An International Accreditation System for Healthcare Professionals Based on Blockchain

Jose Itamar M. de Souza Junior, Denise Sampaio de Araújo, Gentil Veloso Barbosa, and Patrick Letouze

***Abstract*—For health practitioners, accreditation processes are necessary for their career development. The importance is not restricted to attesting competencies and skills, it may even certify that some professionals are legally capable and authorized to perform a specific complex procedures, such as kidney transplantation. For example, physicians are crossing national borders with their practice, especially in Europe, and patients are becoming more demanding, thus in need of reliable information regarding health professionals. In this context, we propose a scenario to exemplify and to elucidate an emerging problem, that is, an opportunity. Let us consider that a group of national societies on transplantation biology and medicine decides to create an International Accreditation System for health professionals. The system would be a decentralized institution composed of multiple organizations, because accreditation is about trustworthiness, which naturally suggests the use of blockchain technology. Hence, in this work, we propose the use of blockchain and service design in healthcare, as fundamentals for the conceptual design of an international accreditation system for health professionals. Additionally, this work may be understood as a strategy for modeling, designing and developing healthcare systems based on blockchain technology.**

***Index Terms*—Accreditation, blockchain, healthcare service, professional society, service design.**

I. Introduction

Globalization made frontiers thinner for professional practice in health. In particular, the European Union promoted the integration among its members, including labor and professional activities. Consequently, an International Accreditation System (IAS) for health professionals would expand the range of operation and validation of accreditation and certification in healthcare services. This is a new opportunity.

Every professional society has its own affiliation procedure and their own accreditation processes. Its importance in healthcare service is well demonstrated by Chen *et al.* in their paper entitled "Surgical Accreditation in Liver Transplantation" [1]. They reported that, in 2009, 25 groups performed over 1000 transplantations activities in Spain. Because of such a significant number, they argued that to initiate the accreditation of programs and surgeons was a necessity.

Chen *et al.* in [1] explained that, in medical care, the definition of professional competence is the ability of integrating and applying the knowledge, skills, and attitudes associated with the best practices of their profession. Therefore, the process by which a professional achieves or satisfies a level of competence and quality is denominated accreditation, while certification is the recognition of an institution where an individual has been accredited.

Still, in the context of organ transplantation, in 2007, the Section of Surgery of the "Union Europeëne des Medecins Spécialistes" (UEMS) [2] and the European Board of Surgery (EBS) [3] created the Division of Transplantation [4] to guarantee the best standard of care in organ transplantation in Europe. It should be accomplished by ensuring that training in transplantation surgery is maintained at the highest level, which requires accreditation and certification. Consequently the division operates in close collaboration with the European Society of Organ Transplantation (ESOT) [5]. This demonstrates that physicians are crossing national borders with their practice, and because of it, accreditation processes are even more important nowadays. An IAS would be an opportunity in supporting the main objective of the Division of Transplantation and of ESOT [6].

For instance, let us consider the following scenario: a group of professional societies on transplantation biology and medicine decides to create an International Accreditation System (IAS). A possibility would be to consider the societies affiliated to the journal "Transplantation Proceedings" [7]. This choice is a consequence of a previous experience with this journal, hence the reason of knowing the case and its possibilities [8]. In order to illustrate how much an IAS promoted by UEMS, EBS, ESOT and the previously mentioned societies affiliated to the journal of "Transplantation Proceedings" may expand the geographic scope of accreditation and certification, we mention in the appendix these societies [7]. Hence, our case study is the proposition of an International Accreditation System (IAS), for a group of professional societies on transplantation biology and medicine. This is an example of decentralized autonomous organization, possibly a non-profit organization, and thus, it is a new application for blockchain.

Hence, we propose a conceptual design where the IAS would be a web system with a social network structure that

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intends to provide a service to health professionals and patients. This system is not restricted to transplantation societies. It may be used by any field in healthcare, and as far as we know, this system does not exist, and a similar system does not exist. That is, this issue has not been addressed directly, which is supported by a search in the web and literature review, that we present in Section I-A.

This paper starts with the Introduction section, where the relevance of accreditation for healthcare professionals is presented, which motivates the development of an International Accreditation System that is a web system structured in a social network manner based on blockchain. Then we present a subsection about related work, followed by a subsection where we explain the basic functioning of the IAS. In the second section, we have the methodological part of this work, where we show the concepts, strategies and technologies proposed in our work, that is, the proposition of how to develop the IAS. After that, the results of our proposition are shown in a specific section, and the discussion of this work is performed in the last section.

A. Related Work

We begin the evaluation of the problem with a search on the internet, for that we used the expression "accreditation network" with Google (06/01/2018) (*It is worth noticing that the search was performed with Google Scholar, IEEExplore and ScienceDirect returning ZERO results*). The search resulted in centralized accreditation systems. The most interesting result in our point of view was the "European Accreditation Network" (EAN) [9], because, as far as we know, it is the only Information Technology (IT) platform related to the problem as "accreditation network". According to themselves, they are a network of professional organization to provide accreditation for educational activities in Europe. They aim to improve the quality of Continuing Professional Development (CPD) activities in Europe, by providing an external quality control. That is, EAN claims to be "an accreditation system by professionals for professionals", supported by an IT platform, the EAN portal, which "provides accreditation for educational activities for health professionals" [9].

The EAN has been created by Qualeetys sprl, a start-up that claims to provide strategic vision about CPD in Europe. EAN says that they initiated in November 2014, but formally launched in November 2015. They say that in the beginning of 2016, they started accrediting educational activities for specialist nurses. Additionally, Qualeetys sprl declares that they developed the accreditation procedure and criteria in close cooperation with its partners. Basically, Qualeetys sprl is an enterprise, which intends to centralize accreditation of health education in Europe.

In this regard, Qualeetys signed a cooperation agreement with ESNO, the European Specialist Nurses Organisation [10], to start accreditation of educational activities for specialist nurses in Europe. Qualeetys is seeking other European Professional organizations that are willing to join the EAN and accredit educational activities for other professions. The EAN is in essence European and interprofessional. It aims to be the umbrella organization for European accreditation of educational activities, and they claim that EAN has been designed to be flexible, compatible with existing system and adaptable to new CPD activities.

At first EAN seems similar to the problem proposed, but it is not a network of professional societies, it is centralized, it is focused on the accreditation of health education providers. It means that the International Accreditation System has a centralized for profit competitor that intends to provide a service of accreditation in educational health. Therefore, the major difference between them is that the former is a non-profit decentralized autonomous organization, while the latter is a for profit centralized enterprise. Therefore, IAS does not interphere with societies affairs, it would provide a web system with the benefits of blockchain and a social network structure, which is a major difference, *i.e.*, IAS provides decentralization with trustworthiness.

Then we performed another search with Google, but this time with the query "accreditation multiple societies" (06/01/2018). It returned "No results", and it showed the results for accreditation multiple societies (no quotes). Analogously, the same happened for the search "multiple societies' accreditation" (*It is worth noticing that the search was performed with Google Scholar, IEEExplore and ScienceDirect returning ZERO results*).

B. The International Accreditation System

The first objective of the proposed International Accreditation System (IAS) for healthcare professionals, as its name clearly states, is to provide a web-based platform to support the accreditation and certification process. This satisfies the accreditation system part, but the international part suggests that, it is a system that provides a service worldwide.

Previously, in the Introduction, we mentioned that "globalization made frontiers thinner for professional practice", the international part of the system is related to that statement. We understand that a collective of professional societies in healthcare using the same web-based platform to award accreditation maintaining all processes independent for each society, is a new and desirable system, as far as we know, in other words a web-based decentralized autonomous organization. This is profoundly different from EAN, since Qualeetys sprl, as mentioned in Subsection-A from Section-I, "declares that they developed the accreditation procedure and criteria in close cooperation with its partners", which does not ensure independence of processes, nor autonomy. Therefore, we believe that IAS should be a system and a non-profit organization created and managed by this collective of professional societies.

We propose to support this decentralized autonomous organization with a web-based system using blockchain technology. In addition to that, it naturally provides trustworthiness and other qualities inherited from the blockchain structure, Subsection-A from Section-II. Basically, the IAS would function in the following manner:

1) *A new professional society would request to be part of IAS:* with its acceptance, this society would define its accreditation and certification processes within the system.

2) *All members of this new society would be members of IAS:* a member may be associated with any number of

societies, and professionals and institutions might be members.

a) Institutions may apply for certification and award accreditation to professional members.

b) Professionals may apply ttfor accreditation.

New perspectives may come from the International Accreditation System for health professionals based on blockchain technology. Besides sharing accreditation processes, societies could share knowledge. The IAS could be a social/professional network. Patients could have access to healthcare professionals' accreditation history and to institutions' certifications history. A personal accreditation among peers could be implemented, that is, health professionals could accredit professional clinical practice interactions. Actually, accreditation could occur among all elements of the network, which seems interesting as references for patients, professionals and institutions, for selecting healthcare professionals and institutions. Nonetheless, a more thorough evaluation of these possibilities is required and should be performed by the collective of societies.

II. Methodology

In this section, we start with a brief explanation and some remarks on blockchain. Then we presente the Healthcare Service System Design used in this work. We follow that with the presentation of the system's development strategy suggested for generating the IAS – the "Evolutionary Acquisition Interdisciplinary Research Project Management" [11], and we finalize the methodology part of this work by presenting the RGM web system, which would be the system/ social network that could be the basis for the development of the IAS, by an evolutionary acquisition strategy.

A. Blockchain

Blockchain is an emerging technology useful for Peer-to-Peer (P2P) networks. It is in a stage of searching potential applications, from its origins in cryptocurrencies [12] to health systems, such as personal health records [13].

A possible application of blockchain technology is service systems, because it facilitates co-creation of value, ensuring availability of information and offering mechanisms of coordination. Additionally, the establishment of an environment for trusted interactions and the formation of a decentralized network may be important aspects of a service system, and they are the core of Blockchain technology [14].

Nonetheless, service systems must regard quality of service. For that purpose, independent professional accreditation processes may support quality and standard of offered services, which to customers mean trustworthiness associated with the service provider. Particularly, a focus on intrinsic quality may close the gap between service design and standards [15]. Therefore, the combination of blockchain technology and service system must consider service quality.

A blockchain is essentially a distributed database of records, or public ledger, of all transactions or digital events that have been executed and shared among participating parties. Each transaction in the public ledger is verified by consensus of a majority of the participants in the system. Once entered, information can never be erased. The blockchain contains a certain and verifiable record of every single transaction ever made. In other words, the five basic principles of blockchain explained by Iansiti and Lakhani in [16] are:

1) *Distributed database*: each party on a blockchain has access to the entire database and its complete history. No single party controls the data or the information. Every party can verify records of its transaction partners directly, without an intermediary.
2) *Peer-to-peer transmission*: communication occurs directly between peers instead of through a central node. Each node stores and forwards information to all other nodes.
3) *Transparency with pseudonymity*: every transaction and its associated value are visible to anyone with access to the system. Each node, or user, on a blockchain has unique 30-plus-character alphanumeric address that identifies it. Users can choose to remain anonymous or provide proof of their identity to others. Transactions occur between blockchain addresses.
4) *Irreversibility of records*: once a transaction is entered in the database and the accounts are updated, the records cannot be altered, because they are linked to every transaction record that came before them.
5) *Computational logic*: the blockchain transactions can be tied to computational logic and in essence programmed.

For implementation purposes, it is worth mentioning some blockchain platforms, such as: Ethereum, Hyperledger (Sawtooth, Fabric, Indy, Burrow, and Iroha), Multichain, Hydrachain, Open Chain, IBM Bluemix Blockchain, Chain, IOTA, BitcoinJ, Web3j. Additionally, some guidance for implementation are useful. For that purpose, we sugest three ways of how to develop a blockchain application follows:

1) The 8 steps in [17]:
   a) Identify the problem and goal.
   b) Identify the most suitable consensus mechanism.
   c) Identify the most suitable platform.
   d) Design the architecture.
   e) Configuring the application.
   f) Building the APIs.
   g) Design the admin and user interface.
   h) Scaling the POC and identifying problems.
2) IBM's suggestion in [18]:
   a) *Build a blockchain network*: (i) Install the Network Dependencies: cryptogen, configtxgen, configtxlator, peer; (ii) Configure the network: Generate the network artifacts; and Start the network.
   b) *Create blockchain smart contracts*: (i) Install and instantiate the chaincode; (ii) Query and invoke the chaincode; (iii) View transactions and chaincode logs.
3) The 5 steps in [19]:
   a) Clone repository and install dependencies.
   b) Run the Ganache CLI.
   c) Compile the contract.
   d) Deploy the contract.
   e) Interact with the contract.

B. Healthcare Service System Design

Wang *et al.* in [20], on the new challenges for the design of systemic services, remarked that:

Service designers should recognize the targeted customers' specifications, which include convenience, timeliness, and other perceivable features, and correspondingly adjust their designs to maximize these attributes.

That is, a user-centric strategy is primordial. Hence, we are inspired by the service system design in [21]: "Patient-Centric Healthcare Service Systems: Evidence-Based Medicine as Architecturally Significant Requirement", which is a strategy that systematizes the design of Healthcare Service Systems, focusing on software engineering – Fig. 1, which is a desirable characteristic for blockchain applications. It is a user-centric Service-Oriented Architecture (SOA) approach and a systematic service design that considers Evidence-Based Medicine guidelines and recommendations as architectural significant requirements in the design of Healthcare Service Systems, which would provide focus on quality of evidence and strength of recommendation.

The consideration of medical/health guidelines or recommendations is appropriate for health professionals' accreditation. Then, we must identify a minimum set of guidelines and recommendations as essential attributes in the requirement analysis for configuring accreditation and certification processes of each professional society. Normally, such guidelines or recommendations are non-functional, therefore they are architectural significant requirements, that is, "the requirements that play a crucial role in determining the enterprise system's software." Hence, the blockchain structure with the smart contract establish a common framework for each accreditation and certification process, then each society has just to request the IAS management board to configure them within the system.

C. Evolutionary Acquisition Interdisciplinary Research Project Management

For the development of the International Accreditation System, we suggest the use of the "Evolutionary Acquisition Interdisciplinary Research Project Management" (EA-IRPM) [11], which is a combination of the IRPM [22] with the "Evolutionary Acquisition" strategy [23].

In IRPM, we start by choosing a problem, in the Initiation stage, the blue stage in Fig. 2. The problem is how to develop the IAS blockchain-based service. For approaching the problem in an interdisciplinary fashion, we chose three fields: blockchain systems' development, service design and health professional accreditation. It is debatable the necessity of an interdisciplinary approach, nevertheless novel applications to blockchain technology are potentially interdisciplinary, and healthcare services probably are, consequently an interdisciplinary approach may be an advantage.

Then we started the Planning stage, the green stage in Fig. 2. In our case, we studied the real problem with the use of the internet. We looked into websites about technologies related to the IAS, blockchain, and scientific papers. The objective is to generate a new fundamental or methodology. Specifically, the objective is to propose a conceptual strategy to support the development of novel blockchain-based services. As a practical application, we chose the creation of an International Accreditation System for health professionals. It is worth noticing that, if we succeed in the Planning stage to develop a new methodology, then we shall publish it, and we have accomplished it, this is this publication, that is, we have finished the Planning stage. After developing a new fundamental or methodology, we begin the Executing stage, the yellow stage in Fig. 2. Here, for a Problem-Based Learning class, an educational material may be prepared. In parallel, a new technology may be developed and used. In our case, the development of blockchain application for the IAS would be part of the Executing stage, then its use in real life would be the last part of the Executing stage, and that does not depend on us. The Control stage exists if in the Planning stage controls were established. Hence, in accordance with the results, papers might be written, and that is the Closing stage, the gray stage in Fig. 2.

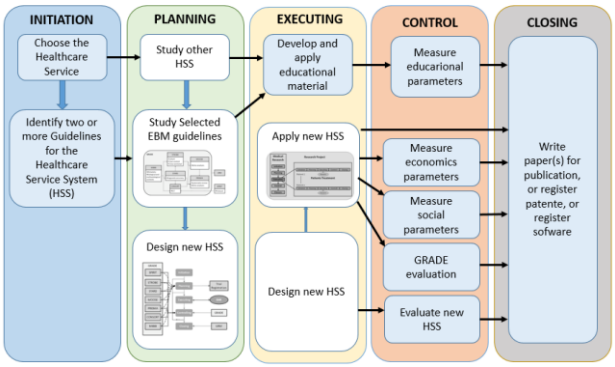

Fig. 1. EBM-Ready-HSS, adapted from [21].

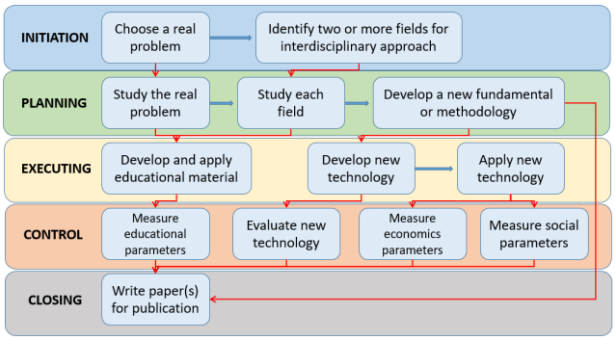

Fig. 2. Interdisciplinary research project management, adapted from [22].

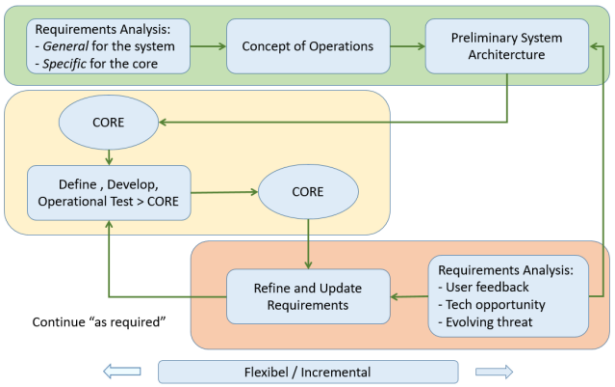

Fig. 3. Evolutionary acquisition, adapted from [23].

The Evolutionary Acquisition (EA) starts with the requirements analysis, which is the definition of the "general" requirements for the system and the "specific" requirements for the core, and then we generate a concept of operations, Fig.

3. We design from a requirements analysis of user feedback, technological opportunities and threat evaluation, a preliminary system architecture, for then we develop the first core of the system. New developments may result from operational tests, experience and use.

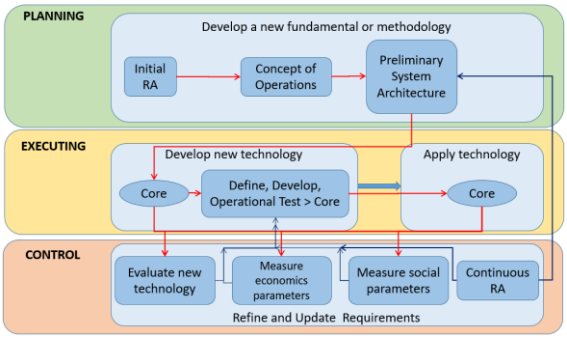

Fig. 4. EA-IRPM, adapted from [11].

The incorporation of EA into IRPM resulting in the EA-IRPM is shown in Fig. 4, and RA means Requirements Analysis. On the Planning stage, particularly in the attempt of developing a new fundamental or methodology, we insert the Initial RA is the general requirements analysis of the system and specific to its core, followed by the elaboration of the concept of operations to design the preliminary system architecture. If available the Continuous RA should be considered, it is about user feedback, technological opportunities and evolving threat.

The Executing stage is about the development of a new technology and to put it into operation. Control stage is about refining and updating requirements, that is, together with the Continuous RA, the evaluation of the parameters: technological, social and economic

D. The RGM Web System

The importance of guidelines in medicine is well established, and usually they are established by medical/health professional societies/associations. In addition to that, Reporting Guidelines in Medicine may avoid poorly reported research, which may induce misinterpretation and inappropriate clinical practices [24]. Because of that, Letouze *et al*. in [24] has developed a system named RGM – Reporting Guidelines in Medicine, a strategy that is a web system. It is a web system for the creation, development and management of guidelines in health. This software was recently patented as a system for managing norms and directives [25]

The patented version of RGM has a hierarchical social network structure. It allows member to be professionals and institutions. It provides project management functions with measurements, for generating and developing guidelines. The interaction among guideline developers are recorded, and the documents are recorded, so how the guidelines are developed is registered in the system allowing tracing its history. Because the system allows the definition of measurement parameters to be shown graphically, it is possible to evaluate guidelines' development.

III. Results

In accordance to the EA-IRPM, Subsection-C of Section-II, Fig. 4, this section begins with the result of the Planning stage in general terms for the Preliminary System's Architecture, that is, the General Requirement Analysis. After that, the Specific Requirement Analysis is presented, here the focus is on blockchain technology based on other blockchain systems [13], [26], where mapping equivalent elements show the potential reuse of these systems. Then this section ends with the proposition of the RGM web system as the natural foundation to build on the blockchain solution for the IAS.

A. General Requirement Analysis

The IAS must be composed by societies and professionals, but also composed by divisions within societies, as explained by Casanova in [18]. The divisions are responsible for the accreditation process, setting the rules for certification, such as, eligibility criteria and examination. In regards with network elements and their connections, societies are not required to be connected to all societies. Professionals may be connected to more than one society, but at least one. A division pertains to a society.

Now, we have some new concepts that may or may not be applied: a professional may be connected to another professional, and divisions may be connected to other divisions and societies. It means that professionals may accredit other professionals, that is, let us say that two professionals had worked together, then they might register that, and it would function as a personal accreditation. Just getting ahead a little bit, two professionals would only be able to perform a transaction if both agree to it, and that would work as a reciprocal approval between professionals, or a personal accreditation. Divisions may work together for combined accreditation.

Therefore, after a brief analysis, we may consider the following elements as the General RA of the IAS:

1) *Decentralized autonomous organization.*
2) *Trustworthiness*
3) *Network elements: societies, divisions and professionals.*
4) *Possibility of accreditation among any node in the network.*

The fourth element reveals that societies, divisions and professionals may perform accreditations among themselves. This property may be very interesting and requires a more thorough analysis.

B. Specific Requirement Analysis

In our case, for simplification reasons, let us consider only the scenario of accreditation explained by Casanova in [1]. Then the Specific RA for the core of the system is the blockchain technology itself. In other words, a mapping between applications or services, as the Specific RA, is presented in Table I.

The Concept of Operation of the IAS could be very similar to Personal Health Records with the blockchain technology, as presented in [26], or by Roehrs *et al*. in [13]. Particularly, it is reasonable to say that data in a Personal Health Record are more complex than data in an Accreditation Log.

Personal health records, as presented in [26], could use blockchain for registering data with a private key granting access only to certain individuals. Additionally, blockchain would store receipts of surgery that would be sent

automatically to insurance providers as proof-of-delivery. The general healthcare management would be possible with the ledger.

TABLE I: MAPPING BETWEEN BITCOIN AND IAS

Bitcoin	International Accreditation System
Spender	Professionals and Divisions
Wallet	Accreditation Log
Miner	Professional society
Transaction	Transaction
Block	Accreditation data

Roehrs *et al*. in [13] named their solution OmniPHR, and their model is based on the following technologies: Blockchain, Routing Overlay, openEHR standard, Chord algorithm, and Public-Subscribe system. Their model proposes a hierarchical PHR encrypted and distributed in blockchains. In their model, we have patients, health professionals, hospitals (clinics or first aid stations). Therefore, in Table II, we have the mapping between OmniPHR and IAS, and due to the similarity, we may consider the OmniPHR model, after mapping, the IAS Concept of Operation:

TABLE II: MAPPING BETWEEN OMNIPHR AND IAS

OmniPHR	International Accreditation System
Patients	Professionals
Professionals	Divisions
PHR	Accreditation Log
Hospital	Professional society
Message	Transaction
Data block	Data block
Health record	Accreditation record
Nodes publishers	Professional societies

C. Building the IAS on the RGM Web System

Except from the social network structure, as a result of similarity after mapping, IAS's Preliminary System Architecture would be the same as the one proposed by Roehrs *et al*. in [13], for their OmniPHR model. However, the reason why RGM is a natural basis for IAS is that it is a system to support the generation and development of medical and health guidelines, and reporting guidelines. That is, it is a system designed to assist medical and health professional societies (or associations) in the development of their guidelines, solving the issues presented by Moher *et al.* in [27] about reporting guidelines in medicine, which are clearly applicable to clinical guidelines. Furthermore, RGM has implemented within itself the EA-IRPM strategy [24], which is suitable for integrating the blockchain technology with smart contracts, to provide flexibility and configurability for the societies' accreditation processes. It has a hierarchical social network structure contemplating institutions, professionals, and if desired patients. It provides a user-centered architecture with the general functions of a web system, which satisfies the General Requirements for the IAS. RGM was implemented with free on the shelf tools and softwares, inherited from [28]: software architecture (MVC), programming language (Javaserver Faces), component suite (Prime Faces), application server (Glassfish), IDE (Eclipse), object relational mapping (Hibernate), application framework (Spring: Security Framework 3), build automation tool (Maven), URL rewrite filter (Pretty Faces), frontend (HTML5), and database (PostgreSQL).

IV. DISCUSSION

The International Accreditation System (IAS) for health professionals intends to provide a web service for medical and health societies concerning accreditation and certification processes. Particularly, our case study is an IAS for a group of professional societies on transplantation biology and medicine, with the suggestion of the creation of a decentralized autonomous organization, possibly a non-profit organization that would host and manage the IAS. The IAS would have a social network structure with the blockchain technology, which would assure decentralization, autonomy and trustworthiness.

Our main result is the proposition of the conceptual design of an IAS for health professionals. It was designed up to the Planning stage of the IRPM and the Preliminary System's Architecture of the EA [11], [21], [22], [24], based on General and Specific Requirements presented in Section-III. The General Requirements can be implemented in a straightforward way using another system called RGM [24], [25], and the Specific Requirements could use as models, two other blockchain applications in healthcare [13], [26].

If we consider that accreditation depends on medical or health guidelines, then RGM is a natural candidate to be used as a basis for the development of the IAS for health professionals. RGM was developed to support the generation, development and management of such guidelines, and in its implementation, it took into consideration Health Service Systems (HSS) design with Evidence-Based Medicine (EBM), *i.e*., an EBM-Ready-HSS [21]. The EBM-Ready-HSS considers evidence-based medicine and medical guidelines as architecturally significant requirements. Consequently, it may be an approach suited for a more profound study or development of the IAS, as a future work.

The adoption of the blockchain technology might evoke some concerns. If we consider the dangers of the adoption of cryptocurrencies, some issues may be of concern. For promoting the debate, we present some possible abuses of Bitcoins exposed in [29], and we comment them with regards to IAS:

1) *The technical weakness-time delay in confirmation, it is not an issue for an IAS.*
2) *The possibility of double-spent does not make sense for an IAS.*
3) *The human dishonesty-pool organizers taking unfair share slices, it also does not make sense in an IAS.*
4) *Human mismanagement—online exchanges for the scenario derived from Casanova's work in* [1], *societies are responsible for exchanges and their verification, which should reduce such problem.*

The complete implementation of the IAS for healthcare professionals based on blockchain for multiple societies require a debate among these societies to ensure a decentralized autonomous system, and desirably, the creation of a non-profit organization that hosts the IAS.

We believe that this new organization would promote knowledge sharing without effort, and with time, the interaction within the system would not only disseminate knowledge, but it would also induce standardization of best practices and the enhancement of medical and health clinical guidelines, spreading it around the world, and with it, promoting the betterment of public health in general.

APPENDIX

Societies members of the "Transplantation Proceedings": American Society for Reconstructive Transplantation, Asian Transplantation Society, Andalusian Transplantation Society, Brazilian Transplantation Society, Belgian Transplantation Society, Catalan Transplantation Society, Chilean Transplantation Society, Hellenic Transplantation Society, Hungarian Transplantation Society, International Hand and Composite Tissue Allotransplantation Society, International Pancreas and Islet Transplant Association, International Society of Organ Donation and Procurement, International Society of Small Bowel Transplantation, Italian Transplantation Society, Japan/Korea Transplantation Society Forum, Latin America and the Caribbean Transplantation Society, Middle East Society for Organ Transplantation, Polish Transplantation Society, Portuguese Transplantation Society, Scandinavian Transplantation Society, Spanish Transplantation Society, Spanish Liver Transplantation Society, Turkish Transplantation Centers Coordination Association, and Turkish Transplantation Society

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REFERENCES

[1] S. Chen, B. Mulgrew, and D. Casanova, "Surgical accreditation in liver transplantation," *Transplantation Proceedings*, vol. 41, no. 3, April 2009, pp. 998-1000.
[2] European Union of Medical Specialists. [Online]. Available: https://www.uems.eu/
[3] Section of Surgery & European Board of Surgery. [Online]. Available: https://www.uemssurg.org/
[4] The Division of Transplant Surgery. [Online]. Available: https://www.uemssurg.org/divisions/transplantation
[5] Leading the Way in Organ Transplantation. [Online]. Available: https://www.esot.org/
[6] The Division of Transplant Surgery. [Online]. Available: https://www.uemssurg.org/divisions/transplantation/transplant-surgery
[7] B. D. Kahan. Transplantation proceedings. [Online]. Available: https://www.journals.elsevier.com/transplantation-proceedings
[8] P. Letouze and M. M. Teixeira, "Project-based transplant management as a research statistical support," *Transplantation Proceedings*, vol. 41, no. 3, April 2009, pp. 852-854.
[9] European Accreditation Network. [Online]. Available: https://www.ean-portal.eu/webean/service/public/home
[10] European Specialist Nurses Organisation. [Online] Available: http://www.esno.org/
[11] P. Letouze, "Evolutionary acquisition interdisciplinary research project management," *International Proceedings of Economics Development and Research*, vol. 30, 2012, pp. 231235.
[12] S. Nakamoto. (March 2014). Bitcoin: A peer-to-peer electronic cash system. [Online]. Available: https://bitcoin.org/bitcoin.pdf
[13] A. Roehrs, C. A. Costa, and R. R. Righi, "OmniPHR: A distributed architecture model to integrate personal health records," *Journal of Biomedical Informatics*, vol. 71, pp. 70-81, 2017.
[14] S. Stefan and R. Schüritz, "Blockchain technology as an enabler of service systems: A structured literature review," *International Conference on Exploring Services Science*. Springer, Cham, 2017.
[15] R. H. Walker and L. W. Johnson, "Signaling intrinsic service quality and value via accreditation and certification," *Managing Service Quality: An International Journal*, vol. 23, pp. 85-105, Jan 2009.
[16] M. Iansiti and K. R. Lakhani, "The truth about blockchain," *Harvard Business Review*, Harvard, USA, pp. 3-11, 2017
[17] Y. Jain. (February 2018). 8 steps to start blockchain development and get your dapp ready. [Online]. Available: https://www.newgenapps.com/blog/8-steps-how-to-start-blockchain-development-dapp
[18] I. Gulhane. (January 2019). Build your first blockchain application. [Online]. Available: https://developer.ibm.com/series/code-pattern-series-build-your-first-blockchain-application/
[19] B. Stewart. (February 2018). Build your first blockchain application in 5 quick steps. [Online]. Available: https://itnext.io/build-your-first-blockchain-application-in-5-quick-steps-89ebb96adbfe
[20] S. Wang, L. Li, and J. D. Jones, "Systemic thinking on services science, management and engineering: Applications and challenges in services systems research," *Systems Journal*, vol. 8, no. 3, 2014, pp. 803820.
[21] P. Letouze, V. M. Silva and J. I. M. S. Júnior, "Patient-centric healthcare service systems: Evidence-based medicine as architecturally significant requirement," *International Workshop on Software Engineering in Healthcare Systems (SEHS)*, Austin, TX, 2016, pp. 26-32.
[22] P. Letouze, "Interdisciplinary research project management," *International Proceedings of Economics Development and Research*, 2011, vol. 14, p. 338342.
[23] *Systems Engineering Fundamentals, Supplement 2-B Evolutionary Acquisition Considerations*, The Defense Acquisition University Press, Fort Belvoir, Virginia, Jan 2001.
[24] J. Y. Ishihara *et al*., "Applying the MVC EAIRPM to reporting-guidelines in medicine: A strategy that is a web system," in *Proc. 2017 IEEE EMBS International Conference on Biomedical & Health Informatics*, pp. 97-100, IEEE, 2017.
[25] P. Letouze, J. I. M. S. Júnior, and V. M. Silva. Sistema de Gerência de Normas e Diretrizes. BR512018052224-6. Institute National of Proprietary Industrial. [Online]. Available: https://gru.inpi.gov.br/pePI/servlet/ProgramaServletController?Action=NextRegister&CodPedido=24831.
[26] Smart contracts: The blockchain technology that will replace lawyers. [Online]. Available: https://blockgeeks.com/guides/smart-contracts/
[27] D. Moher *et al*., "Describing reporting guidelines for health research: a systematic review," *Journal of Clinical Epidemiology*, vol. 64, no. 7, p. 718742, 2011.
[28] V. M. Silva *et al*., "Generating software engineers by developing web systems: a projectbased learning case study," in *Proc. 2016 IEEE 29th International Conference on Software Engineering Education and Training* (CSEET), pp. 194-203, IEEE, 2016.
[29] P. Gil. (January 2019). What are bitcoins? How do bitcoins work? [Online]. Available: https://www.lifewire.com/what-are-bitcoins-2483146

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