

**IMECE2018-88530**

## **A FUTURE TREND IN SENSING ENTERPRISE SYSTEMS**

### **Majid Zamiri**

CTS, UNINOVA, Dep.º de Eng.<sup>a</sup>  
Electrotécnica,  
Faculdade de Ciências e  
Tecnologia, FCT,  
Universidade Nova de Lisboa  
2829-516 Caparica, Portugal

### **Andreia Artifice**

CTS, UNINOVA, Dep.º de Eng.<sup>a</sup>  
Electrotécnica,  
Faculdade de Ciências e  
Tecnologia, FCT,  
Universidade Nova de Lisboa  
2829-516 Caparica, Portugal

### **Elsa Marcelino-Jesus**

CTS, UNINOVA, Dep.º de Eng.<sup>a</sup>  
Electrotécnica,  
Faculdade de Ciências e  
Tecnologia, FCT,  
Universidade Nova de Lisboa  
2829-516 Caparica, Portugal

### **Joao Sarraipa**

CTS, UNINOVA, Dep.º de Eng.<sup>a</sup>  
Electrotécnica,  
Faculdade de Ciências e  
Tecnologia, FCT,  
Universidade Nova de Lisboa  
2829-516 Caparica, Portugal

### **Ricardo Jardim-Goncalves**

CTS, UNINOVA, Dep.º de Eng.<sup>a</sup>  
Electrotécnica,  
Faculdade de Ciências e  
Tecnologia, FCT,  
Universidade Nova de Lisboa  
**2829-516 Caparica, Portugal**

## **ABSTRACT**

The widespread use of sensorial technologies has created new opportunities for enterprises, as these new sources of data assist in increasing the context-awareness in which enterprises operate and enable them to better anticipate and adapt to changes in the business environment. This leads to better decision-making and greater profitability, as well as to reduced operating risks. However, if enterprises are to get any benefit from these new data sources, there is a need for tools, which will enable them to deal with the complexity of the multitude of data sources, both from physical and virtual objects, as well as a means to extract relevant and correct information and knowledge from it. Having access to data is not enough. The real value to enterprises comes from being able to process it, interpret it and being able to make accurate forecasts upon which they can base their business decisions. This paper presents the blockchain technology which is intended to support the development of sensing enterprise systems for intelligent knowledge management. Since the creation of the internet, blockchain is the most important technology created that is in constant development and has still much more to develop. In a simple way, blockchain is a computational technology for register of operations, decentralized, free-access, transparent, global, continuous. It is a public database that is accessible for everyone and is much more secure and reliable than other forms currently

known to perform similar operations. Thus, it is intended to demonstrate the importance of this recent technology in business processes and the future trends of its use in sensing enterprise business processes. The proposed framework intends to demonstrate and serve as the foundation for new business models supported by the new capabilities provided by sensorial technologies in the support of enterprise applications.

## **KEYWORDS**

Trend; Sensing Enterprise; Blockchain; Business Process.

## **INTRODUCTION**

The currency transactions between businesses and individuals have been often controlled and centralized by a third-party organization. In order to transfer currency or making digital payment, it was imperative that a credit card provider or a bank to complete the transaction as a middleman. Moreover, the created transaction causes a fee that should be paid to a credit card company or bank. In other domains such as, software, music, and game the process was almost the same. It means that all information and data were managed and controlled by a third-party organization and in principle the transaction system was centralized, instead of having just the two principal entities involve in their transaction. To change from this established centralized process both sides of a transaction have to trust each other. Hence, by introducing the Blockchain technology, some

possibilities are created to deal with this concerning issue. Indeed, Blockchain aims to create a decentralized, automated, and secure environment in which no third party is needed.

Blockchain although is relatively new technology, it is known as the world's leading software platform for digital assets. Blockchain is now a promising alternative to traditional currency, and centralized banking. Very soon it has succeeded to replace the underlying structure for growing number of services and applications that we use today, including systems for tracking our health, managing our finance, determining how we communicate, transact, and connect with each other, and so on. Right now, Blockchain is going to reshape pretty much every industry and business. As Blockchain can redefine the business processes, interested businesses are willingly embracing the full potential of this technology in order to streamline and secure their data storage. Blockchain will continue to be evolved and applied in more and more innovative ways. In that respect, this research work therefore aims to better understand what is the Blockchain technology? And what are its applications in the context of business process?

This paper is organized as follows: section 1 presents the blockchain technology. Section 2 focus on the blockchain in business process, including the impact in the business processes, benefits of using blockchain in business processes and presents also a use case. Section 3 is dedicated to sensing enterprises, in which are addressed three topics: Knowledge management, actuation and automation, and patents and Intellectual Property Right (IPR). Next, in section 4, are described future trends in sensing enterprises business processes. Finally, are drawn some conclusions.

## 1 BLOCKCHAIN

Leading global institutions, such as European Parliament, believe that Blockchain is a transformation technology.

Blockchain is an open source technology that first appeared supporting a virtual currency, named Bitcoin. According to Financial Action Task Force (FATF) [1], virtual currency is a medium of exchange for goods and services, a unit of account since it is possible to measure it, a way of store value. Additionally, according to the same source, it has not legal tender status, not issued nor guaranteed by any jurisdiction, and it functions only by agreement of its users. Virtual currency is according to European Court of Justice (ECJ) “a type of unregulated, digital money” [2].

Cryptocurrency can be seen as a subset of virtual currency, with additional security feature [3]. It is characterized by allowing the exchange of value directly without the need for an intermediary, in a digital way [4]. It is both a currency and a payment system [5]. The most popular cryptocurrency is bitcoin [6], which was created in 2008, by a pseudonymous person or persons named Satoshi Nakamoto which “outlined a new protocol for a peer-to-peer electronic cash system using a cryptocurrency” [7].

Blockchain is the technology supporting bitcoin. It is shared distributed ledger that allows recording transactions and can be

used to record any transaction and register the movement of any asset (tangible, intangible, or digital). Blockchain is a subset of Distributed Ledger Technologies. The later includes: 1) a data model – used to capture the actual ledger’s state; 2) a language of transactions – that modifies the ledger state; and 3) a protocol – to create consensus among participants to decide which transactions will be accepted. Blockchain builds a chain of blocks in chronological order. Each block is usually composed by: the reference to the previous block, the proof of work, the timestamp, the Merkle tree root for the transaction of the block. According to Antonopoulos, a Merkle tree is a data structure that summarizes the block transactions’ in an efficient manner [8]. Proof of work, used to reach consensus, refers to a challenge proposed to all machines that stores a copy of the ledger. Teams may be constituted to solve the puzzle. The first team solving becomes the winner, with the privilege to add a new block. Despite proof of work be important to public Blockchains, such as bitcoin, it is not necessary in private business network where all participants are known, since it consumes considerable computing power and electricity.

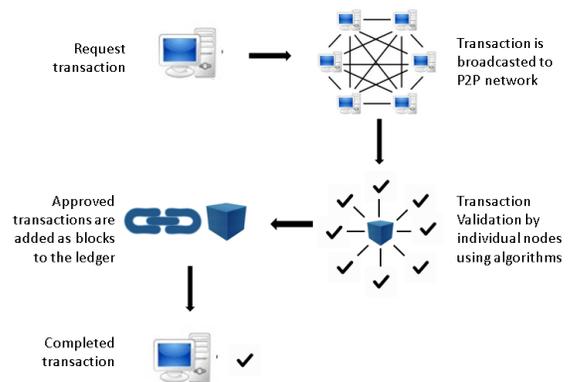


Figure 1 – Blockchain diagram.

Bitcoin is focused on the transference of monetary value between parties and its programming language is very limited. Ethereum, a response to bitcoin, allows other types of programs and applications since it use more programming languages. Ethereum Virtual Machine (EVM), that runs in the Ethereum Network, is the main invention of Ethereum. Ethereum development platform allows the creation of corruption and tamper proof applications.

Specifically, Blockchain is an asset database which is shared across a network of multiple sites, geographies or institutions. Each participant has a copy of the ledge [8]. Blockchain differs from centralized databases since there are no administrator permissions, to edit or delete data.

Cryptography supports both the security of the system and the accuracy of the information that is contained in the database [9]. In Blockchain technology transactions are aggregated in blocks and new blocks are then added to the chain of previous blocks [8]. It provides an immutable record of truth.

Concerning the architecture, in Blockchain the ledger among shared among participants is updated through peer-to-

peer replication. Peer-to-peer consist of the connection of computer systems directed linked to each other, without a central server.

Blockchain can be divided into different categories, including [10]: a) public – any actor can participate; b) private – restricted to a group of participants, i.e., it is limited; c) Permissionless – anyone can participate and would have to be accepted in the network; d) Permissioned – only certain qualified participants can participate.

Smart contracts [11], refers to Blockchains that contains both data and self-executing code. The later are programs that runs themselves, that react to changes in the Blockchain information or to external events.

Blockchain technology can be used in several scenarios, such as peer-to-peer payments and ending, currency exchange a remittance, proof of authorship and ownership, insurance, proof of identity, data storage, security trading, post-trade cleaning and settlement. Additionally, it can be used in public administration in property registry, driver and vehicle licensing, companies' registry and social security benefit payment, digital identity and voting.

Several implementations of Blockchain are based on open source software (e.g. bitcoin, Ethereum, Hyperledger). Such many implementations have functionality and innovation, which are software inventions, have been protected. The number of patent applications related to Blockchain remains low, however the numbers are growing [12]. According to a study [13], “the number of worldwide published patent documents related to Blockchain, distributed ledger technologies and digital or virtual currencies has skyrocketed”. According to the same study, the principal sources for patent filings are the United States, China, and the United Kingdom.

For the future it is expected increase patent filings, include Patent Assets entities, need for parties to have an IP strategy. The ecosystem collaboration will be critical to foster innovation.

Technology evolution changed the way we live, work and play. There are important marks of technological evolution, such as Internet invented by Robert E. Kahn and Vint Cerf, the World Wide Web invented by Sir Tim Berners-Lee, and Blockchain invented by Satoshi Nakamoto who did not aim to patent those concepts. Nevertheless, IP protection plays an important role in technology related to those themes.

According to World Intellectual Property Organization (WIPO), “IP refers to creations of the mind: inventions; literary and artistic works; and symbols, names and images used in commerce” [14]. That information is protected through documents recording in database. Considering Blockchain is a more efficient way of recording data, and generally its characteristics are appropriated to help recording IP. Furthermore, Blockchain has the potentiality to remove many inefficiencies of the actual system, recording IP and also using smart contracts to accept payments and make payments to IP owners. It can record IP ownership, IP transactions and origin and movement of goods. Copyright deposits that are not required in most countries can be easily implemented in a voluntary manner in Blockchain.

There are initiatives concerning Blockchain IP. Ascribe project [15], uses Blockchain technology [16] and smart contracts to allow creators of artwork and digital media to secure their copyright. Creativechain project uses Blockchain technology to “offer a public and transparent alternative to IP registration” [17]. It allows compensation of authors, if new works are created on it according to licence stamped in the Blockchain. Bernstein offers “Blockchain solutions for securing IP assets and innovation processes”. Specifically, it allows to prove the existence, integrity and ownership of creations that can be registered in early stages and later updated and added proof of use. Rosa et al. [18] proposed an IP approach for Open Innovation (OI) and SmartContracts. They advocate that a Networking Innovation Room (NIR) could be a solution for IPR management in OI and SME. It would be a multiplatform offering services to the users and advisors where they interact in order to develop solutions, under the supervision of Blockchain technology. NIR participants declare their IP contribution and knowledge and the NIR will timestamp and store it. That can be used, for example, to fulfil a project consortium for future project proposals. When the user enters the NIR a Non-Disclosure Agreements (NDA) is digitally accepted and signed. The contract allows to the description of the IP and protected creations.

## 2 BLOCKCHAIN IN BUSINESS PROCESSES

Blockchain it's a recent method of tracking transactions using technology that could prove to be revolutionary and that is going to change everything over the next five to ten years [19]. In the future, Blockchain can be applied to every sectors of the economy, where there are transitions due to its faster development and easily adaptation to business uses. This method can be used in tech-businesses and non tech-businesses, namely in the area of financial services, such as: pharmaceutical industry, healthcare, ecommerce companies, etc. Other point also important, is that Blockchain also offers an important term for business processes named "Smart Contracts". These contracts need to respond to specific conditions being subjected to rigorous rules.

### 2.1 Blockchain Impact in the Business Processes

Blockchain can help organizations to implement and execute business processes across organizational boundaries even if they cannot agree on a trusted third party [20]. This is a huge progress, because this technology are enabled to support enterprise collaborations much further than asset management [21]. Blockchain might allow us to discuss many incremental changes using the conventional BPM lifecycle as a framework of reference. This method is also a decentralised and distributed system which can holistically manage relationships and steps. Here the participants share the transactions linked to each step, i.e., the same data source, having into account the accountability, security, internal rules, processes and government regulations. As a consequence, is possible to reduce, costs, time delays and

risks improving the quality of transactions ensuring consistency in the operations.

Beyond the traditional BPM lifecycle there are also challenges and opportunities for BPM and Blockchain technology. This thought is attributed in areas beyond the methodological support such as culture, information technology, strategy, governance, etc.

"Companies can also set up business relations, streamline contractual and legal procedures via smart contracts and conduct cryptocurrency transactions in a safe and easy manner" [22]. This allows entrepreneurs to adopt all the Blockchain technology advantages without the need to develop or adapt them on their own.

## 2.2 Benefits of Using Blockchain in Business Processes

With Blockchain offering a secured, shared, transparent, inexpensive, friction-free for users and unalterable ledger for transactions, it streamlines business processes in need of trust, accountability and transparency. Therefore, the emergence of Blockchain technologies like Ethereum and Neo, among others, came with smart contract and cross-chain capabilities. Smart Contracts represent paper processes in a standardized format and being executed on the Blockchain [23][24].

The question that prevails in any business is how the Blockchain can have an impact on profitability, operations and productivity.

Although, the Blockchain most obvious benefit is the idea of being able to transact and exchange value. However, this method can offer a lot of advantages of these solutions to business of all sizes.

Due to the unique features of this technology, it's allowed to rethink the business processes. This method doesn't need intermediaries, the mechanisms used are cheap and trust is something that doesn't need to be verified as it is embedded in the business networks, as well as respective processes and potential vulnerabilities can be overcome. The advantages or benefits of Blockchain are numerous, however will be presented those that the author considers most relevant:

Decentralization- is a Blockchain benefit and core concept, i.e., a consensus mechanism is used to agree on the validity of transactions, excluding this way, the necessity of having an intermediary to validate transactions.

Transparency and trust- The system is transparent and trustable, due to the fact that this method is shared, and everyone can see what is in it. This is more relevant in some scenarios such as benefits or disbursement of funds in which personal discretion should be confidential.

Immutability- When the data is written in Blockchain it is very difficult or almost impossible to change it. This benefit is seen as a maintaining an immutable ledger of transactions.

High availability- The Blockchain system is based in a peer-to-peer network. This means that is based on thousands of nodes and these ones are updated and replicated on each and every node become the system highly available. Even if the nodes become inaccessible or leave the network the network continues to work making it highly available.

Highly secure- Every Blockchain transactions give integrity and are cryptographically protected.

Simplification of current paradigms- Nowadays, this method is quite disorganized in several sectors like health or finance. However, several entities maintain their own databases and the sharing of this data can become very difficult due to different nature of the systems. This method can serve as a single shared ledger among interested parties, which can result in the simplification of the model decreasing the complexity of managing the separate systems maintained by each entity.

Faster dealings- Blockchain can play a fundamental role in the financial industry namely in post-trade settlement functions, allowing a faster settlement of trades since a single version of agreed data is available on a shared ledger between financial organizations.

Cost saving- As no third party is required in the Blockchain method the overhead costs (in the form of fees) can be eliminated.

Thus, adding Blockchain to existing IT system landscapes to empower a specific use case, one ends up with business integration [23]. The triumph of a Blockchain performance is measured by the time and costs it took to be implemented having into account the advantages it brings to the procedure.

## 2.3 Use Case of Blockchain in a Business Process

The author is going to use a simple use case, that can be used by everyone in your quotidian life such as to buy a car through an internet portal, via e-mail. Normally, in this case the buying process is done with the seller directly and to complete the sale it is necessary that the buyer pays the car and the seller deliver the car, the car documents and receives the money, but usually they don't know each other, which can generate a problem of trust between both parties. And to solve this problem, usually it is contracted an intermediate such a lawyer, or the bank, etc., to finalize the transaction with success. However, the intermediates costs money. Consequently, to solve these problems, the lack of trust and the intermediate costs it can be used the Blockchain technology. In this case the "smart contract" which is an automated and small software program in the Blockchain that is secure and can replace the intermediates, making transactions less costly than in a "real, physical" transaction. Thus, the Blockchain contains a database (ledger) where all data is distributed to everybody joining and adding some clever cryptography to make it impossible to change or fake data once it is in there and to ensure that certain methods can be called by the appropriate participants [25]. And how it works? The smart contract can be easily built through the "Ethereum" application (there are other applications) using the cryptocurrency as a transaction coin. This contract as the power of lock virtual money in a safe way. Thus, it is possible to connect business processes that are automated with the "Ethereum" application for instance using the "Camunda Platform" as a way to build a prototype.

Therefore, the private business process of one party (e.g. the car dealer) can be automated on a classical workflow automation platform and the public process is automated using a smart

contract. Because you can get rid of paperwork with smart contracts this setting will allow straight-through end-to-end processing of two parties without mutual trust.

### 3 SENSING ENTERPRISE

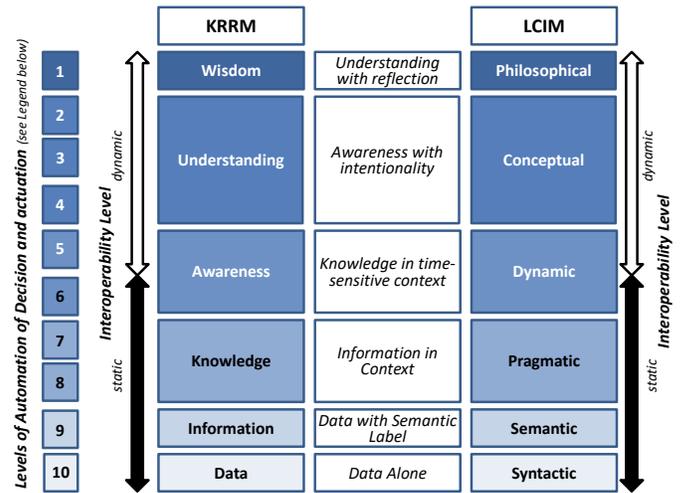
Today, due to developing globalization, strict regulation, and uncertainties on the one hand, and evolution of the Internet of Things (IoT) on the other hand, enterprises are faced with increasing demand for an adopted class of enterprise systems. In order to meet this demand Sensing Enterprises (SE) are introduced to not only make enterprise aware about the environment they operate in, but also facilitate forecasting their future decisions. It also helps enterprises to optimize their behaviors and take the best action by capturing multi-dimensional data from verity of sources (e.g., virtual, physical, and social environments) through Cyber Physical System [26]. Although sensing enterprise is still a trending topic these days, it can positively influence a great deal on the redesign of business processes by taking the advantages of application IoT. Therefore, the things are connected with others anytime, anywhere, and anybody can apply any services and network. The literature [27] shows that the adaptation of this new paradigm helps improving the performance and productivity of almost all major business process with tech-wise operations, specifically those processes that are associated with Information and Technology (IT) in an organization.

Evidences demonstrate that SE opens a new door of opportunities for businesses to widely benefit from a networked-ecosystem (including partners, customers, suppliers and even competitors), extended business function, triggered rules, collected valuable information and so forth. [28] declares that SE is characterized by decentralized intelligence, and relies on context awareness, dynamic configurability and multi-identity oriented virtual entities. In parallel perspective, the two main characteristics of SE (knowledge management, and actuation and automation) are pointed out in follow to pave the way for the rest:

#### 3.1. Knowledge Management

SE relies on collecting and processing wide variety of information and data from different sources. Real time information and data are constantly received by SE from the surrounding environment both virtual and physical through underling applications and technologies such as, sensing information, tweets, or RFID that reinforce the sensing capabilities of the enterprise, and they are used to feed decision makers. SE by applying for example, the internet, intranets, extranets, data mining techniques, data warehouses, software agents and also by changing the manner of leveraging and managing the created, stored, and/or shared knowledge enables business to effectively turn their incoming big data to useful knowledge, achieve sustainability, gain competitive advantages, improve response to environmental changes, promote efficiency

and innovativeness, foster inward and outward knowledge flows, and etc. [29].



LEGEND: Levels of Automation of Decision and actuation

1	The computer decides everything, acts autonomously, ignoring the human
2	The computer informs the human only if it decides to
3	The computer informs the human only if asked
4	The computer executes automatically, then if necessarily informs the human
5	The computer allows the human an restricted time to veto before automatic execution
6	The computer executes an decision/action if the human approves
7	The computer suggests one decision / action
8	The computer narrows the set of decision/ actions alternatives to a few ones
9	The computer offers a complete set of decision/action alternatives
10	The computer offers no assistance: human must take all decisions and actions

Figure 2 – Sensing Enterprise System Automation, Intelligence and Interoperability Levels [29]

#### 3.2. Actuation and Automation

Sensing enterprise system has been defined as “an enterprise anticipating future decisions by using multidimensional information captured through physical and virtual objects and providing added value information to enhance its global awareness” [30]. That can be achieved, among other factors, through the application of automation processes to acquire information, for instance the use of sensors to sense objects. The automation level is gradual and related to intelligence & knowledge representation capability and interoperability as represented in figure 2. Exemplifying, if the computer allows the human a restricted time to veto before automatic execution, the interoperability level is dynamic and the level of knowledge handling which relates to the intelligence is awareness. Since automation are fundamental to sense, adapt and act according to contexts, one can say that all sensing enterprise systems should have a considerable level of automation/actuation.

SE by using various means and control systems such as, machinery, hydraulic, mechanical, electrical, and computers or combination of them can support the process of actuation and automation in order to for example, minimize human intervention, optimize value chain, improve monitoring and controlling of production and delivery system, promote product quality, reduce factory lead times and etc. Considering the two above-mentioned characteristics of SE, and findings in [28], there are some similarities and overlapping between the concepts of context awareness and knowledge management, as well as between the concepts of decentralized intelligence and dynamic configurability with knowledge management, and actuation and automation.

### 3.3 Patents and IPR

The evolution of SE has help to gain new business value across digital business innovation and supply chains to unexplored trajectories in *innovative product design*. That is, businesses are hereby empowered to provide unprecedented levels of valuable knowledge and information which can be used in the process of product design in order to not only make this process convincingly ground-breaking, but also provide new delivery services for customers that could enhance subsequently revenue opportunities [31]. It is widely believed that innovation enables organizations to achieve a range of key business outcomes, and also it is commonly viewed as the primary driver of sustained improvements in human welfare and economic growth. The creation of IP institutions, particularly patents, has been motivated by a desire to stimulate innovation, and support economic growth [32]. The process of innovation begins from the conception of an idea to the launching of a new product or process in the market place being the IPR used to facilitate successful innovation. Gauging the importance of IP in innovation by merely focusing on patents as input and/or output of innovation, does not do justice to the significant role that can be played by the other tools of IP. IP provides access to financing and technical facilities, as well as, a strong negotiation position when it comes to entering into and maintaining business partnerships [33]. Therefore, IPR and patentization processes have a connection with the business processes or business methods. To understand this connection, it is necessary to comprehend what a business process is.

A business process is a collection of linked tasks which find their end in the delivery of a service or product to a client, and also a set of activities and tasks that, once completed, will accomplish an organizational goal. This process must involve clearly defined inputs and a single output [34]. The benefits of using business processes include improved customer satisfaction and improved agility for reacting to rapid market change. Process-oriented organizations break down the barriers of structural departments and try to avoid functional silos [35].

It is usually to hear about how IP protects all creations of the mind and at once think that these ideas have monetary value. Business process may be referred to a process of operating any aspect of an economic enterprise, since every company has its own strategy and goals evolving an approach or system to

achieve them. These companies usually invest huge amount of resources in order to find a suitable approach or system to reach their goals. One of the ways of protecting their innovative methods and approach from their competitors is patenting their business method [36].

SE by connecting large number of people (who may have great ideas), and also bringing pool of cutting-edge tools and technologies into organizations has greatly accelerated general and particular improvements in business innovation. There are a lot of successful examples of entrepreneurial businesses that have been harnessing the transformative power of SE in *innovation*. In this regard some legal rights such as, *IPR and patenting* can be effectively used to facilitate successful innovation.

SE has a high potential to influence on almost all industries around the world in the near future. As businesses and companies over the last years have shown too much interest to use SE, it can be augmented and also reach greater results when coupled with second version of Internet so-called "Blockchain" (that is a continuously growing list of digital files that are distributed to a peer-to-peer network of computers). Although these two hot buzzwords are rarely seen together, from associating perspective, as a result of created network of businesses, when a change or an improvement is made within the network, it can be immediately accessed by other linked partners. Benefiting from this coupled service has undeniable advantages for businesses, decentralization, better supply chain management, quality assurance, regulating the availability of health records, providing transparency, reducing transaction costs, facilitating transaction settlements, peer-to-peer global transactions, are to name but a few [37].

## 4 FUTURE TRENDS OF BLOCKCHAIN IN SENSING ENTERPRISE BUSINESS PROCESSES

### 4.1. Knowledge Management

There is no doubt that knowledge is power, and when it is appropriately harnessed and managed, it could fuel a prosperous business. Knowledge management deals with the organization of the entire process of identifying, generating, representing, sharing, and utilizing of knowledge. Normally, businesses keep vast collection of knowledge or information in the form of database, files, or memos. In addition, businesses of all kinds are almost conscious of the need to properly and securely manage their possessed knowledge. Hence, successful businesses are going beyond the traditional or paper-base approaches of knowledge management that require spending money, time and energy in large amount. Literature shows that as technology is advanced, it has had a tremendous influence on managing knowledge or information. Every day, new technologies, tool, or software are emerging that can facilitate rapid knowledge discovery and application in critical businesses. Over the last years various supportive technologies from computers and tablets to screen casting, whiteboards or webcams have all found their uses not only in businesses but also in educational settings. Currently, various knowledge management strategies,

techniques, and trends are also existing that each of them have certain benefits over the other, for instance, use of mobile technologies, enterprise collaboration, search indexing, user-friendly interface, automatic update, customization and scalability, etc. [38].

The fact is that times are changing, and those businesses that fail to well adapt and keep up to date, would be left behind. With that in mind, it is reported that Blockchain has also been gaining popularity for growing usage in different contexts. One emerging application of Blockchain is for knowledge management, in which knowledge and information are permitted to store and manage in tamper-resistant and irrevocable manner by means of cryptographic technologies and distributed computing. It also opens up the possibility for even providing a decentralized knowledge sharing ecosystem where knowledge can be widely but securely distributed between large number of collaborative nodes with no central control. For example, Lunyr is a Blockchain start up giving the familiar crowdsourced encyclopedia model we are all familiar with a decentralized facelift. Its platform provides rewards for those sharing knowledge or information. However, there is a scarcity of clear knowledge and understanding of how Blockchain effectively impacts on knowledge management. Furthermore, the full capacity of Blockchain in knowledge management is not yet completely revealed at this early stage. It can be envisaged that if greater attention is paid surrounding this issue, it could potentially shape the future of modern knowledge management [39].

#### **4.2. Supply Chain**

Blockchain in conjunction with IoT (Internet of Things) will probably revolutionize the monitorization of the supply chain, automatizing it. The products conditions can be monitored using sensors; that data can be stored using Blockchain technology. In that context Smart contracts, which allow to reduce the number of intermediaries, will be self-executed on the data in the Blockchain. One advantage of reducing the number of intermediaries is the reduction of operational expenses and manipulation risks [40]. This trend can be used in the monitorization of temperature during the transportation of medical products, as used by modum.io [41]. Enterprises that transport food also can benefit from this perspective, ensuring that food is always transported in good conditions.

#### **4.3. Innovative Product Design**

Although the Blockchain applications are a new breed, particularly in the context of innovative product design, and both the concept and process are evolving, it is not unexpected that in the near future it could considerably alter the way companies do business and operate. In view of this, at the present, there are several evidences that show Blockchain not only has the potential to enhance the product development supply chain by eliminating financial services intermediaries, and through low-cost assurance of trust that brings about by means of technology underpinning cryptocurrencies, but also it allows businesses to immediately find each other and start trading relationship. As

well as them Blockchain is also shown have the capacity to improve business development operation and positively influences on innovative product design. For instance, The Digital Supply Chain Institute (DSCI), in partnership with Aricent and the Bitfury Group reported that the results of their pilot projects which take the advantages of Blockchain technology can deliver products 34 percent faster than before. They also added, in the process of new software design and development, Blockchain has enabled them to increase the cycle time by 34 percent, productivity by 29 percent, and quality by 11 percent [42].

#### **4.4. IP and Patents**

As said before, Blockchain is the evolution of the system based on trust, to a system based on mathematics and technology. It is also a large distributed, open, and public database that is accessible for everyone who is connected to the internet [43]. Thus, the Blockchain can be used in the IP market as a method extremely secure, which was already validated in some markets. The main goal is to connect the owners of IP assets with other people and companies that could have interest in using and licensing such assets. Therefore, it creates a digital asset repository that allows the owners of the IP assets to license their assets online and securely, monetizing their trademarks, patents, industrial designs, etc.

For instance, if one company in Portugal has a technology patent, but doesn't make use of it, it would generate unnecessary costs to the company due to the maintenance of the active registration. If another company from other country saw in this patent an opportunity of market, they will be interested in use this patented technology. The 'standard' way of licensing such technology requires a lot of time and money until the contract be finalized and the patent used.

Blockchain can speed up and facilitate this process. The contract between the companies will be signed digitally and stored on the network, with all the security provided by the technology. Additionally, if the royalty payments are made in a kind of pay per use this technology is able to be more effective protecting both sides from fraud.

This technological method will be a new option to facilitate the consumption of patents and other assets that are not in use, creating a new source of revenues for companies that invest in innovation.

Thus, the patents and IP processes performed through the Blockchain method will transform the process of evaluation faster, cheaper; trustable, reducing the plagiarism and increasing the opportunities between companies all around the globe.

## **5 CONCLUSIONS**

Blockchain is an emerging paradigm and a revolutionary change towards democratization and decentralization. Blockchain is known as a distributed ledger, and businesses are now adopting it more and more. Blockchain can record transactions between two parties efficiently in a verifiable and permanent way without the need for a central

authority. There is no limit to how much Blockchain technologies can provide businesses a better way to do things in finance, operations, management and more.

Evidences prove that Blockchain has the potential to apply in different contexts and positively impacts on all sectors of economy. As the economies and societies are becoming increasingly networked and digitalized, generating the so-called SE systems where the adaptation of Blockchain in their related enterprises provides them the possibilities to reduce costs and improve certain processes, advance product and customer data tracking and security, increase product safety, and reduce fraud and counterfeiting.

## ACKNOWLEDGMENTS

The authors acknowledge the European Commission for its support and partial funding and the partners of the research project Horizon2020 Program under grant agreement No. 723710 "Virtual Factory Open Operating System" (vf-OS). The work has also been promoted under the project CARELINK, AAL-CALL-2016- 049 funded by AAL JP, and co-funded by the European Commission and National Funding Authorities of Ireland, Belgium, Portugal and Switzerland.

## REFERENCES

- [1] Financial Action Task Force (FATF) report, 2014. "Virtual Currencies Key Definitions and Potential AML/CFT Risks," 2014. Retrieved from the web in April 2018 at: <http://www.fatf-gafi.org/media/fatf/documents/reports/Virtual-currency-key-definitions-and-potential-aml-cft-risks.pdf>.
- [2] "Case C-264/14," 2015. [Online]. Available: <http://curia.europa.eu/juris/document/document.jsf?docid=170305&doclang=EN>. [Accessed: 29-Mar-2018].
- [3] M. Koevoets, "Monetary Policy Implications for the trade-off between a Private Digital Currency and a Central Bank Issued Digital Currency."
- [4] M. Crosby, "BlockChain Technology: Beyond Bitcoin," *Appl. Innov. Rev. Issue*, no. 2, 2016.
- [5] A. Robleh *et al.*, "Innovations in payment technologies and the emergence of digital currencies," *Bank Engl. Q. Bull.*, vol. Q3, no. 3, pp. 262–276, 2014.
- [6] S. Nakamoto, "Bitcoin A Peer-to-Peer Electronic Cash System," 2008.
- [7] D. Tapscott and A. Tapscott, *Blockchain Revolution: how the technology behind bitcoin is changing money, business, and the world*. Penguin, 2016.
- [8] "Blockchain Definition | Investopedia." [Online]. Available: <https://www.investopedia.com/terms/b/blockchain.asp>. [Accessed: 30-Mar-2018].
- [9] A. Narayanan, J. Bonneau, E. Felten, A. Miller, and S. Goldfeder, *Bitcoin and Cryptocurrency Technologies a Comprehensive Introduction*. Princeton University Press.
- [10] "Types of Blockchains & DLTs (Distributed Ledger Technologies)." [Online]. Available: <https://blockchainhub.net/blockchains-and-distributed-ledger-technologies-in-general/>. [Accessed: 30-Mar-2018].
- [11] "What is smart contract? - Definition from WhatIs.com." [Online]. Available: <http://searchcompliance.techtarget.com/definition/smart-contract>. [Accessed: 30-Mar-2018].
- [12] "Blockchain For Patents - Patents For Blockchain - Fin Tech - Switzerland." [Online]. Available: <http://www.mondaq.com/x/677326/fin+tech/Blockchain+For+Patents+Patents+For+Blockchain>. [Accessed: 30-Mar-2018].
- [13] M. KAUFMAN, "A Blockchain Innovator's Guide To Ip Strategy, Protecting Innovation & Avoiding Infringement."
- [14] "What is Intellectual Property?" [Online]. Available: <http://www.wipo.int/publications/en/details.jsp?id=99&plang=EN>. [Accessed: 31-Mar-2018].
- [15] "Artists & Creators | ascribe." [Online]. Available: <https://www.ascribe.io/>. [Accessed: 31-Mar-2018].
- [16] "You Own Your Intellectual Property - Ascribe.io Looks To Revolutionize Digital Art." [Online]. Available: <https://www.ccn.com/intellectual-property-ascribe-io-looks-revolutionize-digital-art/>. [Accessed: 31-Mar-2018].
- [17] "Creativechain - Blockchain culture project for the registration and distribution of content." [Online]. Available: <https://www.creativechain.org/project/>. [Accessed: 31-Mar-2018].
- [18] J. Lluís De La Rosa, D. Gibovic, V. Torres-Pedrosa, L. Maicher, F. Miralles, A. el-Fakdi, A. Bikfalvi, "On Intellectual Property In Online Open Innovation For Sme By Means Of Blockchain And Smartcontracts."
- [19] Adam C. Uzialko, 2017. "Beyond Bitcoin: How Blockchain is Improving Business Operations". Retrieved from the web in April 2018 at: <https://www.businessnewsdaily.com/10414-blockchain-business-uses.html>.
- [20] Jan vom Brocke, Jan Mendling, Ingo Weber, 2018. "Part 1 the BPM Lifecycle" - BPTrends Column. Retrieved from the web in April 2018 at: <https://www.bptrends.com/bpt/wp-content/uploads/04-03-2018-COL-Class-Notes-VomBrocke-et-al-word-doc.pdf>.
- [21] Mendling, J. et al., 2018. "Blockchains for Business Process Management - Challenges and Opportunities". Retrieved from the web in April 2018 at: <https://arxiv.org/pdf/1704.03610.pdf>.
- [22] Bruce Hughes, 2016. "The benefits of digital business process management with blockchain technology". Retrieved from the web in April 2018 at: <https://www.computerweekly.com/opinion/The->

- benefits-of-digital-business-process-management-with-blockchain-technology.
- [23] Vladislav Kirichenko, 2017. "Smart Contracts On The Blockchain: Can Businesses Reap The Benefits?". Retrieved from the web in April 2018 at: <https://www.forbes.com/sites/rogeraitken/2017/11/21/smart-contracts-on-the-blockchain-can-businesses-reap-the-benefits/#6e6bc2991074>.
- [24] Unibright.io, 2018. "Blockchain enabled business processes". Retrieved from the web in April 2018 at: <https://medium.com/@UnibrightIO/blockchain-enabled-business-processes-b7fa234f224f>.
- [25] Yulia Zorkina, N/A. "What is the benefit of blockchain technology?". Retrieved from the web in April 2018 at: <https://www.quora.com/What-is-the-benefit-of-blockchain-technology>
- [26] FInES Cluster Position Paper on Orientations for FP8: A European Innovation Partnership for Catalysing the Competitiveness of European Enterprises. 2011.
- [27] M. Ferretti, and F. Schiavone, "Internet of Things and business processes redesign in seaports: The case of Hamburg, " *Business Process Management Journal.*, 22(2):271-284, 2016.
- [28] G. Santucci, C. Martinez, and D. Vlad-Câlcic, "The Sensing Enterprise, " *FInES workshop at FIA*, 2012.
- [29] J. Sarraipa, M. Ferro-Beca, C. Marques-Lucena, and R.Jardim-Goncalves, "Knowledge Management support in Sensing Enterprises Establishment," *Proceedings of the 19th World Congress The International Federation of Automatic Control Cape Town, South Africa*. August 24-29, 2014.
- [30] Satucci, G., Martinez, C., Vlad-câlcic, D. 2012. The Sensing Enterprise.
- [31] F. Lampathaki, I. Alvertis, S. Koussouris, P. Kokkinakos, J. Psarras, G. Viscusi, and CH. Tucci, "FutureEnterprise, A Roadmap for Sensing Enterprise," *Proceedings of the 6th Workshop on Enterprise Interoperability, Nîmes, France*, 27-05-2015, published at <http://ceur-ws.org>.
- [32] M, Petra. 2016. "Patents and Innovation in Economic History". *Annual Review of Economics*. Vol. 8:241-258.
- [33] World Intellectual Property Organization. Retrieved from: [http://www.wipo.int/sme/en/documents/ip\\_innovation\\_development\\_fulltext.html](http://www.wipo.int/sme/en/documents/ip_innovation_development_fulltext.html)
- [34] <https://www.appian.com/bpm/definition-of-a-business-process/>
- [35] Wikipedia. Retrieved from: [https://en.wikipedia.org/wiki/Business\\_process](https://en.wikipedia.org/wiki/Business_process)
- [36] Selvam & Selvam. 2018. Retrieved from: <https://selvams.com/blog/protecting-business-processes-intellectual-property-india/>
- [37] M. Swan, "Blockchain: Blueprint for a new economy, " 2015. Available at: <http://w2.blockchain-tec.net/blockchain/blockchain-by-melanie-swan.pdf>
- [38] B. Dutta, D. P. Madalli, "Trends in knowledge modelling and knowledge management: an editorial, " *Journal of Knowledge Management*, Vol. 19 Issue:1, 2015. <https://doi.org/10.1108/JKM-10-2014-0442>
- [39] F. Hans-Georg, H. Felix, "Knowledge Blockchains: Applying Blockchain Technologies to Enterprise Modeling," *Proceedings of the 51st Hawaii International Conference on System Sciences*, 2018.
- [40] T. Bocek, B. B. Rodrigues, T. Strasser, and B. Stiller, "Blockchains Everywhere -A Use-case of Blockchains in the Pharma Supply-Chain," 2017.
- [41] M. Heimgartner, "Improving the Blockchain System for Temperature Monitoring."
- [42] Ira Sager, 2018. "New Research Shows Blockchain Speeds Product Development for Mobile Operators". Retrieved from the web at April 2018: <https://www.aricent.com/news/new-research-shows-blockchain-speeds-product-development-mobile-operators>.
- [43] Malgueiro Campos. 2017. O Direito na era do blockchain- Retrieved from the web at April 2018: <https://www.malgueirocampos.com.br/o-direito-na-era-do-blockchain/>