, Christopher	No recommendation
2016	Yu, Yangyang R.; Abbas, Paulette I.; Smith, Carolyn M.; Carberry, Kathleen E.; Ren, Hui; Patel, Binita; Nuchtern, Jed G.; Lopez, Monica E.	No recommendation

2016	Laviana, A.A., Ilg, A.M., Veruttipong, D., Tan, H.-J., Burke, M.A., Niedzwiecki, D.R., Kupelian, P.A., King, C.R., Steinberg, M.L., Kundavaram, C.R., Kamrava, M., Kaplan, A.L., Moriarity, A.K., Hsu, W., Margolis, D.J.A., Hu, J.C., Saigal, C.S.	Future studies should include building decision analytic trees between diagnose and treatment options to assess the total cost of care.
2017	Özyapici, H., Taniş, V.N.	Studies should be conducted in other healthcare settings to make the results more generalizable.
2017	Yu, Yangyang R.; Abbas, Paulette I.; Smith, Carolyn M.; Carberry, Kathleen E.; Ren, Hui; Patel, Binita; Nuchtern, Jed G.; Lopez, Monica E.	Future studies should explore the value of newly generated capacity through improved healthcare delivery by applying TDABC to other medical conditions.
2018	McCreary, Dylan L.; White, Melissa; Vang, Sandy; Plowman, Brad; Cunningham, Brian P.	Future studies should be run regarding unit costing accounting in other facilities and healthcare systems to see what insight can be gained.
2018	Menendez, M.E., Lawler, S.M., Shaker, J., Bassoff, N.W., Warner, J.J.P., Jawa, A.	Future studies should link TDABC to patient experience and quality of life.
2019	Simmonds, Jonathan C.; Hollis, Russell J.; Tamberino, Ruby K.; Vecchiotti, Mark A.; Scott, Andrew R.	Studies should be conducted using TDABC in other healthcare institutions to gain more insight.
2019	Al Amiri, N., El Khmidi, S.	Future studies should implement TDABC for calculating the indirect supervision cost of the outpatient nursing unit.
2019	Kurt, Pinar; Saban, Metin; Cankaya, Fikret; Annac, Mehmet Cengiz	No recommendation
2019	Khan, R.M., Albutt, K., Qureshi, M.A., Ansari, Z., Drevin, G., Mukhopadhyay, S., Khan, M.A., Chinoy, M.A., Meara, J., Hussain, H.	No recommendation
2019	Basto, J., Chahal, R., Riedel, B.	No recommendation

*Table 4 - Research recommendations from the selected papers.*

Of the 23 papers, 8 of them did not offer any suggestion for future research. Those that did focus on covering the limitations were discussed previously. Expanding the research to more aspects of the care cycle, applying the methodology in other treatments and conditions or simply applying it to other units or hospitals. Any research that helps generalize the conclusions so that it can be polished and applied to the whole cycle of a hospital seems to be valued.

A curious remark pertains to the publication year. All the papers were published in the last 10 years (2009-2019) with 86% since 2015. This shows a lack of attention on the subject until recently, perhaps spurred by the efforts of Kaplan and Porter in recent years to do research on the subject.

## **VI – Conclusion**



One of the major goals of this paper was to understand in which fields blockchain can be used and its potential. Healthcare happens to be one among others found in the literature. It currently faces some technological difficulties like scalability that need to be addressed in order for them to be useful and have mass adoption. In the same note, different blockchain architectures need to be studied so it becomes easier to identify which models fit best for each economic and social necessity. Companies also need to be able to adapt and be able to incorporate decentralized business models and the process of tokenization if appropriate. Currently there is a big lack of research on the impact this has on economic business models, but it may simply be due to lack of applications to study and evaluate.

Our biggest limitation during this part was the access to research tools. The one used for this (b-on), doesn't offer the robustness that something like "Scopus" does in regards to quality control, but it's the only one the researchers had access during this period. Because of this and to circumvent the quality issue surrounding the database, we selected the top journals from "SCImago Journal & Country Rank" and conducted the search from articles within those journals.

The second major goal of this paper was to understand if TDABC can outperform traditional cost accounting methodologies currently practiced. The results of our review show increasing potential with some limitations. The vast majority of studies in the field are focused on a single treatment or procedure and ignore many cycles of care that can account for a big part of the cost in most cases. It does have the benefit of mapping out the procedures, which provides insight and understanding that in some cases bring about immediate change.

We expect to advance our research soon to the next phase where we will be mapping the procedures and costs of a public hospital using TDABC. We expect this hospital to be "Centro Hospitalar Universitário de São João" where the required paperwork has already been submitted and 4 meetings happened with: a member of the board, the ethics commission, the financial department chief and imaging services chief.

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## **Attachments**

**Publications:**

Ferreira, J. P. M., Gonçalves, M. J. A., & da Silva, A. F. (2019). A Systematic Literature Review in

Blockchain: Benefits and Implications of the Technology for Business. In Á. Rocha, H. Adeli, L. P.

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**Communications:**

Conference on Consumer Protection and Supervision in the Financial Services - June

18, 2018 – Topic: cryptocurrency taxation



**Tema:**

Aplicação de preços de transferência em organizações públicas de saúde: o caso de um Serviço de Imagiologia.

**Objetivos gerais do projeto:**

Definir, aplicar e testar um modelo de preços de transferência, para um Serviço de Imagiologia de um hospital público, que sirva simultaneamente a tomada de decisão e o controlo de gestão.

**Objetivos específicos das entrevistas:**

Identificar os processos de trabalhos do Serviço de Radiologia;

Identificar as atividades e tarefas envolvidas na realização de Ressonâncias Magnéticas (RM)

Identificar os recursos aplicados nas atividades e tarefas necessárias à realização das diversas tipologias de RM.

Blocos	Objetivos	Questões orientadoras
A - Legitimação da entrevista e Questões éticas	<ul style="list-style-type: none"><li>- Explicar os objetivos da entrevista</li><li>- Assegurar o anonimato e a confidencialidade da entrevista</li><li>- Solicitar autorização para a gravação da entrevista</li></ul>	<ul style="list-style-type: none"><li>- Explicação sumária dos objetivos da entrevista no contexto da investigação</li><li>- Explicação sobre o anonimato e a confidencialidade do conteúdo da entrevista</li><li>- Pedido de autorização para proceder à gravação da entrevista</li></ul>
B – Descrição dos Processos de trabalho	<ul style="list-style-type: none"><li>- Identificar os processos de trabalhos do Serviço de Radiologia;</li><li>- Identificar as atividades e tarefas envolvidas na</li></ul>	<ul style="list-style-type: none"><li>- Quais as 10 tipologias de RM mais realizadas nos últimos três anos;</li><li>- Em termos gerais, quais são os processos de trabalho envolvidos na realização de uma RM, desde a sua requisição até ao encaminhamento dos resultados finais;</li><li>- Para cada tipo RM quais as</li></ul>

	realização de Ressonâncias Magnéticas	atividades e tarefas envolvidas e em função de que fatores essas tarefas podem variar.
C – Recursos utilizados	Identificar os recursos aplicados nas atividades e tarefas necessárias à realização das diversas tipologias de RM.	<ul style="list-style-type: none"> <li>- Quais os consumíveis e respectiva quantidade utilizados na realização de cada tipo de RM e de que fatores depende a quantidade consumida;</li> <li>- Quais os equipamentos utilizados na realização de cada tipo de RM e de que fatores depende o tempo e a intensidade da utilização;</li> <li>- Qual a capacidade teórica e a taxa de utilização normal dos equipamentos utilizados na realização de cada tipo de RM;</li> <li>- Quais os Recursos Humanos utilizados na realização de cada tipo de RM e de que fatores depende o tempo gasto;</li> <li>- Qual a capacidade teórica e o tempo útil dos Recursos Humanos envolvidos na realização de cada tipo de RM;</li> <li>- Que outros recursos, além de consumíveis, equipamentos e recursos humanos são utilizados na realização de RM.</li> </ul>

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**Observação:**

Outras questões a efetuar dependem de cada entrevistado e da condução da entrevista, dado que cada entrevistado tem experiência profissional e percepção dos processos de trabalho singulares.



João Ferreira

**A/C do Sr. Presidente do Conselho de Administração  
do Hospital de São João**

**Exmo. Sr. Doutor António Joaquim Freitas Oliveira e Silva**

Na qualidade de aluno de Mestrado do Instituto Superior de Contabilidade e Administração do Porto, sob a orientação da Professora Doutora Amélia Ferreira da Silva, encontro-me a preparar para realizar um trabalho de investigação académica na área da Gestão hospitalar.

A contabilidade de gestão dos hospitais públicos portugueses tem registados uma grande evolução nas duas últimas décadas, quer na sua vertente de controlo de gestão, quer na vertente de tomada de decisão. Não obstante, existem ainda importantes questões em aberto. A complexidade operacional das instituições hospitalares gera um conjunto de transferências internas de difícil tratamento contabilístico.

A finalidade última deste trabalho é a de definir e testar um modelo de preços de transferência, para um serviço de imagiologia de um hospital público, que sirva simultaneamente a tomada de decisão e o controlo de gestão. É neste contexto que venho solicitar a V/ Exa. uma breve reunião para apresentar o meu projeto de investigação e propor a participação da V/ Instituição nesse estudo.

Na expectativa de o meu pedido merecer uma resposta favorável de V/ Exa., fico ao dispor para qualquer esclarecimento que entenda necessário.

Grato pela atenção dispensada.

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João Ferreira

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