Smart city development, blockchain for the vehicle registry: a study in Romania

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Abstract

The current state of business worldwide is being challenged by technology, which completely transforms old and arduous processes. As the main modern concern is overall data protection and the greater aim is building smarter cities, companies and government agencies are increasingly focused on blockchain databases.
This paper focuses on the vehicle market, as it is continuously evolving sales-wise, technology-wise and for comfort/driving possibilities. While studies (Meticulous Market Research, 2020) show that vehicle Artificial Intelligence grows in revenue, they also prove that this is an insecure market, due to miss opportune hackings. Thus, a greater need for security is being expressed all over the vehicle market and many industry players have shifted their attention towards blockchain and its benefits.
This paper investigates and describes the concept of vehicle industry in Romania focusing on students sampled from a small demographic segment, due to research limitations. The aim of this study is to examine the importance of having a blockchain system implemented and what are the challenges to have this in place. By analyzing the surveys gathered from 150 students, this study has found that a huge percentage of respondents have a positive attitude towards this technology, hence this is a valid solution for future implementation as it is discussed below in this research.

1. Research Overview

1.1 Introduction and research background

Several specialists (e.g., Zhao et al. 2016) believe the technology that is anticipated to have the greatest effect in the following decades is not social media, or big data, not robots, or AI, it is the underlying technology of cryptocurrencies, such as bitcoin, and it is named blockchain technology. Pilkington (2016) states that this is the technological transition that can be incorporated and applied with mobility, the social media, the Internet of things, big data, artificial intelligence, drones & robots, and the cloud. That means that blockchain may be the next phase of the Internet, as blockchain holds tremendous promise for every company and every society.

For the past decade most, if not all, organizations have come across or used the internet of information, for sending emails or Excel, PowerPoint files, but in fact what organizations don't realize is they are actually sending a copy of the original file, which is good as it is democratized information. However, when it comes to assets, being money, stocks and bonds, copyrights, patents, trade secrets or even a vote, sending a copy is a really bad idea. (Fawcett and Buhle, 1995).

Blockchain technology improves the protection of sensitive data in the creation of decentralized models of business. Thus, this paper will introduce a vehicle registration scheme based on the blockchain concept from using Hyperledger Fabric. This scheme takes account of many government bodies in one region but can be expanded to a be used and interconnected in one system that facilitates the exchange of vehicle information at the European level (Van et al. 2018). Since this is still a scarcely used system for various applications and it's relatively new in government affairs, this seemed a great occasion to analyse the advantages of using a blockchain application for a local vehicle registry.

The current vehicle registry in Romania is old, complex and is not fully digitalized, as it just started, in late 2020, to improve its online services, with the implementation of online payments. According to the Romanian paper Anon (2020), DRPCIV also decided to reduce constant queues and start the digitalization of its services, by allowing their customers to book online appointments, to help reduce the number of people queuing. Another issue with the current system is the fact that, even today, there are still around 1% fake documents and frauds discovered in this segment, for example there are errors in vehicle mileages declared, among other issues that exists in the traditional paperwork processes, especially in the used vehicle market (Ministerul Afacerilor Interne, 2009).

Thus, the background of this paper is to discuss and present an overview of how vehicle registration currently works in Romania, together with its main components and processes and reveal can these be improved. The premise of analysis was the idea of improving a government agency by implementing a new solution: blockchain technology. As a result, the paper will introduce the blockchain technology into the Romania vehicle registry, showing how it would hypothetically look like. The next section will discuss the smart city concepts like Dubai or Estonia (2020) and how can blockchain adoption help in developing smart cities in Romania, showing examples for when it is used with other systems. Secondly, the paper will highlight the barriers of government agencies, sharing data among each other, and how can blockchain resolve these barriers, with an emphasis on its implementation on the vehicle registry (UAE Government, 2018).

Furthermore, the paper will look at the vehicle registration process and, mainly focuses on how university students deal with it (students are viewed as individuals who already own a vehicle or are about to purchase their first one). Due to limited time and resources, this research analyses a small segment, but the recommendation is to further this subject and collect more data, essential to the end purpose: using blockchain for the Romanian vehicle registry. Narrowing down the research only to students helps by analysing an important segment of the vehicle market, such as beginner drivers or first-time owners, since they are less experienced both in vehicle registry, as well as in technology implementation. Studies by Hedges (2021) show that vehicle owners aged 25-51 represent 50% of all vehicle categories, many of them having bought a vehicle for the first time.

Moreover, the paper will also discuss the general adoption of blockchain technologies, and how large organizations profit from them, but also about how blockchain can help improve the vehicle registry in Romania. Surely, the subject stretches to improvements such as smart city development, since technology is big part of the entire process, with an emphasis on Romania.

1.2 Problem statement

An analysis of the current Romanian vehicle registry helped identify current issues, as they all underline the barriers between functional processes and the state of affairs. The general problem is that we uncovered a platform that needs technological improvement, to better serve its clients. The faults identified with this research are related to the time and money consuming aspects of vehicle registering in Romania, as well as to the health issues involved in current procedures.

For a better understanding of this problem, there is a need to identify **who, what, when and where** are affected by the current faults of this system. These parameters will help discover a comprehensive and solvable idea, in the form of an effective proposal. Since the general concept of **what is under analysis:** the Romanian vehicle registry, the following paragraphs will identify the **who, when and where** variables of the problem statement.

1.3 Research Aims and Objectives

The intent of this paper is to explore how the government should first digitalize the related government departments and introduce a blockchain solution that will help make the vehicle registration activities more efficient IBM Blockchain (2019). Of course, this implies that research will uncover the opportunities and advantages this solution may give to DRPCIV and Romanian people. Another aim of this research is to get a deeper understanding of how vehicle owners and potential buyers (especially students) see digitalization and how different actors within the Romanian second-hand car market see the relationship with local vehicle registry.

Integrating blockchain technology into any vehicle registry represents an extensive subject, with many angles to approach (Mougayar, 2016). In addition to exploring the current process and issues of the Romanian vehicle registry and how blockchain adoption into this segment may impact smart city development, there are a few main objectives carefully polished inside the current research. After intense consideration, the objectives chosen for deeper analysis were the following:

- To get a deeper understanding of how vehicle owners view the registry and, possibly the implementation of blockchain;
- Address issues relating to data sharing among government agencies, how can blockchain resolve them and how it can to further help in the process of vehicle registry digitalization.

Furthermore, these objectives will be highlighted with help from the questions set for the research segment of the current paper. These will be detailed inside the next chapter, with details about their contribution to the research objectives.

1.4 Research Questions and Contribution

The starting point of this research was the idea of how could blockchain solve the issues of students' vehicle (used or new) registration and how it could impact them, by first identifying how they view the system, if they care about what technology is behind the digitalization the and if it is centralized or decentralized. Theory shows that blockchain is far greater than other options, even than centralized data, for private or public platforms (Xu et al. 2017).

Research questions are an essential tool to the entire process, even if they are related to academic purposes or daily life endeavour, as they help the researcher define the purpose of the act. Also, targeted questions shape and influence all the following steps taken in order to conduct and successfully finalize the research (Haynes, 2006). Having all the objectives defined, the next step in this inquiry was to identify a series of questions that could help achieve a valid result.

Main research questions are:

1. How do different actors involved, such as vehicle owners and potential buyers, especially university students in Romania, see digitalization in this area? Will they be able to properly use this technology?
2. Will they be able to sign and exchange private (like name, ownership documents) information online? Will they be able to pay a fee for this process or do they prefer it to be free?
3. Which main issues do users/vehicle buyers have when dealing with vehicle registry?
4. Which are the main objectives in implementing the blockchain system?
5. How well can blockchain improve the processes of the Romanian vehicle registry? How much time, money will it save and how it can socially, financially impact users, government agencies, the city, the environment?

As the main research questions were identified, the next logical step was to select a demographic group, relevant to the study, which can provide an essential feedback, needed to draw the conclusions. This paper mainly focuses on students without limitation to age, as most students are at young age in general and to focused more it will focus only on students from Bucharest, Romania, due to the fact that the entire process takes time and students are forced to spend 2 – 3 days to complete the process of registering a vehicle, while they should be studying or working, to support their financial needs (Wallstreet Romania, 2019). Most students have a part-time or full-time job, which allows them to support the cost of living, thus are more careful with their expenses.

Local studies INS (2019) show that, in 2019, 50% of Romanian population was represented by age categories ranging from 20 to 50 years, which include student ages. Another reason for choosing this segment is the fact that students are more digitalized, are more familiar and aware with the technology, much more experienced than older generations. Also, one other argument on their behalf is the classic idea that people usually purchase their first vehicle while being a student (Hedges Company, 2021).

This topic has been chosen out of personal interest as well since, until now, no other research has been found on blockchain technology for vehicle registration in Romania. Since the Romanian vehicle registry is not yet fully digitalized for public use (although steps are being

taken in this direction), private information can get highly vulnerable to frauds and data tampering or even become untraceable (Koteska et al. 2017).

The process of vehicle registration has always been complex, it is a time-consuming process, where multiple parties are involved and leaves room for error. Also, this process poses a risk of information manipulation, data duplication and various errors, especially for people without the experience needed or knowledge required when purchasing a vehicle, not necessarily a new one. Most large companies or big dealers handle most of the paperwork on customers' behalf, but when it comes to used vehicles, there are multiple errors, for example millage frauds, duplicated documents and many more (UAE Government, 2018).

Having set the demographic fraction for analysis, the survey objectives came easy and in line with the desired outcome of this paper: to determine if people will use blockchain solution for this sort of government services, if they are willing to exchange personal data online and if they will be willing to pay a fee for the new and improved platform. Ultimately, a main purpose is to discover if and how can blockchain technology improve the system, how it will impact all parties involved (socially, financially, practically and timewise).

As all principles and systems necessary to go further with this study were established, there are various details to consider, which will be detailed and documented inside the following chapter of the literature review.

1.5 Structure

In order to achieve its objectives, the paper is structured according to theme relevance, as follows: Section 1 is presented as a general introduction into the subject, the aims of the current research and the purpose of conducting such a study. Following closely, Section 2 introduces literature review – absolutely vital in understanding the concepts addressed inside the research, as it includes blockchain and smart city definitions, classification and other technical aspects. The 3rd and 4th Sections particularize research methods used, their classification, analyse collected results and interpret the data, finding connections and variables. Lastly, Section 5 reviews research conclusions and recommends future ways of action in this area.

For the empirical part of this study, a quantitative research was conducted among a small demographic sample, which helped identify the validity of our theory. The questionnaire at the core of this research was distributed online, as this is the general subject approached all across this paper. Given the numerical aspect of research data, a series of statistical analysis methods were employed, which helped interpret results. Further details and findings will be particularized inside the research and data analysis chapters.

2. literature Review

Romania is home to the highest number of people in the Balkan area, and so it is no wonder that it provides a wide variety of ecosystems and cultures. While the Carpathian Mountains are not as universally rugged as many other Balkan countries, they are a significant part of the country's heritage. Romania joined the EU in 2007 and has a population around 19 million, representing 3.8% of the EU population and it is the twelfth-largest country in Europe (Romania, 2021).

As many are aware, Romania is the European champion and sixth in the continent, with a density average of 1,000 inhabitants (higher than the US or Russia) for the number of **qualified IT specialists**. Nearly 100,000 IT Romanian practitioners are open. Around 5,000 of Romania's 30 thousand engineers graduate in ICT every year (Anon, 2021). The outstanding number of IT specialists made every year in Romania only shows the depth of desire for digitalization in young generations. To understand the current research hypothesis, we have analysed the general

conditions of Romania, as a country, with an emphasis on its economy, population indicators and, of course, its vehicle registry.

2.1 The Economics

There are several rivers in Romania, The Danube is the longest (which is 1,777 miles and the longest river), which during its course it passes **through** 10 countries, among which: Germany, Austria, Slovakia, Hungary, Croatia, Moldova and Ukraine, ending in the Black Sea port of Constanta (Romania River Map, 2021). Given that water-based transportation is the cheapest and goes across much of the country, it has great benefits for trade in Romania (Bosomitu, 2017).

The average population is 18 million and, according to the World Bank, Romania's per capita income is 31,840 PPP dollars (2019). The turnover from treads declined in 2020 by around 17%, even though high frequency indicators are predicting quick rebounds. According to the world bank, Romania is a high-income state for the first time, following the results from 2019, when per capita income indicates 12.630 USD. This shows high value of development for the investment rating to organizations for economic co-operations and development.

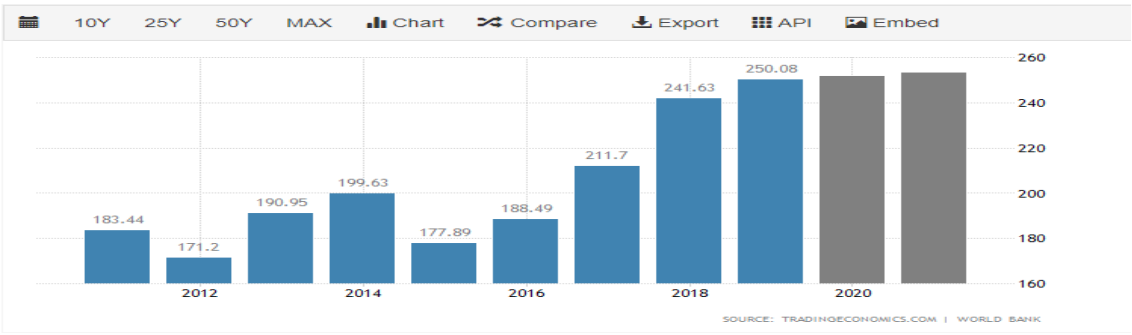

Figure 1 - GDP Annual Growth details (Source: worldbank.org, 2020a)

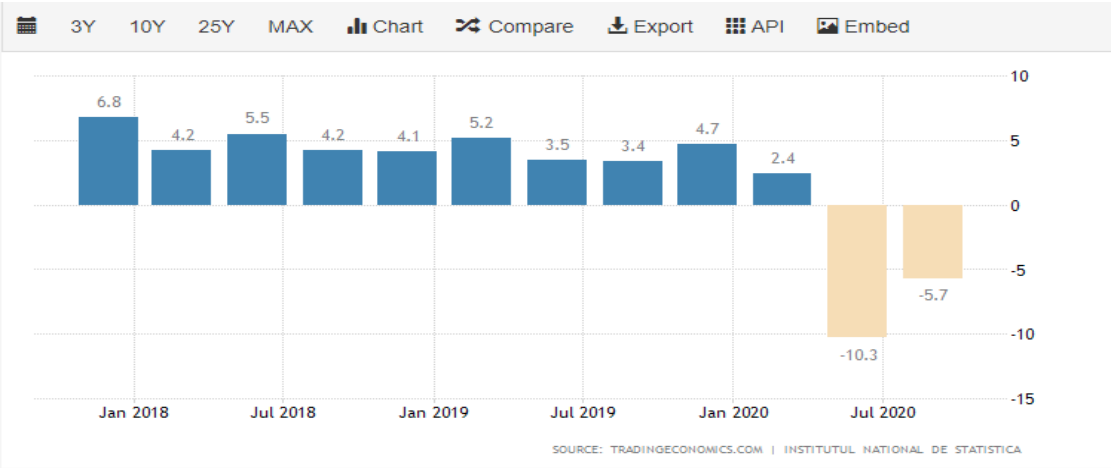

Figure 2 - GDP, 2020 monthly growth details (Source: worldbank.org 2020b)

2.2 Students' statistics in Romania

As the targeted demographic for this study is the Romanian student fraction, there is a need for further comprehension in numbers and details which characterize this group. In the chart below, there is shown how complex is the number of foreign students enrolled in degree programs in Romania between 2014 and 2018. Studies by statista.com (2021) show, in 2017-2018, that the largest number of foreign students studying in bachelor programs in Romania was 24,815 individuals. This marked a rise with 14.4% from the previous academic year. See below, in Figure 3, a chart representing the number of student's evolution over the 2014-2018 timeframe.

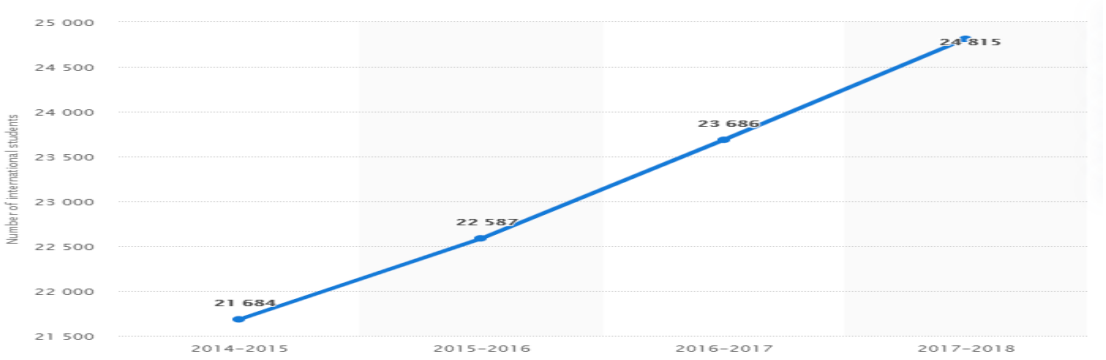

Figure 3 - Romanian foreign students' statistics (Source: INS)

Romanian academic program is wide, as there are more than 500,000 undergraduate and post-graduate students enrolling every year.

All this data shows that student demographic is suitable for analysis in the present research, as it makes out a large percentage from the Romanian population. Having answered the "**who"** part of the aforementioned problem statement, let's take into review the main segment: the Romanian vehicle registry and determine how it works, what problems does it show and where there is room for improvement.

2.3 Romanian vehicle market overview - current situation

Regarding the vehicle market, Romania has seen an increase in 2021 compared to 2020 fourth quarter, from 134k to 152k vehicles registrations according to statista.com (2021). This means that about 58% higher registrations occurred for used vehicle sales in Romania compared to 2016. The website Autovit.ro, the largest vehicle online dealer, evaluated data from the Licenses and Automobile Registration Direction (DRPCIV) to estimate that 642,000 of used vehicles have been registered in Romania.

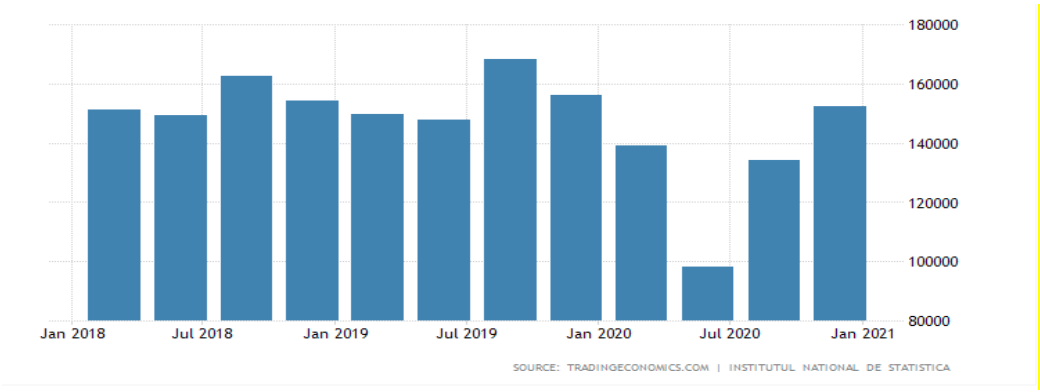

Figure 4 - Romanian vehicle market statistics (Source: INS)

In the meantime, new vehicle sales rose by over 10 percent, to over 105,000 vehicles (Autovit.com, 2020), estimates that "The imported used vehicle market segment recorded its maximum level ever reached in local statistics, after a 74% rise compared to 2016, to over 500,000 units. The amount of used vehicle sales grew from 398,000 units in 2016 to a high point of 496,000 vehicles in 2017, following the environment tax elimination, enabling Romanians to trade their vehicles more comfortably (Second-hand car registrations reach all-time record in Romania in 2017, 2021). Figure number 4, on the right, shows vehicle market statistics over the last two years.

A vehicle registry system, as introduced by most government bodies around the world, is a consolidated system that records vehicle details. This case study overlooks the Romanian vehicle registry scheme in depth and uncovers that this system is difficult and requires many steps. These steps include physical presence, required to sign documents, and it means going to different places to complete the process. To better understand how Romanian vehicle registry works, find below a list of the required stages to officially log a vehicle:

List of steps to follow when officially logging a vehicle (Source: DRPCIV, 2020)

Vehicle registration step required by Romanian local authorities

1- The individual's application
2- The original vehicle identity card
3- The original registration certificates
4- Plate with registration number
5- Copy of the compulsory motor liability insurance contract, for damage caused to third parties by vehicle and tram accidents (RCA), within the period of validity.
6- Proof of payment for a value of the registration certificate-39 RON, (for payment methods see taxes and charges section).
7- Proof of payment of the value of the number plates and, where applicable, of the legal tariff for the award of a preferential combination for registration number.
8- The applicant's identity document, in original and in copy.
9- In the case of legal persons, there are required documents attesting to the acquisition of legal personality, name and place of business, in copy (e.g., certificate registered with the trade registry), as well as the empowerment of their legal representative will be submitted, delegation.
10- Special prosecutor's office authenticated by the notary public, where the document are submitted by a person other than the holder.

The entire process may seem simple, but if we look at the ten steps above, we will discover that the required document and places a person has to go to are far away from being simple. The section below explains the steps of registering a vehicle after purchase (Direcția Regim Permise de Conducere și Înmatriculare a Vehiculelor, 2021).

Once the documentation has be completed, the final step is to request or accept a random plate number and, once finalized, there is a wait time of couple of weeks until the new owner receives the new documents as well as the plate number requested by going again in person to collect them. To conclude, the current process consists of 10 steps and many documents to complete the process and have a vehicle registered in Romania. All these will be further analysed inside the next chapters.

2.4 Current steps and shortcomings in Romanian vehicle registration

Case study research revealed that the current process of registering a vehicle with the DRPCIV usually takes 1 to 2 working days, maybe more, depending on customer availability to do the paperwork (DRPCIV website, 2020). Also, the entire process consists in traveling from home to visit different public sector buildings such as the tax office, DRPCIV office, an insurance broker, etc. Below diagram shows the steps and process that must be followed at present to register a vehicle.

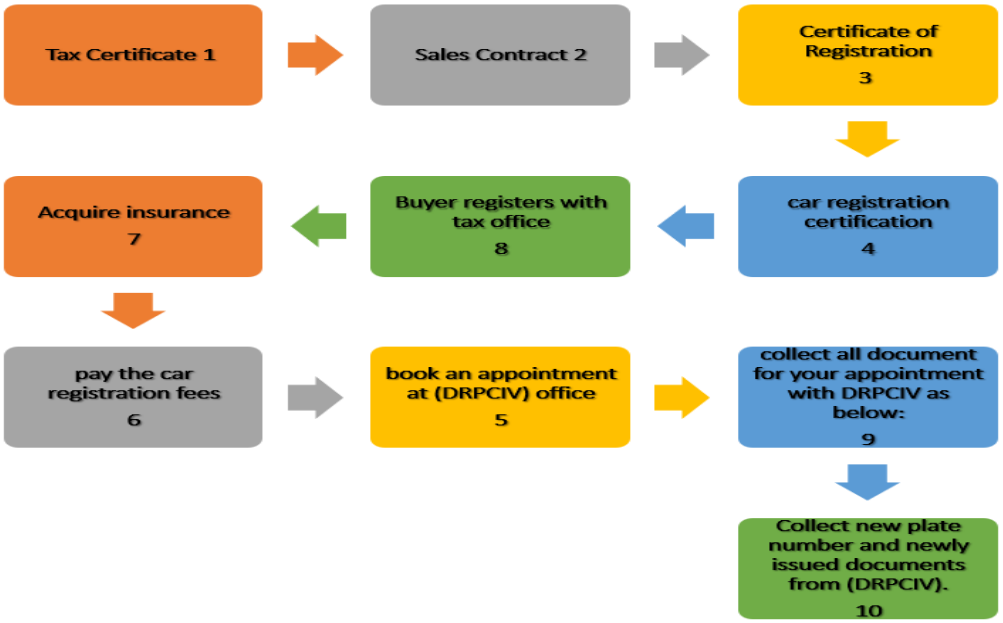

Figure 5 - Diagram representing steps and processes of vehicle registration; (Source: by author)

In current ages, time means money, so people who want to register their vehicle have to take a day or two off from work or university, only to be able to follow the process and get the needed documents. Romanian citizens from the capital city of Bucharest can only register the vehicle in Bucharest and no other city, unless they have their residence in another city registered with the authorities (DRPCIV, 2020). The same applies for students who live in the capital city and due to their study schedule or seeking job opportunities in larger cities, they will have to go back to their home towns to register their purchased vehicle or to obtain the needed documents, in order to be able to sale their current vehicle (Promotor website, 2020). Therefore, for these particular cases, traveling means more time spent, more money lost, which often translates to citizens' dissatisfaction.

Another issue is found with the current process is related to health risks, that the public representatives, as well as the city citizens, face visiting different authority buildings, especially during pandemics like COVID-19. Since people have to go in person, they would have to stay in line and wait for hours, endangering other people present on site (Autobild website, 2020). Let's take for example a university student getting the COVID-19 virus and going the next day to his university, we can only imagine what could happen.

Climate issue come in place when finding that visiting different locations to process the paperwork of vehicle registration requires transportation between different locations. For example, in Bucharest the DRPCIV building is in the north side of the city, which requires traveling, leading to an increase in CO2 emissions produced by the public transport or personal vehicle transportation (Jaroszweski et al, 2017).

Of course, there is the financial issue, meaning that everything has a cost, starting with fuel for transportation or public transport tickets, having to pay taxes at counters if needed, etc.

Some may argue it can be done via bank transfer, but bank transfers take a day or 2 to process, leading to more time spent, where it can be reduced by adopting technologies (UAE Government website, 2020). Another considered factor is that many people cannot travel, such as people with special needs - like age for example-, while adopting the right technology could solve it. Next problem uncovered on the DRPCIV official website, (2020) is that vehicle registry database is not interconnected with other government institutions, like the tax office, therefore each document obtained must be physically presented in original to the other authority, in order to be recorded.

Another problematic fact is that all the current systems are centralized, therefore it easier to be targeted by a hacker, since the moment they manage to penetrate the system, it enables the hacker to change and corrupt the data, which could lead to a shutdown and stoppage in all services. Surely, privacy issues are to be discussed - citizens' privacy is not secured with current functioning process. If one corrupt public service employee could copy a person's identity card and use it for personal interests, he will be able to do it without the fraud being traced back to the public employee. As all sides involved in vehicle transfer or registration are bound to make errors, see below the list of entities currently involved in the Romanian vehicle registration process.

Parties involved in vehicle registration process (Source: DRPCIV, 2020)

Manufacturer; pushes the vehicle to blockchain, by adding basic details like make, model, variant, chassis number, engine number etc and executes the sale of the vehicle.
Dealer; executes the sale of the vehicle to the end customer.
Insurance agency; validates the customer and the vehicle data and provides insurance.
Registration authority; RTO will be responsible for approving registrations and providing the registration number, performing vehicle transfers and vehicle resale.

Vehicle title theft takes on different types. When miles on vehicle are changed to a lower one to increase the sale price of a vehicle. Sure, there are cases when a forged or false title is created, where a title legitimately belongs to someone who is not the real owner, in order to evade taxes or commit crimes (Promotor website, 2020). These are all popular today, as inventions that can produce practical fakes at home have evolved and modern printers can be purchased by anyone nowadays (Smart engines website, 2020).

There are many other issues which can also be discovered during the process if a further research is done and which also includes the DRPCIV and other public agencies involved in the process (Ministerul Afacerilor Interne, 2020). This leads to high volume of back-office work, and many other issues due understaffed systems or motivation lacking employees. As this case study has limited access to the public agencies and the aim is to research university students in Romania and how they see digitalization (with blockchain), further step is to theoretically determine what are the best solutions. Next subchapters will help identify how will blockchain technology impact the Romanian vehicle registry.

2.5 Study objective: to improve or eliminate current issues

2.5.1 Blockchain implementation for public systems

After carefully analysing the long list of shortcomings and flaws inside the Romanian vehicle registry, the first step was to find a technology that eliminates them and overall improves the quality of public services. As this is a government agency that deals with personal information and sensitive information, the best current digital technology is blockchain (UAE official website, 2020).

Many people still associate blockchain technology with cryptocurrencies, since blockchain is the foundation behind many digital currencies, also known as cryptocurrency (e.g. Bitcoin, Ethereum), which, in the past years, have shaken the idea of currency. Bitcoin is a digital currency, known as the first and most recognized application that uses blockchain technology. In an ideal setting, blockchain technologies would offer a decentralized array of resources, competitive with government services including land registry, citations, registrations and even a substitution of financial processes, which make most of the government function obsolete (Ahram et al. 2017).

As blockchain evolves and gains popularity, governments and companies should also consider blockchain technology as an incentive for creativity, to increase their performance. Many organizations evaluate and apply blockchain technologies for market productivity and accountability government. One instance is the Estonian Government, which has been using this technology since 2012. Their model is called KSI blockchain and it is not only used by Estonia, but also by the NATO and the American defence department. (The Blockchain Technology in Performing Banking Operations Using Digital Financial Assets, 2018).

Moreover, to present a theoretical vehicle registration infrastructure, a blockchain-based vehicle registry framework will decentralize those registrations and, thus, increase data reliability and fault tolerance. A decentralized framework, focused on blockchain, will increase efficiency and protection in contrast with a centralized approach, spanning from leasing firms, to state authorities and all involved parties in the vehicle registration process (starting with the DRPCIV, ITP, insurance viability and claims, tax offices, payment system and police departments - to verify fines).

2.5.2 Solution overview using blockchain for vehicle registry

As shown in the following chapters, literature review found numerous examples of blockchain's successful implementation into government agencies and, more specific, in similar vehicle registration departments. A general overview of this solution for the Romanian vehicle registry will imply less time spent, less paperwork and less physical presence needed for the entire process. Surely, the targeted segment for this research will offer a fresh insight into this domain, as students are technology oriented, believe in the digitalization of things and have a critical eye on the current state of government agencies.

Upon analysing DRPCIV and its current issues, it is only fair to particularize blockchain's hypothetical contribution to its improvement. The proposed platform for the DRPCIV should be able to handle vehicle registry processing procedures, e.g. registering a vehicle, modifying the status of its possession and registering a lease arrangement with the lessor and the leasing officer, and much more services. The proposed platform will simplify the information exchange between many countries, if interconnected, for example with the EU stat members, as the vehicle registration system is distributed in a single decentralized system, to each government body.

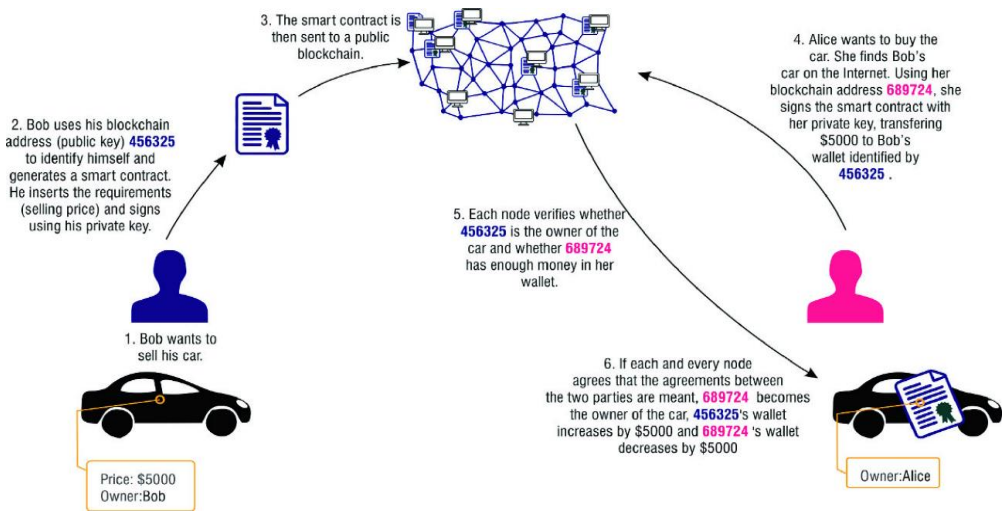

Figure 6 - Bitcoin blockchain system diagram model (Source: Anon, 2021)

A blockchain program for vehicle registration would also require jurisdiction of national registry agency. It can be developed using modern technologies, but its activity can be controlled by a central authority (Rondinelli, 1983). In reference to automobile related facilities, a scheme that handles licensing, tax, and vehicle's features and specifications for a vehicle to be legal to drive previously is a reasonable starting point. Blockchain may also be a solution for legal, industrial, and reduces criminal registry issues, as well as growing creativity in government services (Allessie, 2019).

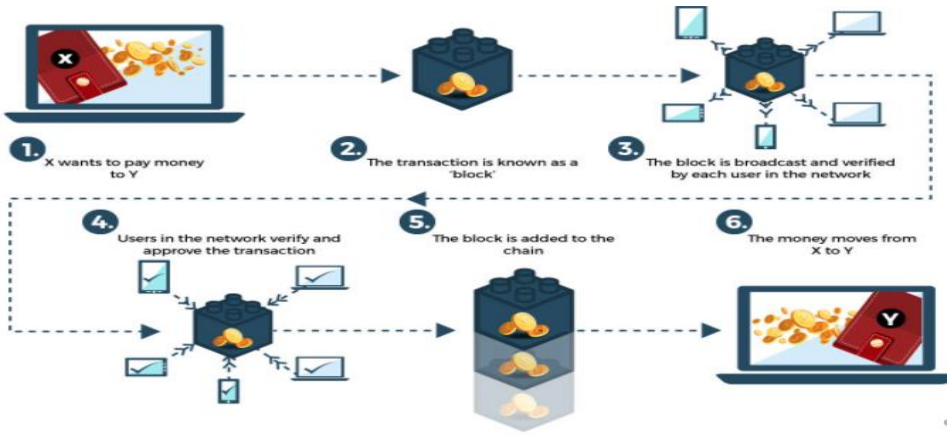

Figure 7 - Blockchain process model, Source: (Source: Understanding blockchain, 2021)

The usage of E-signatures makes governance more effective and open. In addition to decentralized data collection, it is therefore important to allow for the implementing of innovative frameworks and recognize future challenges over this strategy, spanning from the initial configuration of the system to the continued support of the hardware and software. Therefore, blockchain technologies will be applied for vehicle registration to boost vehicle registration procedures by using smart contracts and its impact on vehicle registration business processes will be outstanding (Guo et al. 2018).

All the advantages coming from implementing blockchain into the Romanian vehicle registry must be taken into consideration, as it will vastly improve all processes. For a better

overview and for better choosing the type of blockchain more suitable for DRPCIV, firstly we must overlook all blockchain available technologies.

2.6 Blockchain technology

Blockchain is still for many individuals an ambiguous subject. Lack of a clear understanding or a definition plays an important role in this suffering, as many believe that blockchain can be a subject of hacking thus everybody has many questions regarding blockchain. How it actually works, how can we adapt it, and how it can further help the development of a country or a smart city, this is just the tip of the iceberg! To answer these questions, we will start with the history of blockchain (Pierro, 2017).

Blockchain technology is a protected sequence or chain of time-stamped records stored in a database maintained by a community of users, who also are members of a distributed platform. Blockchain is a decentralized or distributed ledger in which each device on the network has access to data or information resource in a blockchain. Cryptographic methods are used to encrypt all the essential records throughout the blockchain. This means that the data in the blockchain is highly protected (Yaga et al. 2019).

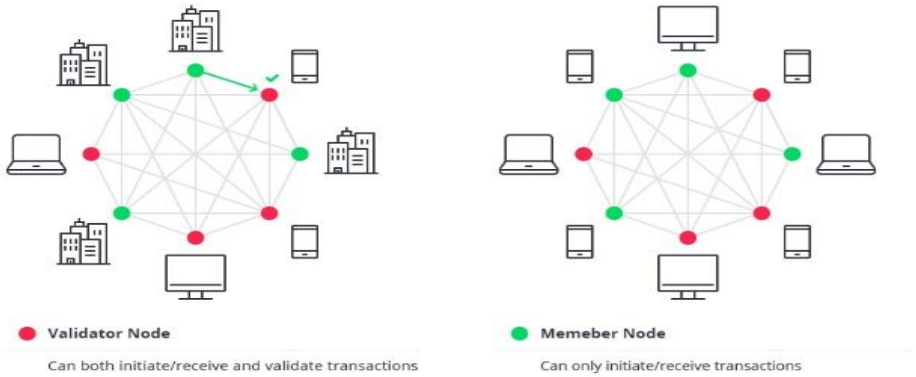

Figure 8 - Represents a diagram that shows an overview of the architecture of process inside that blockchain (Source: Lastovetska, 2021)

Blockchain platforms allow each registered node to access the blockchain database, which is appended as a valid block throughout the chain. Every block in the chain reflects a transaction or a document, which ensures the blockchain is able to take advantage of the following

characteristics: permanence, stability, and a distributed ledger that maintains track of every form of record, even monetary transactions. This concept of chain came originally from Stuart Haber and W. Scott Stornetta in 1991, when they developed the idea of a "protected chain of blocks" or set of records. Following the financial crisis in 2008, a person or group of persons called "Satoshi Nakamoto" developed and came up with the first cryptocurrency called bitcoin in which they resolved the "double ledger" problem known in the financial system by using the blockchain platform. Cryptography, also called hashing in the blockchain framework, makes sure the system is highly secured, in order to seal it and see that nobody can modify something, destroy data or sets of records, until it has been saved in the blockchain (Beck et al. 2016).

Now that we have looked into the background of the blockchain, we need to also better understand the concept behind, the essential two concepts behind blockchain are the hash functions and Merkle tree. **Hash function (Figure 9, below paragraph)** is known as part of the cryptography, hash takes an input - large arrangement of bits, and provides an output of fixed

value. This process has two main aspects: the first one is that if any bit has been changed, the output is always different, the second one, it is impossible to find out the input data. In order to find out the input data, a person has to test every possible input, which is purely impossible, thus meaning the system is very secure (Pierro, 2017). Below graphic shows how the cryptographic hash function works, showing different hash when there is the smallest change to the input (Blockchain key characteristics and conditions to use it as a solution, 2018).

Figure 9 - Cryptographic function (Source: Anon, 2021)

The second concept is called **Merkle tree** (**Figure 10, below paragraph**), after Ralph Merkle, back in the 1979. A hash tree or Merkle tree known in the cryptography and computer science field, is a tree where each leaf node is tagged with an encryption hash of a data block and each non-leaf node is tagged to a cryptographic hash of its children's nodes. Hash trees enable the content of large amounts of data frameworks to be easily validated and protected. Hash trees are a common collection of hash lists and hash chains (van Engelenburg, 2018). First proof that a leaf node is part of a particular binary hash tree needs that a sequence of hashes be measured in comparison to the logarithmic of the number of leaf nodes of the tree, which contrast with hash lists where the number is commensurate with the number of leaf nodes itself (Lin and Liao, 2017).

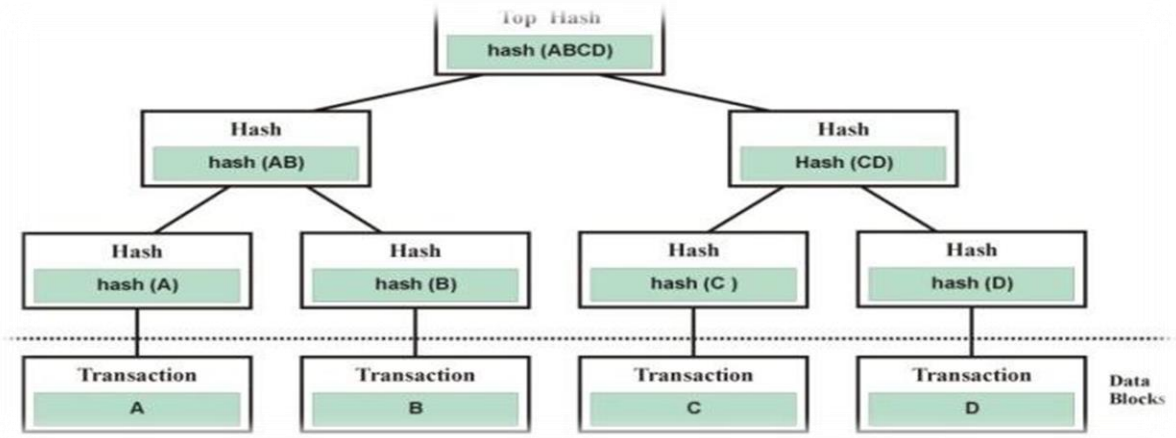

Figure 10 - Merkle Tree (Source: van Engelenburg, 2018)

2.6.1 How the blockchain works

The theoretical concept is to have a decentralized network and a distributed data ledger, which has legitimate and secure transactions that enable end-to-end or point-to-point transactions or exchange of data. A blockchain is a n intricate system, which operates in a distributed network worldwide, characterised by many nodes or devices. Each device or node can make receive

transactions, verify them and create a block. The blockchain is connected cryptographically in the chain of blocks (or usually called "set of records") in a way that no one can change or delete the data stored in the blockchain, and once a transaction takes place in the blockchain, it becomes part of the chain forever (Kakavand, 2016). Diagram below – **Figure 11** - shows how hash functions are structured and connected.

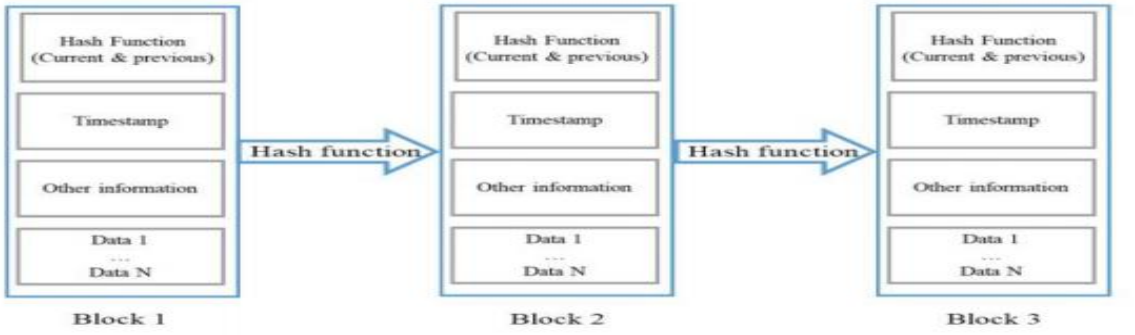

Figure 11 - Usage of blockchain diagram (Source: Anon, 2021)

Furthermore, the blockchain distributes sets of records or databases that are unchangeable, unless a new block is created and added to the set of records as new block to the chain. Each node on the blockchain network has a separate copy of the ledger, in which users can access past transactions, whenever they need to update them (Pilkington, 2016b).

Blockchain components below shows a number of particularities of the blockchain network.:

Consensus Protocol: One of the main challenges of shared blockchain networks is to guarantee that the whole peer-to-peer network achieves agreement (Kraft, 2016). To ensure the members follow the rules of the network and to ensure transactions are validated in the correct sequence, a consensus protocol is introduced. To ensure the information in a block is right, to prevent the double-spending dilemma, it is often used to ensure that the nodes (miners) get a reasonable compensation. Proof-of-work protocols, such as the ones used by the Bitcoin network, are by far the most commonly used consensus protocols. BlackCoin often utilizes proof-of-stake, another complement to proof-of-work. It is difficult to promise that all consensus protocols can preserve the proper sequence of transactions through the blockchain network. As several network nodes simultaneously malfunction, it triggers a form of Byzantine fault. An effective Byzantine Fault Tolerance (BFT) consensus protocol can be used to resolve this issue.

Proof-of-Work Backlund (2016) proposes that authenticity is maintained by letting each network participant have one vote and having all network participants vote on which transaction can be included in the next block. Each vote reflects a vote on which transactions to include. Systems with this form of consensus mechanism are prone to Sybil attacks, where one person may develop several accounts and thereby gain a disproportionate amount of control within the network. By introducing a cost to vote, Nakamoto resolved the issue of power. A user's control is equal to their processing capacity. Computing capacity (not to be mistaken with numerical power) boosts electricity and hardware prices. Proof-of-work consensus protocol is this term. The bitcoin network gathers all of the transactions that have happened over a specified time into a block.

Nodes: are by far the most fundamental components of the Blockchain. A network of nodes makes up the chain. In fact, the nodes are computer systems. Nodes' role is to validate and write transactions into a blockchain. To help preserve the credibility of the results, they hash it,

too. Each node has an economic motivation to begin mining and hashing as new blocks are detected, and the further blocks are identified, the further bitcoins are circulated. Carlsson and Huang (2016) suggests that nodes are usually responsible for generating new blocks, which are then spread to other nodes. To ensure that each block is right, as well as that the rules of the algorithm have been followed, the neighbouring nodes individually validate each block. It is advised to wait at least six blocks on a bitcoin network until you deem a transaction final.

Transactions: Each Chain stock constitutes a transaction. A new transaction is generated in the Blockchain if you would like to alter a value and then the digital currency is transmitted through one client to the next. In order to allow a transaction, at minimum 50% +1 of current nodes should be accepted.

Block: It reveals how data is held by the blockchain. There are data from multiple transactions in a block. The cryptographic hash binds each block to the previous block. Every node contains all these blocks.
Account: Blockchain accounts consist of 2 variables, a private key and a public key. the account owner holds the private key for the account if the private key is lost there is no way to recover it. unlike other centralized infrastructures.

Smart Contracts: A smart contract is an electronic agreement that enables a deal between two parties. If implemented, blockchain contracts cannot be updated by any side, and the contract conditions are continually reviewed for enforcement. A new contract must be formed if a change is necessary. smart contracts were created to codify contractual relations and exchange agreements in an online world, rather than utilizing paper contracts, smart contracts are lightweight, introduced software that are stored like every other exchange in a blockchain that operates automatically when standardised contract terms are met. The agreement program is compiled in a particular programming language like Solidity, a high-level object-oriented language built for Ethereum Virtual Machine platform (Puthal. Et.al., 2018).

Features of Blockchain:
Scalable: An unlimited number of network nodes can exist.
Safe/Secure: Blockchain technically cannot split from modern technologies. As described earlier, fifty plus 1 of the network nodes must acknowledge a transaction. If an intruder tries to change a block or to adjust one bit of data, a new block will be generated which all nodes in the blockchain network will have to validate. To approve a fraud claim, 50 + 1% of the nodes should be amended and all broken at the very same moment to make a change. When one node behaved otherwise, the node's vulnerability is checked, and the node is forgotten by the network before it responds with the real data.
Intelligent: Beyond Blockchain's core technologies, customized code can be written independently for each program, allowing space for many rules and case uses.
Auditable: since each block is connected to the preceding block by a hash, the Blockchain enables you to travel through all the blocks up to the "Genesis" block, the beginning block of the Blockchain, allowing the chronological monitoring of all modifications.

2.6.2 Types of blockchain

As more private entities discuss blockchain and its advantages (Price Waterhouse Cooper, IBM, banking companies), they all understand the importance of choosing the right system, which will match their specific needs. Origin validation, unchangeable data backups, tax compliances, workers' rights, medical records, managing IOT "internet of thigs" applications, equity trading, firearms tracking, wills, estates and inheritances, securing access to private and physical properties, tracking medical prescriptions, energy futures trading and compliances and many more applications can use the blockchain and benefit from its secure immutable and

encryption infrastructure. However, each company or entity that wants to use blockchain, must take into consideration the best option to fit their needs. In order to identify the best solution, one must have a comprehensive understanding of the available types of blockchain. In the following part below, we enumerate these types.

Public blockchain

Public blockchains are designed to be fully decentralized, with no individual or entity controlling which transactions are recorded in the blockchain or the order in which they are processed. The design of Public blockchains is completely transparent and decentralized therefore there is no one manipulating the transactions or the order for them to be handled or registered in the blockchain.

Public blockchains is particularly immune to interference, so anyone can access the net work, no matter where they are lactated or citizenship, etc. which makes it tremendously difficult for authorities to close down. Finally, there's a token affiliated with public blockchains, which is generally designed and structured to stimulate, and reward connected devices. (Abram et al. 2017)

Private blockchain (centralized)

To put it plainly, private blockchain is simply the private blockchain and permissioned blockchain is the method applies commonly recognized as private blockchain. All users of the private blockchain network must have permission or acceptance to participate. Connections are confidential and representatives of the network only have access to the network if they have been given approval. Furthermore, private blockchains are intended to be more centralized than public blockchains. This chain by nature is more centralized, and chain-run organizations regulate all participant and governance structures. For eg, a CBDC (central bank digital currency) may live on a private blockchain as well.

Consortium or permissioned

This is considered a private blockchain with the difference that in the consortium blockchain can be managed by a group instead of one entity, this type has the advantage of private blockchain and cloud be a subcategory of it, this model can bring a group of businesses which collaborate together and compete against each other in the same time, this model can enable them to be more efficient in both individually and collectively by working together on some aspects of their businesses, this model can be used by anyone from central banks, private banks, governments, and supply chains.

Hybrid blockchain (decentralized)

Also known as Dragonchain, hybrid blockchain is unique in that it is a hybrid blockchain inside a blockchain environment. This ensures that a licenced and private blockchain blends the privacy advantage with the public blockchain advantages in terms of confidentiality and accountability. This offers organisations great versatility in deciding which data they choose to make accessible and transparent and which data they choose to keep confidential. this offers organisations great versatility in deciding which data they choose to make accessible and available and which data they choose to keep confidential.

Public blockchains are particularly immune to interference, so anyone can access the network, no matter where they are located, without need to prove citizenship, which makes it tremendously difficult for authorities to close down. Finally, there's a token affiliated with public blockchains, which is generally designed and structured to stimulate, and reward connected devices (Niranjanamurthy et al. 2019).

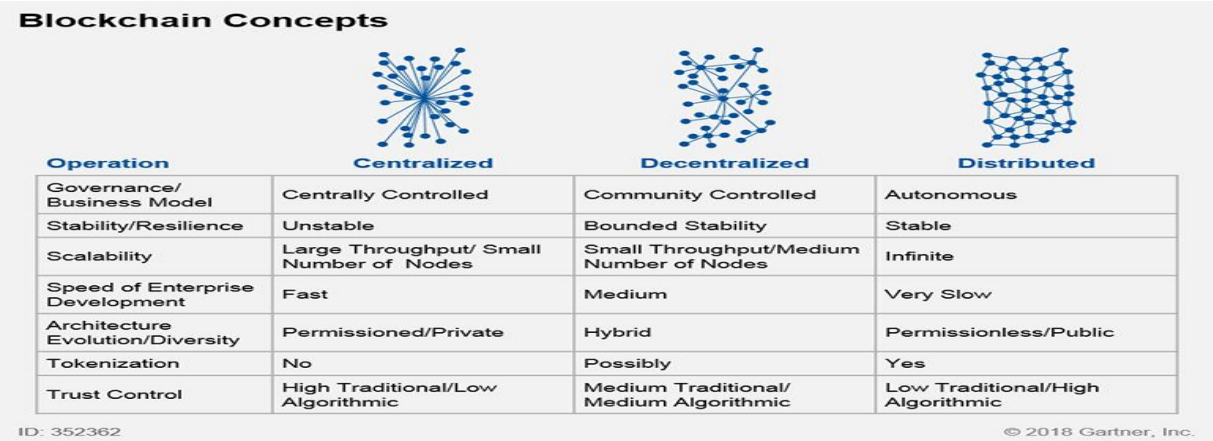

Figure 12 - Diagram comparing the types of blockchain (Source: Gartner, 2018)

Hybrid aspect of the Dragonchain blockchain platform enables patented interchain features, that allows it to be easily integrated or connected to different types of blockchain protocols and enables multichain network. This is important for businesses to work with the requested transparency, without compromising their privacy and protection. See image above, with examples of what types of blockchain are suitable for various entities – government, private.

Being able to communicate or to transfer data with multiple public blockchains at the same time increases the security of transfers or transactions. Also, these systems have the benefits of mixture and they hold the advantage of combined hash power in shared chains, used with the public chains (Watanabe et al. 2016).

2.7 Blockchain implementation for vehicle registration

2.7.1 Vehicle Registration on Blockchain

IT is important for the strengthening of vehicle registration system. The solution manipulates the data relevant to the vehicle in the scheme by the approved user, and it does so to their personal direct gain. Through putting all the departments into one portal that is linked by blockchain technology, any adjustments made by one approved individual will reflect all over the system and it will be simple for anyone to collect the details on who did it and when. Blockchain infrastructure will show where the vehicle is being manufactured, as a way of preserving all transactions during the production phase which no other systems currently provide (Hossain et al. 2020). The below chart depicts how different entities are connected through blockchain and its transaction gets recorded into blockchain. The vehicle registration system is divided into different modules.

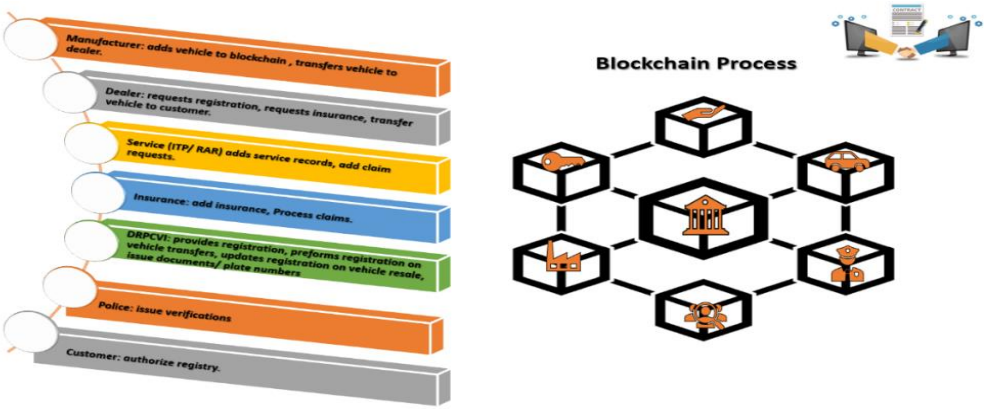

Figure 13 - Blockchain connecting different entities (Source: by author 2021)

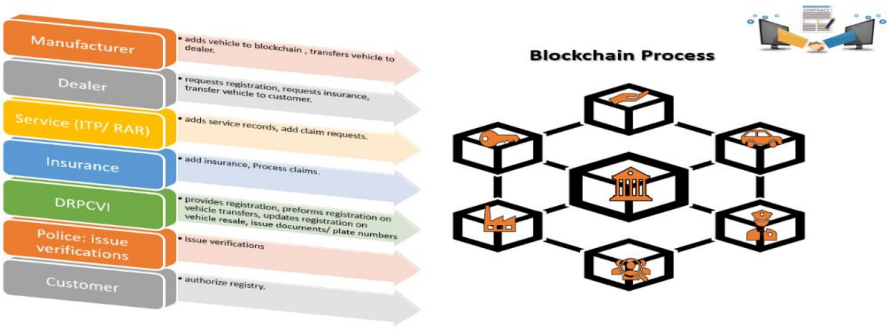

Figure 14 - Diagram with details about parties' connection to the blockchain (Source: by author 2021)

As all vehicle registration modules in other countries, the Romanian one implies a series of actors and procedures, with the end purpose of officially enlisting a vehicle into government databases. Below, there is a short list of parties involved in this process (DRPCIV official website, 2020). On the side, there is a diagram with the parties' connection to the blockchain and further details about their role in the vehicle registration process.

For a better view on how blockchain will look if implemented inside DRPCIV, the paper advances a list of processes and how they will be structured. As described below, customers, authorities and all other involved parties will forget about time-consuming, manual, and repetitive tasks. All these are improved by efficient, rapid, and safe steps designed inside a blockchain-based platform.

Model of Blockchain implemented into DRPCIV

Manufacturer-Dealer Workflow:

This is a simple partnership, where the manufacturer adds new vehicles to the blockchain network as a smart contract by adding basic details like make, model, variant, chassis number, engine number etc. Executes the sale of the vehicle to the dealer on the smart contract, a smart contract can then automatically transfer ownership to the dealer.

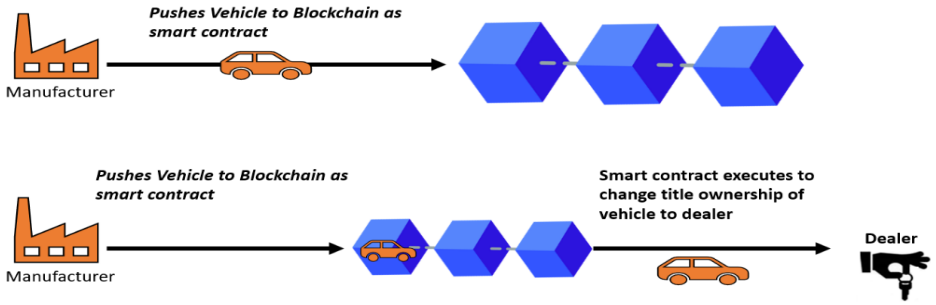

Figure 15 - Diagram with details about process flow to the blockchain (Source: by author 2021)

Vehicle Sale/ Registration Workflow

As the vehicle is agreed upon between seller and buyer, the involved workflow must be cursive and efficient. Firstly, the Dealer can initiate vehicle sale contract and a smart contract can then automatically send out requests for registration and insurance. The DRPCIV and

insurance agency can validate from blockchain the required data about the requested vehicle and about the customer and provide registration and insurance respectively. Upon successful processing of the above step, the vehicle ownership can be automatically transferred to the customer by the smart contract.

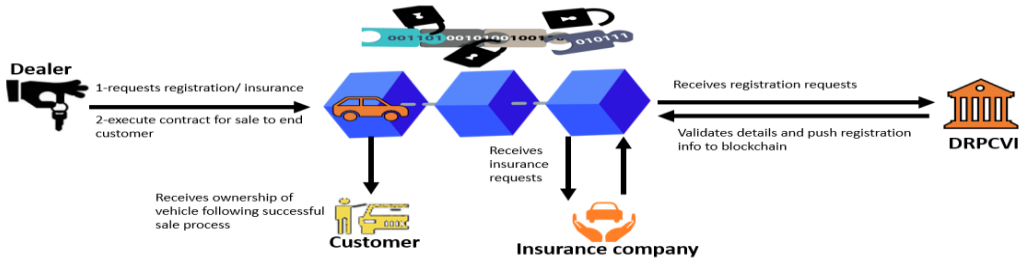

Figure 16 - Diagram with details about -process flow in blockchain (Source: by author 2021)

Vehicle Transfer Workflow

The vehicle owner can request for NOC via smart contract. Smart contract sends a request to concerned authorities to NOC and clearance. After successful validation of information from Blockchain, the concerned authorities can provide clearance and NOC, which can be used to obtain a new registration.

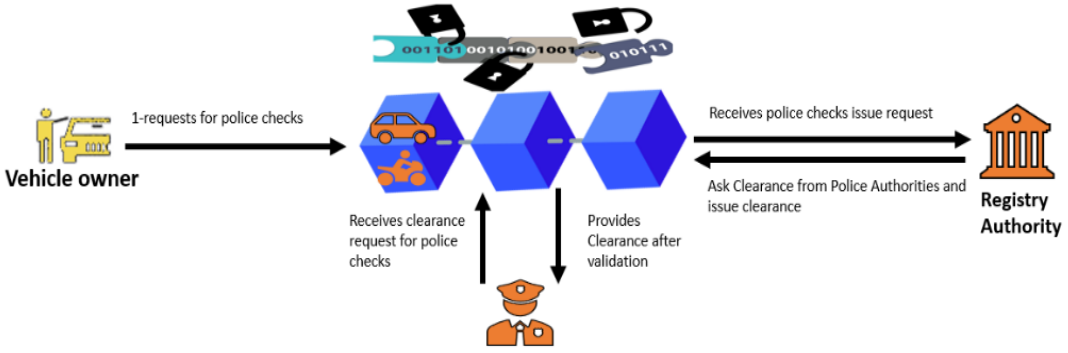

Figure 17 - Diagram with details about -process flow in blockchain (Source: by author 2021)

Vehicle Resale Workflow

For this sort of procedure, things are simplified: the vehicle owner executes the smart contract for resale of a vehicle. Smart contract sends a request to concerned authorities for NOC (No Objection certificate) and clearances. After the successful clearance, a smart contract can execute itself to transfer ownership to a new owner.

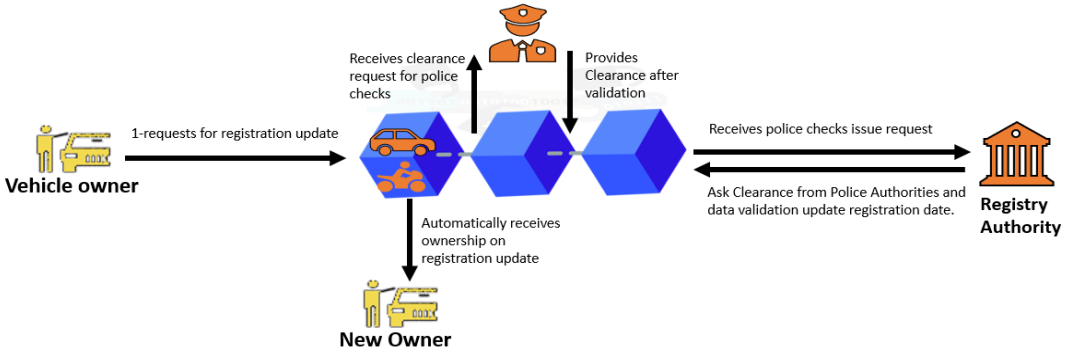

Figure 18 - Diagram with details about -process flow in blockchain (Source: by author 2021)

Buyer Module:

The confirmed purchaser would have the ability to access the vehicle. A purchaser will be issued a recorded identification number for potential usage. The aim of satisfying all the organizations gets achieved as purchaser approve the vehicle offered by dealer on the same mechanism that is being used by various organisations the vehicle will be sold to the buyer and transaction would be registered in the blockchain. After completing the transaction, the purchaser may request for an identification number to the respective authority such as the DRPCIV and can obtain it. (Alexopoulos et al. 2019).

For this step and, maybe, others, the purchaser/citizen should be able to use a digital signature, which is valid without physical presence or signature required. According to the Cybersecurity and Infrastructure Security Agency (CISA, USA, 2019), a digital signature is the equivalent of a handwritten signature and it is a software based on mathematical sequences, which may be used to validate and sign the authenticity of an electronic message, a software or a digital document.

DRPCIV Module

DRPCIV can record the vehicle while the buyer and seller have concluded the transaction. Both records will be open to the DRPCIV, both entities are housed under the same roof, and makes registration processes more versatile than transferring flexible. The DRPCIV will issue a vehicle registration code. This is reported in the public ledger. This will have a single-entry point to vehicle and all information required can be obtained from this. It may also be applied to the auto module where insurance providers move cars to it for managing potential claims. the relation between blockchain and any other individual i.e., manufacturer, supplier, customer, distributor, etc. An additional protection framework cloud be introduced between any linked entity which ensures validity of communication in the transmitted messages. For digital signatures to be attached to contracts, all sides need to have approvals and therefore they are linked to a block and is added to the blockchain. This system allows for two-way authorization of each contract, this provides dual way authorization for each transaction to be complete without any kind of third party in between. (Roy et al. 2018).

Blockchain is the tool to store the data in an immutable and decentralized network. All participants of the network have fair access to the results. Blocked accounts are used for saving financial transfers. Any provided transaction is assisted by a new block, and the new block is linked to the previous one. The block hash value is collected during the block development and is deposited in the previous block rendering the chain complete.

2.7.2 Why build next generation vehicle registration system

Blockchain technology is being applied globally, primarily for its potential to handle financial transactions, asset exchanges, and regulatory obligations. Blockchain is an emerging pioneer in the area of decentralized, immutable data and automated registry which can be adapted by vehicle registry authorities. When implemented, blockchain businesses help organizations boost productivity, reduce expenses, and increase revenue by developing digital products and services (UAE official website, 2020).

There are many companies which offers blockchain solutions, such as Oracle blockchain as a service in cloud, IBM and many others and they should be consulted for further and deeper expertise on the technical solution in order to meet the exact requirements of the DRPCIV in Romania to help modernization of the city and adding one smarter city project to their portfolio (Notheisen, 2017). Here is a list of real examples of governments which adopted blockchain technology around the world. When asking why to build the next generation vehicle registration system, there is a series of valid arguments, as listed in the previous chapters. But, an important

reason why this should happen, especially in Romania, is the fact that there are already similar systems integrated in other countries, such as USA, Estonia and Dubai.

Dubai is paving the way for a blockchain-powered state. In 2016 officials from 30 government agencies organized a commission to research prospects across all fields including health records, transportation, company registration and the reduction of war diamonds. The Estonian government has joined up with Ericsson to build a new public information framework on the blockchain, while Samsung is proposing a blockchain technology that can be used on the nation's transport and public safety networks. On the same note, the UK Department of Employment and Pensions is discussing the usage of a blockchain to handle people's health benefits and blockchain platform Followmyvote.com serves as a safe and open voting system which reduces the opportunities for voter fraud by better accessibility to democracy. These are all open-source initiatives, intended to empower the development of political institutions and the establishment of states or nations (Marr, 2021).

According to official American website infosyspublicservices.com (2021), the Blockify vehicle registration solution has more advantages than any other type of solution, as it improves data integrity, reduces fraud and reduces the overall cost of operations. All these are problematic points for the Romanian vehicle registry, identified earlier on this research. See below

2.7.2.1 Advantages and utility of USA's blockchain platform (USA gov. website, 2021):

Improved data integrity and real- time visibility: de-centralized database and blockchain technology will help the agencies maintain all the data (vehicle registration, citations, insurance details) in a consistent manner and enable quick access to assess vehicle ownership.

Improved collaboration and information: with blockify, agencies will be able to share data in real-time instead of batch-mode and keep customer and vehicle records updated and current, at all times.

Reduced fraud: the information is kept current, updated and can be accessed and assed by any stakeholder quickly and cost-effectively, thus minimizing changes of fraud.

Reduced cost of operations: cost of blockchain implementation and use can be lower than maintaining different systems for storing and managing vehicle related details.

As Mark Walport states in a comprehensive case study, Estonia uses blockchain features for government related problems and uses. He says that their Keyless Signature Infrastructure (KSI) pairs cryptographic ‘hash functions’ with a distributed ledger, allowing the Estonian government to guarantee a record of the state of any component within the network and data stores.” Among others available features for Estonian taxpayers, there are the following activities: register a car, apply for state benefits, apply for licenses, submit planning applications, vote, etc.

Another successful example of blockchain systems into vehicle registries is the Dubai platform, which is currently being verified and is functional on the RTA official website. As RTA officials revealed to Emirates Today (2020), the blockchain technology on the platform connects all agencies involved in vehicle registration or other issues, such as Dubai Police, Dubai Customs, car agencies, insurance companies. Also, this means that all users may access

information about the vehicles' life cycle, meaning intricate details from the stage of manufacture to its arrival on the market and into supply.

The paper discusses the implications of blockchain technologies and how distributed data mining could transform, how information is exchanged and how it can remove the power gap between administrative and information sharing. Following chapters will take into review blockchain strong points and how it contributes to smart city development.

2.7.3 Blockchain system general advantages

If above examples of blockchain use were not convincible enough to all readers, find below a full documented list of advantages. Among these, there are definitely a few from which DRPCIV could benefit on short and long terms. Blockchain technology can enhance the management of trusted records, making it easier for government entities and people to access and use important public-sector data. The task of government is to preserve records on citizens, organisations, properties and actions that are of good faith. Thanks to its decentralized and distributed existence, blockchain technology has the ability to leverage data and auto-distribute the data among multiple applications (Abdullah et al. 2017). See below a list of general advantages, identified by specialists in this field (Nathani and Singh, 2020; Khan et al. 2020).

Blockchain other uses:

Money transfer and processing payments: banks act as an intermediary to validate transactions which can take long time, but with blockchain technology this can be done within seconds depending on the blockchain infrastructure design and network speed (Khan et al. 2020).

Blockchain in supply chains: Delete paper traces, detect inefficiencies in the supply chain, find real time goods, and check the consistency of products while on the move (Nathani and Singh, 2020).

Reward programs for shops: blockchain can Boost shopping engagement by implementing token-based customer loyalty programmes. To encourage customers to come back to the shop. Remove waste-related loyalty cards and stop theft as well.

Government issued Id cards for its citizens: blockchain offers citizens the ability to maintain, monitor and use their digital identities in an encrypted and secure manner.

Sharing Data via the blockchain: As a market for the distribution or selling data from businesses, which is mostly unused. Blockchain can be used to encrypt, archive, monetize and relocate data safely, when required (Fan et al. 2019).

Royalty and copyrights: The blockchain can provide artists and content producers with an in-house and open royalty allocation, whilst consumers are assured to buy accurate data.

Government voting platform: blockchain digital votes is encrypted in the anonymity of a person, stays private, as well as it is reasonably open for authorities to see illegal network behaviour to guarantee that all votes are immune (Syeed, 2018).

Property ownership such as real estates and vehicle change: with blockchain: Whether you purchase or sell a home, estate or a car, you have to move the property and money between one individual to the next. It makes all this data clear with blockchain and the transfer is done as smart lock-by-step contracts that do not need any party's confidence, everybody stays confidential and does need any third-party involvement. (Foroglou and Tsilidou, 2015).

2.8 A step towards Smart City development

As the Dubai government aims and has shown ("Blockchain and Beyond: Encoding 21st Century Transport", 2018), blockchain technology is an important component in Smart City development. According to EU's definition official EU website, (2021), a smart city is defined as "place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business". In conclusion, a smart city is as better as the technology it includes, and blockchain is defined as the newest and most complex technology.

To better understand the smart city concepts this chapter will discuss smart city concepts and its definitions, several researches have been undertaken about the ideas of smart cities and their design features, which involves conceptual materials, their tools, and how their establishment can be worked into a community. In the Palestinian territories, authorities aim to encourage sustainable urban growth by implementing the smart city strategy, by defining the idea of smart cities in the reality of the cities of the Gaza Strip, considering Khan Younis city as a case study (Skulmoski et al. 2007).

Smart cities are a classification granted to a community that integrates Information and Communication Technology (ICT) to improve the efficiency and output of municipal resources such as electricity, transportation and infrastructure to minimize resource use, wastage and provide a more sustainable and informed approach. According to Ishida and Yasouka (2010), one of the aims for a Smart City is to improve and refine the standard of life of the people by technological changes. Anything linked to the Internet and automated mechanism will be influenced by the force of blockchain. Utilizing emerging technologies whilst maintaining the standard of confidentiality, confidence, and transparency that is required.

Recognizing the ability for the blockchain movement to redefine confidence by transitioning to a transparent framework of trust means underlying principle that unites both BIM and blockchain technologies in their mutual desire to function as a common repository of reality. BIM may combine information from the blockchain, like supply chain, proof of origin, payment specifics, etc., and it can also apply information to the blockchain, including design choices, source of data or product change orders. This data may be later used by smart contracts that automate the transaction of invoices or purchasing materials (Antonsen, 2017).

Inadequate convergence with various technology and structures of IT has proved to be the most difficult aspect to solve. In terms of the smart city pillar, the emphasis is on the smart city to provide the vehicle registry in Romania the study and ability to use in applying blockchain technology for their processes and how to incorporate with other involved entities to help the citizens (Mell and Grance, 2011).

To achieve the key aim of a city's evolution, the advancement of the Standard of Life and improvements in the Quality of life "QoL" are primary. Everywhere now, cities around the world are introducing new technology to their growth, and they are trying to reduce costs, utilize energy effectively, and build a more liveable urban climate, and facilitating mobility and ease of access to all public services by adapting new technologies every day, creating smart cities (Caputo et al. 2019).

2.9 Smart City Classification

In fact, there is no common concept of a smart city. An inventory of various meanings of a smart city is mentioned in the following paragraphs. There are a number of different smart city concepts, by specialization, point of view, and the aspects that smart cities discuss, which determine their classification (Anthopoulos and Fitsilis, 2013). A smart, sustainable city fulfils all five requirements well, with focus on autonomous and conscious people. Effective knowledge processing is a vital skill, and it is by automation and analytics that this is made possible. This can be achieved by technology through examination of a broad and comprehensive selection of literature, it is described the five crucial factors influencing the smart city initiatives.

Smart city classification:

2.9.1 Administration & organization, technology, governance, regulation, economy, and the built infrastructure along with natural environment. A smart city is one which tries to aggregate and evaluate data, and then use that data to solve societal problems (Anthopoulos, 2015). Smart City programs usually require ICT's. ICTs are three-part: (1) knowledge and communication technologies (ICTs), which produce and aggregate data; (2) analytical tools, which turn that data into useful information; and (3) organizational systems, all of which promote cooperation, creativity, and the application of that information to solve public challenges.

2.9.2 Transportation, urban facilities, and technology development. A smart city services network is made up of a specific ledger framework and credit system which are set up to allow trades to happen between businesses and corporations using Blockchain technologies for decentralized transactions.

2.9.3 Citizens, Standard of Life and Blockchain. Furthermore, this demonstrates five attributes of a smart city that are better matched with the project's geographical focus; smart economy, smart citizens, smart government, smart connectivity, smart climate, and smart life. The country is now integrated into what is referred to as the smart economy, much of which entails influences in technical advancement, creativity, patents, efficiency and flexibility in the labor force as well as the integration of the foreign market. A community of smart people is not only defined by the degree of qualification or schooling of the residents but also by the nature of social experiences about integration and public life and the openness towards the "outer" world. (Anthopoulos, 2015).

2.9.4 Smart democracy applies to the electoral involvement of individuals, such as granting people the power to vote, and even comprising the operation of institutions, such as ensure that people access benefits and legislation are passed in the correct manner. All four of the other attributes and their related components. Following this portion, the next section would discuss blockchain technology in terms of concepts, modules, forms, features and core specifications, and other primary elements relevant to the blockchain ecosystem in a smart city which this paper proposes to adapt blockchain for vehicle registration system a step towards a smarter city and smarter government system (Lakshmanaprabu et al. 2019).

2.9.5 Competitive, Green and robust, just and inclusive, and Well-managed. Moving further, the World Bank (2019) will begin collaborating with municipalities in Bucharest-Ilfov to develop the secondary cities and the whole city of Bucharest as they accelerate development in Romania. In addition, it assists the state in creating Romania's first urban strategy in order to help organize governmental programs and projects in a more sustainable and equitable way. As identified above paragraphs of smart city classification it is clear that adopting technology is a key factor and a very important aspect for Romania to become smart city, additionally Romania is investing millions of Euros to develop the country and provide its citizens with better public services, now that's where blockchain is a tailored solution for the movement to adopt.

Requirements for a smart city include economic development, mobility, climate, government, economy, quality of living. A smarter community plans to change its central structures through technology. At the highest stages of sophistication, a smarter community is a knowledge-based framework that alerts residents and decision makers and facilitates proactive control of the city's sub-systems (Mohite and Acharya, 2018).

The development of cities is guided by municipal councils, and they are essential in ensuring cities prosper. To resolve sustainable planning issues internationally, the World Bank has a large database set. After the launch of the Bucharest office in 1991, the company has worked with numerous urban planning concerns. More than 70 consulting programs are under development which comprise over 50% operations. This study is led in collaboration with key government departments and national and international organizations. Through offering technological support, the World Bank plans to develop cities in Romania in many different forms (Maassen et al. 2021).

Taking into consideration the fact that Romania's largest actual problem, from the population's point of view, is the relationship they have with state institutions, the smart city initiative should help straighten these issues. Starting with 2020, when the pandemic problem

arises, local authorities and the Romanian Government started paying more attention to digital solutions for the general population. For example, in 2020 the government released (ANAF – Romanian Fiscal Administration Agency, 2020) an urgent ordering, which allowed taxpayers to send documents in electronic copies and digitally sign official documents sent to state authorities. Until this piece of law came through, Romanian citizens were forced to present original documents at state agencies, a sort of activity considered much too dangerous during pandemics.

Since 76% of Romanian people reside in towns and suburbs, and these regions make up almost 97% of the country's GDP. Having urbanization's correct benefits, not just to city dwellers and the country's development, but also the remaining 24% of the citizens, who should have fair access to the opportunities provided by smart cities, from quick and elevated transport to access to schooling, employment, medical Centers and numerous recreational areas (Urban Development Portfolio in Romania, 2021).

According to the world Bank analysis, Bucharest is one of the fastest growing regions in the EU, and several other cities in the country have become cores of growth and creativity. Bucharest and several of Romania's main major cities - Craiova, Iași, Ploiești, Timișoara and others - together are home to 50% of the population and produce 75% of income.

Thus, small steps are being taken into the development of the smart city of Bucharest, but these need to be more planned, useful and in line with advanced technologies. Currently, Romania does not have a centralized information system for its citizens, so they must provide the same personal data to each institution they visit. This means that a complete solution as blockchain, will secure their information and help them solve their problems faster.

2.10 Data sharing among government agencies

States and other government entities provide a large volume of useful data. Data exchange among various government agencies may enhance the application of data, contributing to a more accurate and useful date the helps decision-making. How to promulgate these data in a way that is both fair and to be efficient both a technological and organizational concern arises. Centralized collaboration is all-inclusive data aggregation by various agencies and separate government entities and is controlled by a single government agency, therefore each agency has its own data and keeps hold of it.

This section of the study examines the Romanian government data systems, as an illustration to analyse the challenges and obstacles of unified sharing on blockchain, including stability, protection, advantages, and permissions issues. Furthermore, a collaborative government data exchange mechanism based on blockchain technology, introduces the possible advantages of this technology, and details realistic guidelines to help with the scenario of vehicle registration. Government information sharing applies to whether different government entities are given access to information, which can usually be used internally by the specific government agency (Andersen et al. 1996).

With the progress of digitalization in governance and administration, government knowledge exchange has become more comprehensive (Garcia et al. 2009). The idea of government information exchange focuses around the social network, the exchanged knowledge and data, the integrated details, and the interoperable technological infrastructure. This concept examines the diversity of stakeholders involved in government information sharing, and how their interactions communicate with each other (Garcia et al. 2009b).

Other scholars also studied the effects of different variables on public-sector data and information exchange. To provide a mechanism for recognizing various factors that influence exchanging knowledge among participants, within a government organisation, and between other government organizations (Yang and Maxwell, 2011)

An overview of how local authority involvement in a government information sharing initiative is influenced by the different variables. They have guidance for whether a government can engage in an information sharing project or not. However, the introduction of government

information sharing also faces difficulties from the decision-making phase but with complex administrative micro-operation processes, even during the government information sharing acceptance process, bureaucratic governance mechanisms of project approval(s) will limit the efficiency of project construction. Using policy mechanisms may help develop common goals, but there could be a lack of problem-solving capacity as to solve control concerns and reduce the possibility of information protection problems. Local governments have developed integrated computer networks to provide different organizations with easier access to their records. (Yang and Wu, 2014). However, governments can strengthen their cooperation capacity for balancing the interests of both the power scheme and their needs to share information (Pardo et al. 2008; Tuya, 2019).

Presently, all government organizations and commercial businesses are involved in the advancement of blockchain services and applications. For starters, the Dutch government set up collaboratively sponsored pilot projects at various levels (e.g., ministries, municipalities). Their pilot projects helped develop blockchain-based networks to store and process digital signatures, judicial decisions, and public finance. Estonia developed a blockchain network to avoid tampering, hacking, and device breaches in electronic records. Experts estimate that blockchain-based information technology can help government agencies save resources and improve productivity (Ølnes et al. 2017). Full advancement of data sharing has triggered technological and operational problems, and blockchain technology is the potential remedy (Ølnes et al. 2017).

All numerous advantages of utilizing blockchain technologies in information integration and exchange would allow for reliable identification of the origins of data and the process of data dissemination. When the data was extracted from devices, the agencies still retain the data management privileges, but not control. One IDC report centred on the ability of blockchain to enhance encryption and data protection. The report claimed that blockchain technologies demonstrated potential for creating trust, protecting privacy, and improving security (Fan et al. 2018).

In order to avoid the leakage of classified details and reduce the possible misuse of data processing, a developed blockchain-based provides a traceability scheme. There are a range of blockchain implementations that government departments should introduce today to safeguard data and enhance the handling of documents relating to vehicle registrations and incorporation.

2.11 Key focus points for the government vehicle registry

As analysed in previous chapters, Romanian vehicle registry is based on old protocols, still requires physical presence and must be rapidly updated, digitalized. As this study advances the discussion for blockchain implementation within a particular demographic: students, it will provide a few key focus points in dealing with vehicle registry digitalization. The key focused points identified through careful documentation are current issues in Romanian vehicle registration, how can blockchain help solve them, are the current taxes justified.
However, such study is in its early stages and requires more empirical studies. Other important issues also exist, such as:

(1) What are the possible advantages and risks of utilizing blockchain technologies for government knowledge sharing?
(2) How do data processing systems help to face the challenges of institutional processes? Complicating matters is that real-world cases are required to have a deep interpretation of each scenario.

2.11.1 Data security issues

The government is the key focus of hackers, and they seek to remotely probe into citizens' private records. They pose a serious danger to organisations because they collect huge amounts of money when they have access to the data. when data is placed in a secure distributed network,

it becomes harder for hackers to break through the system. (Hasib, 2019). Blockchain technology offers cyber protection against future data breaches, as data is processed on the blockchain, various approvals are placed in the network that can accept or reject the access the data. therefore, it is impossible for a cybercriminal to obtain entry to the network (Aashish, 2019).

In the case of DRPCIV, data is centrally located on their centralized data centre. Data loss will be devastating if there is a security breach though, data should not be held centralized. With blockchain distributed infrastructure there will be the possibility to connect all department's specifications and all data operations are carried out on the blockchain. Each department functions like a node and is able to use it to communicate with the blockchain. When there is a security violation, the issue will be identified, and remedies can be discovered very easily. Thus, blockchain technology has the ability to solve a problem on how to exchange data in a decentralized manner (Hildebrand et al. 2011).

2.11.2 Issues related to polices, sense of identity in government departments

For the particular case of DRPCIV's centralized scheme solution, each participant is required to submit their data and share it, then the data is centrally stored. In this type of scheme all agencies involved are worried about losing the ownership of the data stored centrally specifically where a public sector agency data it is its lifeblood for their daily operations, therefore all public agencies are avoiding this sort of initiatives. But with the blockchain data still can be shared in a distributed manner and, as a consequence, agencies do not need to upload their digital documents to a centralized data hub. The details stored on the blockchain reliably monitors the ownership of the data and participants are in majority. It is extremely complicated to modify or adjust the information. Blockchain systems may theoretically address problems about how to enforce exchanging information in a shared manner with consistent meaning of ownership rights.

2.11.3 Citizen privacy concerns

Citizen privacy has always been the main objective in any government system. Sure, a centralized sharing mechanism is more permissive and allows extensive data sharing, but these are sensible details, which must be integrated inside a safe sharing structure. As different data is stored in different government offices, for example one can provide full name, address of phone number, while others use personal information, "therefore the aggregation of data through multiple government entities would allow the government to create a full profile of each person, which greatly impacts citizens privacy (Zoonen, 2016).

Regarding safety reasons, by using blockchain, all information will be protected, as it is stored through hash segments. This means that data usage is restricted and carefully handled, in order to limit or, maybe, eliminate the risk of creating a full profile on an individual, which translates into solving a few citizen privacies concerns. Blockchain alone does not provide the full resolve for this problem, there is still a need to have additional policies and governance laws which tend to privacy concerns.

2.12 Which type of blockchain to use for DRPCIV

Blockchain technology may be categorized into several groups, based on the extent of transparency: public chains, private chains, or alliance/coalition chains. A public chain is accessible to everyone and anyone may join, while an alliance/coalition chain is open to those groups, whereas a private chain is only visible to a small number of individuals or organizations. A national data center will use a public chain through which the data are held by the public and are exchanged by the public (Xu et al. 2017). However, for city government agencies, it could be a safer option to have alliances/coalition/private chains, as it the case for Romanian DRPCIV.

However, a private chain is the safest approach for handling data within a single agency. Thus, a chain should be built for each category of data in order to include a systematic solution to the initiative. This could include the number of participants and the form of data they would function in collaboration to carry off an operation (Pedersen et al. 2019).

2.12.1 Issues with designing the right mechanisms

Multi-party involvement, accountability and sovereignty are the core criteria of a consensus process, ensuring that the whole data life cycle can be controlled and tracked. A successful consensus process involves participation of all stakeholders to facilitate efficient management of data. Everyone may become a public actor, but an approval procedure from a central node is needed in a private chain.

Authorization to join an alliance/coalition chain requires consensus by a majority of existing actors. Actors are able to leave chains. The recorder will be given points after actors have entered the chain a reward Points which then then can be used to request date on blockchain. In addition, as a data supplier, accumulated points will be awarded with a mutual data collection. Therefore, it is very important to combine the social, economic and contextual influences in order to design consensus processes. Designing suitable rewards into the framework is also important (Schmeiss et al. 2019).

2.12.2 Smart contracts right for access considerations

Data rights protection and exchange guidelines can be enforced by utilizing intelligent contracts and they should be coded into the contract mechanism in a way that needs no human interference. This guarantees that legitimate, fair and reliable data operations are performed in real time. For example, in a multi-department shared data model, each department obtains points by exchanging its data (type, data volume, update frequency, etc.) via an agreed-upon basic integration process. The chain can establish scoring and allow higher permission requests and use of data from other agencies. When the authorization value is met, the data block of the request operation will be created automatically, protocols will take place, and no manual involvement is needed to boost performance. However, because transactions would be performed instantly, it is very important to think closely about guidelines that need to be established inside the blockchain (Gilcrest and Carvalho, 2018).

2.13 Literature review conclusion

In order to better outline the implications of blockchain and its benefits, especially if applied into Romanian government services, it was imperative to describe the current state of Romania, its government platforms and all the implications of public services. As described inside the literature chapters, Romania has a long, difficult history in time-consuming services for its citizens, mainly because the platforms are not properly digitalised and are not able to serve millions of taxpayers. After reviewing current issues in governmental agencies, which also includes DRPCIV, a short description of the current vehicle registration workflows was necessary, as it helped identify its weak points for which the later blockchain chapter help find solutions.

Furthermore, the digitally inclined subchapters about blockchain, smart city and data sharing and security concepts include definitions, classifications and details about the best solution applicable for the Romanian DRPCIV. Thus, an in-depth analysis of these notions helps draw the connection between them, how can blockchain contribute to smart city development, which type of blockchain is better fit for DRPCIV and how it can generally improve this service. After completing an in-depth research on blockchain technology and on how a vehicle registry

functions, in order to further elaborate this matter, the first step of action was to determine if local vehicle owners will approve of this solution.

Next chapters include such an analysis: a research conducted on Romanian citizens, who were asked if they are content with current state of the local registry and if they would agree with advanced digital solutions, which can help improve the entire system. The documentation indicates that blockchain implementation will help improve in terms of cost-effectiveness, timesaving, privacy and security. The following research contributes to the theory, by providing a better view over the market it will be implemented to, as it takes into consideration answers from a relevant population segment.

3. Research methodology

A hypothetical idea, a theory of any sort, must always be backed-up with practical examples, studies or research findings. When dealing with a sort of research, experimental or theoretical, the often-used methodology implies a quantitative or a qualitative approach (Layder, 1993). Upon having set the research objectives, it is very important for a researcher to choose the best methodology for analysis, as this could help better elaborate the general findings, conclusions and, overall, the entire concept. The present hypothetical question refers to the digitalization of Romanian vehicle registry by using blockchain technology, thus meaning research results should have strong argumentative points that may confirm or infirm this development.

According to sociologic specialists, qualitative research involves a thorough analysis and understanding of the investigated situation and, usually takes into consideration a small number of participants, as it is time restricted (Tashakkori, 1998). As for the quantitative analysis, it requires medium to large number of respondents and it often relies on questionnaires or intricate statistical records (Dușa, and Adrian, 2014). Thought to be more objective than the qualitative one, the quantitative method usually enables generalisation to a much wider group than the one considered for the research sample.

Since the selected approach should aid in answering the research questions, the analysis choice should be suitable to demonstrating the proposed theory (Kothari, 2004). As the current paper revolves around specific departments (vehicle registry for a set country) and to a pre-determined segment of population, the proper analysis method will influence the outcome of the study. For a better understanding of qualitative and quantitative research methods, a comparison between the two is required.

3.1 Comparison between qualitative and quantitative research

Although by definition and characteristics may seem very different, the two research methods: qualitative and quantitative are often complementary. The main difference between them is the analysis process, for one of them it involves a subjective approach, as it's dealing with descriptions, while for the other it implies an objective one, with mathematical calculations, variables and numbers (Patton, 2002). Find below a table (**Table 1, below**) with a few differences between the two research methods:

Aspect	Quantitative data	Qualitative data
measurability	Measurable	They are generally not measurable.
Nature of data	Expressed in numerical form	They are descriptive rather than numerical in nature.
Research methodology	Conclusive	Exploratory

Quantities measured	Measures quantities such as length, size, amount, price, and even duration.	Narratives often make use of adjectives and other descriptive words to refer to data on appearance, color, texture, and other qualities.
Methods of collection	Statistics is used to generate and subsequently analyze this type of data	The are only gained mostly through observation.
Reliability	The uses of statistics add credence or credibility to it so that quantitative data is overall seen as more reliable	Less reliable and objective.
Data collection techniques	Quantitative surveys, interviews, experiments	Qualitative surveys, focus group methods, documental revision, etc.
outcome	Develops initial understanding	Recommends the final course of action.

Table 1 - Differences between quantitative and qualitative research methods (Source: Patton, 2021)

3.2 Quantitative research as the selected analysis method

Given the local approach chosen for the current paper – targeting the Romanian vehicle registry- the research uses a survey model. Thus, the research method is based on the use of a questionnaire, which will be sent via e-mail or social platforms, targeting mostly Romanian respondents (as the research focuses on the majority points of view regarding blockchain implementation into Romanian vehicle registry).

Primary data collected with help of the questionnaire is better analysed from a quantitative point of view, as the main objective is to find out how many respondents from the sample agree with the implementation of blockchain into the vehicle registry. Also, the study does not focus on why this should happen, but more on the numerical measurements that weigh the number of respondents able to agree with the solution. As the general results of this research will be presented as numbers and variables, the quantitative approach was the appropriate method.

3.3 Research sampling technique and size

All questions were carefully selected as to support the research objectives and they were organized into three thematic segments: the first one refers to general data, useful for data analysis – age, educational and work background, etc.; the second one focuses on local vehicle registration issues and the third segment aims to underline the importance and utility of a digitalized platform for vehicle registration (based on blockchain systems). After the answering process had ended, all collected data were analysed by sorting them and by using specific data analytics software. Also, given that the questions are classified by relevance, all gathered information was divided by level of meaning and significance inside the interpretation segment of this paper.

Before sharing the questionnaire online, it was first tested on a small group of close peers, colleagues and other students, who were asked to take part in a pilot study and leave their feedback on this programme and on time required for completion. Upon completing the pilot study, the respondents' feedback was positive on questions' flow, difficulty, interpretation and relevance, and comments on time spent for their answers were in complete agreement with initial

estimates (the questionnaire requires 10-15 minutes for answers). This concluded that the research instrument was valid and, as pilot participants confirmed, ready to be sent online.

The study was conducted in Romania, in European country, with vast culture and long-time experience in digital technologies. As student count in 2020/2021 in Romania was somewhere over 350.000 individuals, the sample that participated in the study will reflect an important percentage from the citizens who use vehicle registration services annually (INS, 2020). All information analysed in this study was collected online and helped shape the objectives by listing the students' opinion on the matter and their attitude towards current way of registering a vehicle in Romania.

Survey participants were selected from proximity groups, social-based groups or other peer recommendations. The technique selected for sampling the respondents was chain sampling (or the snowball technique), as this functions on peer recommendations and all respondents were asked to share the questionnaire with their acquaintances and friends (Anon, 2020). Also, in order to collect more answers and have an ampler view, a link with an invitation to take part into the study was posted into social media pages and students' communities in Romania.

All individuals were asked first if they are willing to answer the questions and they will be given information about the thematic of this survey. They were also informed about the time needed for giving their answers and they were assured no specific personal information will be asked during the survey.

For the realisation of this study, all questions were uploaded on the Google Forms platform (by Google), which has a user-friendly interface and is dedicated to questionnaires of any sort. After the answering step was completed, all answers and results were analysed with specialized software (IBM SPSS Statistics, version 24.0). Among the functions used to determine values, means, variables and connections between questionnaire results, we used the following functions: descriptive statistics (with correlations between different numerical result, like age or studies), crosstabulations (which take into consideration who responses are connected through variables), frequency statistics, ANOVA, etc.

According to the IBM website regarding its software for analysis, the ANOVA (Analysis of variance) represents a number of statistical ways, described as a „linear modelling method for evaluating the relationship among fields". As there are different parameters interconnected when analysing charts, ANOVA tests to see if the medium value has variations. As a general disclaimer presented by all definitions found (Lane, 2020), although ANOVA shows statistical differences between means, it does not reveal specific differences. Along with ANOVA, a type of variable identification used was the Bayesian factor function, which represents a "likelihood of one particular hypothesis to the likelihood of another and it can be interpreted as a measure of the strength of evidence in favour of one theory among two competing theories" (Beard et al. 2016).

3.4 Research limitations

Among the advantages underlined during the realization of this survey, there was a number of limitations identified, which must be taken into consideration if further studies on the matter are conducted. Firstly, as one advantage on choosing the students as the sample for analysis (since they are technology enthusiasts and have more knowledge on the matter), might represents a limitation, as the general population is mainly comprised of individuals with ages ranging from 40-54 years old (INS, 2018). This issue, though, may not weigh so heavy, as the study shows undeniable results, which may function as a generalisation process. Another issue regarding this study is the fact that blockchain as a concept is very new to the Romanian population, as many do not understand it or know very much information.

Lastly, a government point of view or implication into this study may have helped in better understanding blockchain's advantages and, maybe, accelerate the process of implementation (since there is already a discussion on the matter of Romanian vehicle registry

digitalization). The above-mentioned weak points may help find new ideas and maybe, generate future similar initiatives, which could greatly improve Romanian public services.

3.5 Ethics

The Research Ethics Application Form was submitted and approved by Research Ethics Committee respecting all University's rules on ethics and compliance. All participants are provided with the Participation Information Sheet. The link invitation for the survey with sufficient level of information accompanied with Participation Information Sheet was sent to all survey participants. Participants are informed about topic and purpose of research, methodology, process of collection of information and how research findings will be used and stored. Participants are clearly informed that their participation in survey is voluntary.
In summary, the researcher followed and applied all ethics instruction in line with regulations which contributed toward credibility of this research.

3.6 Study and specific questioning route

Blockchain is a vast subject, as is the vehicle registration department of any country, so, in order to better classify the data collected, the questionnaire is divided into three sections, each having a correlation with the research objectives. The set starts with simple, demographic related questions, continues with vehicle related ones and ends with the specific digitalized platform related questions. Also, the list includes 8 or 9 the particular questions related to DRPCIV and its digitalization, which will help identify the number of respondents that agree with this development. As the answers were analysed, they were cross-referenced between modules and helped distinguish opinion patterns from a specific demographic's point of view.

The entire set of questions was built around the research theme, and, as mentioned in previous paragraphs, it is divided in three main modules. This questionnaire was inspired by previous researchers or specialists: it is based on the Likert Scale, as it measures individuals' attitude by checking the scale on which they agree upon a question or a statement formpl.us (2020) and a few questions were inspired by Schwartz and Bilsky (Schwartz and Bilsky, 1990) in matters of identifying behavioural tendencies and values. Also, the nature and direction of the third module of questions was created by mirroring an Heinelt study on changing local democracy (Heinelt et al. 2018).

The first module of the questionnaire consists of four demographics related information, the second segment requests answers about vehicle transactions and the third and final set of questions refers to the blockchain-based platform for DRPCIV. All these helped design a set of valuable and relevant questions, which will paint a better picture of what the respondents feel about blockchain implementation. Of course, this entire study will help determine which processes can blockchain improve and what are its the benefits in terms of facilities, internal processes, financial, etc.

4. Findings

Upon gathering information about how blockchain will fit into DRPCIV and having checked all its advantages and flaws, this chapter will canvas results of the survey, compiling them into statistical data and analysis. The main questions that arose from the initial hypothesis were: will people accept the digitalizing solution and what are the terms for which they will be able to accept this? And how well can blockchain improve the processes?

Very important to mention that 100% of participants have accepted the ethical and consent forms listed at the beginning of the questionnaire. As informed in the previous chapter, the application used for data analysis and interpretation was IBM SPSS Statistics, which is an

advanced statistics platform, with multiple software patterns available (IBM website, 2020). Among the SPSS tools used, there are the following: frequency reports, descriptive statistics, variable–based data interpretation (ANOVA) and ranking functions.

4.1 General demographic data

In order to confirm or infirm the current hypothesis, after carefully selecting the demographic segment, a questionnaire with relevant study questions was sent to set group. The survey was conducted in March 2021, aimed 150 students' responses and gathered a total of 134 participants, meaning that general response rate was successful, as the final percentage was 89,33%. As described in previous chapter, the respondents were found by the chain referral method - or snowball technique (Changing minds website, 2021), meaning that each individual which completed the questionnaire was asked to forward it to another student he/she knew.

Regarding the student confirmation status aspect of the questionnaire, over 90% of participants are currently undergoing University or Master studies. **The average age** of the respondents is 32 years old – 46% of them are 31 to 40 years old and 28% of the individuals who took part in this study are 25 to 30 years old. The smallest percentage of respondents is represented by students aged 18-24 (15%) or 41 to 50 years old and above (11% in total). Also, as identified with help from SPSS, the majority of respondents aged 18-24, 25-30 and 31- 40 believe that digitization of government processes in Romania is required and beneficial (see **Tables 2 and 3** - charts below).

Studies classification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highschool	9	6,7	6,7	6,7
	University	57	42,5	42,5	49,3
	Master	65	48,5	48,5	97,8
	PHD	2	1,5	1,5	99,3
	Other	1	,7	,7	100,0
	Total	134	100,0	100,0	

Table 2 - Studies classification for study respondents (Source: by author, 2021)

Age parameters					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-24	20	14,9	14,9	14,9
	25-30	38	28,4	28,4	43,3
	31-40	62	46,3	46,3	89,6
	41-50	13	9,7	9,7	99,3
	51 and above	1	,7	,7	100,0
	Total	134	100,0	100,0	

Table 3 - Studies classification for study respondents (Source: by author, 2021)

One of the first characteristics noticed inside the answers received was the fact that 55% of respondents were male (see **Table 4** below, with details about gender segmentation). This concurs with recent studies **regarding male/female** parity among Romanian drivers, which show that a third of driving license owners are female ones (DRPCIV, 2020). According to the Romanian vehicle registry (DRPCIV, 2020), more than 2,67 million driving licenses were granted to female citizens in 2019, from a total of 7.9 million in general.

Table 4 – Respondents' gender segmentation (Source: by author, 2021)

Gender segmentation					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	f	60	44,8	44,8	44,8
	m	74	55,2	55,2	100,0
	Total	134	100,0	100,0	

Table 4 - Studies classification for study respondents (Source: by author, 2021)

Regarding the ownership aspect and experience in registering a vehicle, **questions 4** and **5** were attributed to findings related to this area. Most student respondents (80 percent) said they have owned one or have dealt with registry public services by now. Considering they were not already vehicle owners or did not go through a vehicle registration process by now, when asked if they intend to buy a vehicle in the following 3 years, results show a staggering 78% affirmative intention to do so (see **Figures 19 and 20,** below).

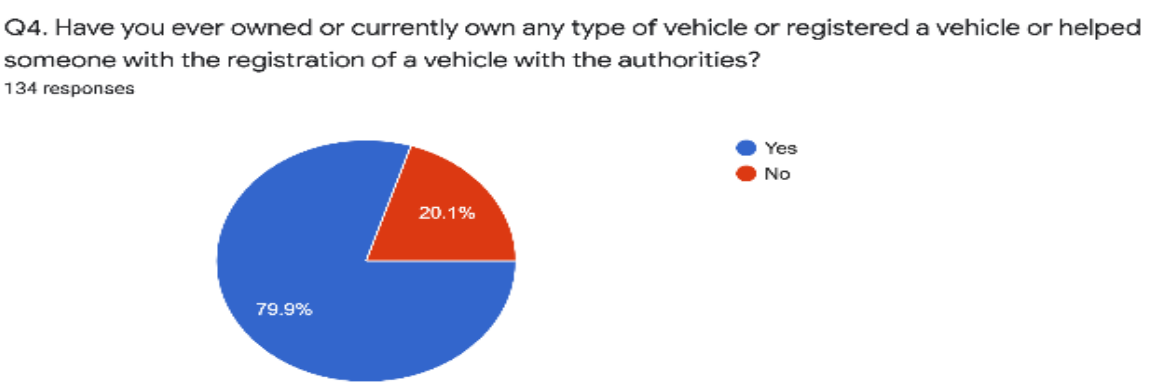

Figure 19 - Responses to question 4 from the questionnaire (Source: by author, 2021)

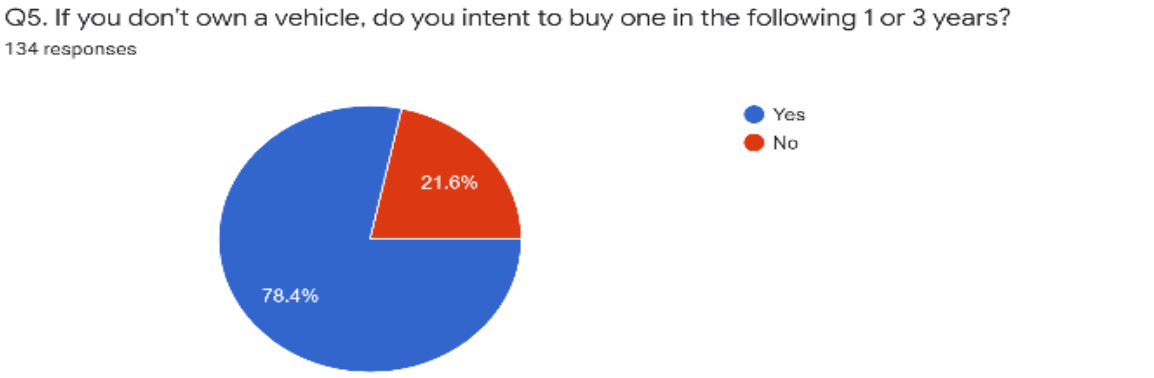

Figure 20 - Responses to question 5 from the questionnaire (Source: by author, 2021)

When it comes to the actual process of vehicle registration, the outstanding majority (67.9 percentage points) of answers show that individuals **prefer to do it themselves**, rather than asking a professional or someone else to do it for them. This indicator shows that there is an enormous interest in dealing personally with these types of services. See below, table 8, with the general analysis resulted from IBM SPSS data analysis on results from **question number 6**.

Q6. Prefer professional or not

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	22	16,4	16,4	16,4
	Use special service like broker or agents	21	15,7	15,7	32,1
	Do it by myself	91	67,9	67,9	100,0
	Total	134	100,0	100,0	

Table 5- IBM SPSS analysis results (Source: by author, 2021)

Strongly related to question number 6, **the following question** comes to confirm that, even though it proves to be difficult for them in terms of knowledge, citizens still prefer to go through vehicle registration processes by themselves. When asked if they believe that *any party (e.g. a broker or a specialized company) has an information advantage compared to them in the buying process*, more than half of them (45% agree and 20% strongly agree) said yes, as response chart on **Figure 21** shows.

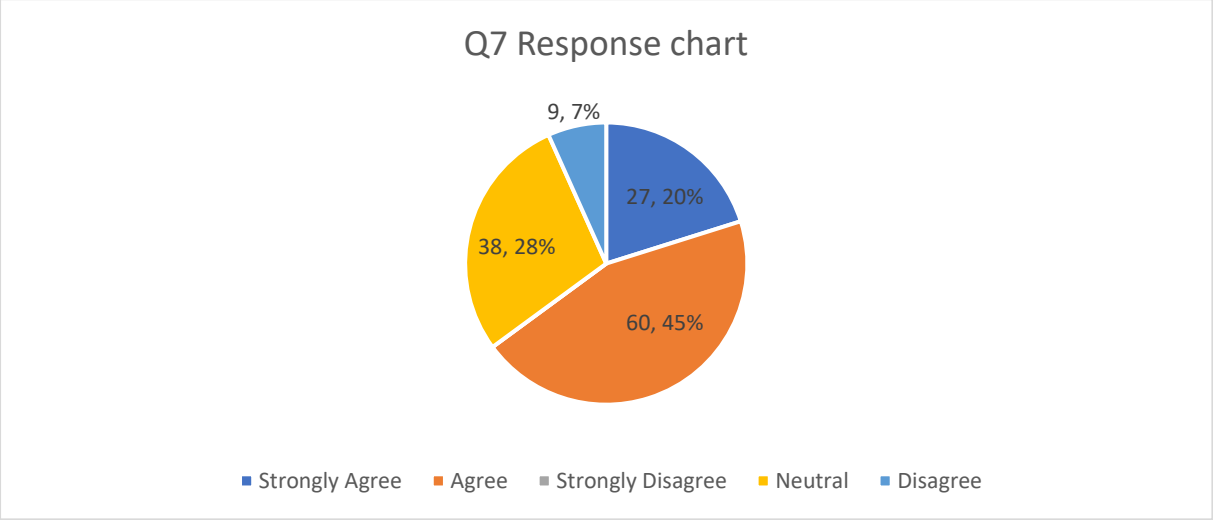

Figure 21 - Responses to question no. 7 from the questionnaire (Source: by author, 2021)

Taking into consideration the current issues of DRPCIV, there was a need to identify if the problems discovered in literature review coincide with actual facts, thus **question 8** was referring to one of these points: *Today's vehicle register is centralized to one authority, which can make the system more vulnerable. Is that something you feel uncomfortable with?* As answers received show, the centralized aspect of vehicle registration does not represent a significant problem: 40% of the respondents agree. 7% of them strongly agree, but 30% feel neutral and 28% disagree with the statement (see responses bar below - **Figure 22**).

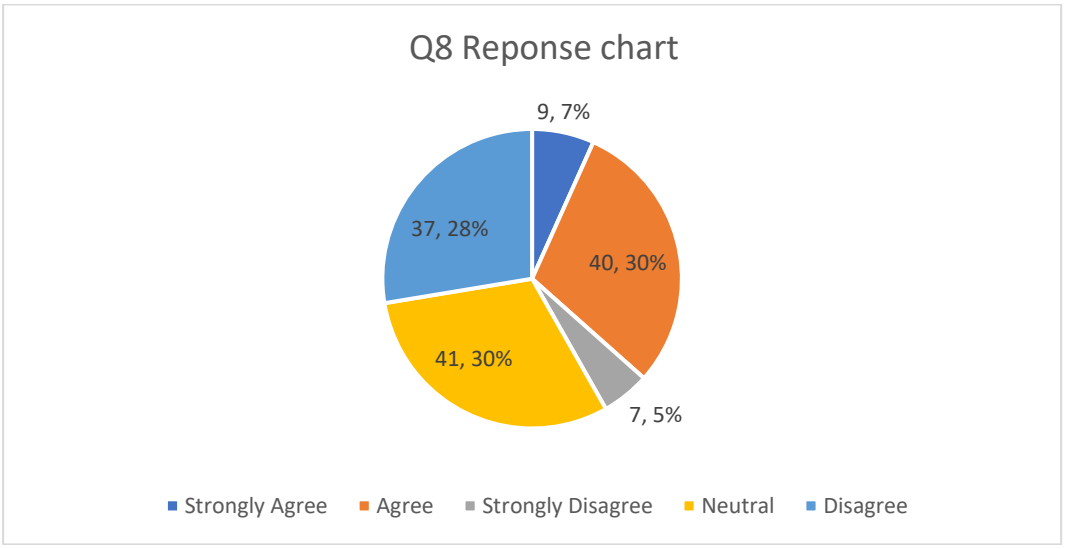

Figure 22 - Responses to question no. 8 from the questionnaire (Source: by author, 2021)

Further advancing with this analysis, it becomes clearer that vehicle owners or future owners believe that all services will function better if they were online, as **the 9th question** of this study asked *If a reliable digital system (such as an AI) could replace a broker's services, would you be comfortable to use such a digital system?* and 116 answers (an outstanding 86%) support the claim. On the same note, **question number 10** asked respondents if they would agree on signing a contract through a telephone application and 111 votes were given to affirmative answers (73 votes for *Agree* and 38 votes for *Strongly Agree*). This result is conclusive, as only 23 individuals chose other options.

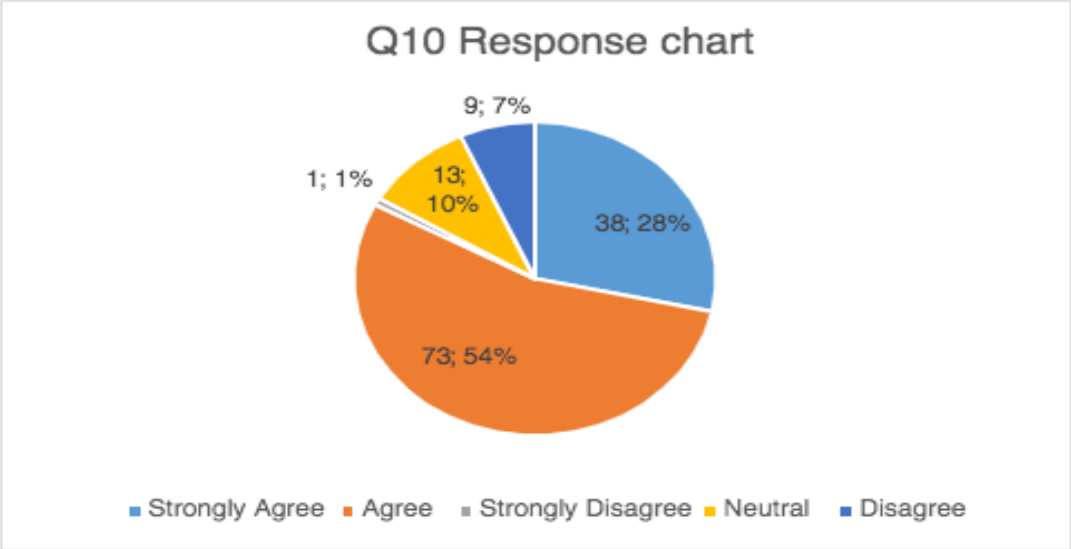

Figure 23 - Responses to question no. 10 from the questionnaire (Source: by author, 2021)

As we continue observing these results, a general picture is being drawn, which states that online, digitized services are preferred to the physical registration ones, with a majority percentage – as shown in the SPSS chart bar below. Related to this idea, there is a strong correlation between digitization and young ages, among students or working individuals. As a crosstab report in SPSS calculated (see **Tables 4 and 5**), most students with a University or master's degree want to access government services via online platforms.

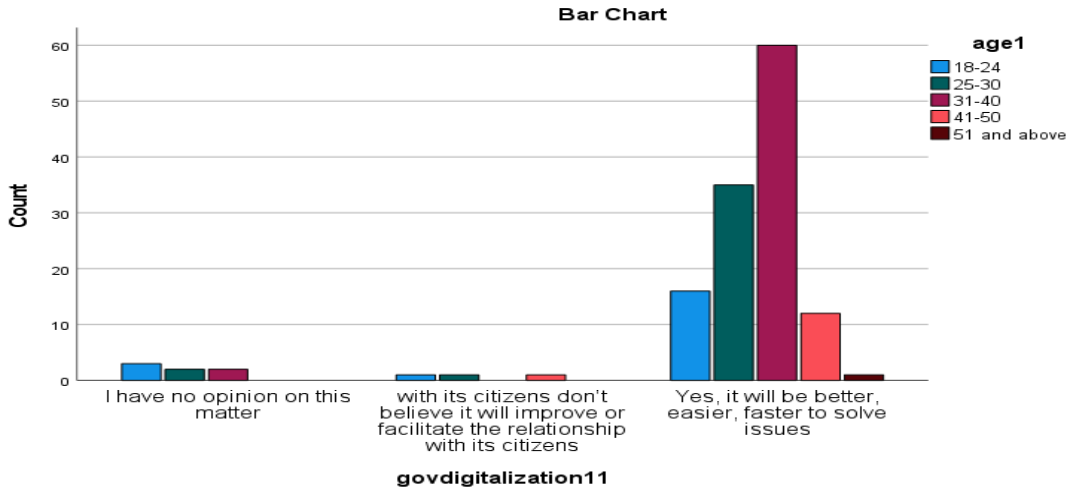

Table 6 - SPSS Crosstab report for responses classified by age (Source: by author, 2021)

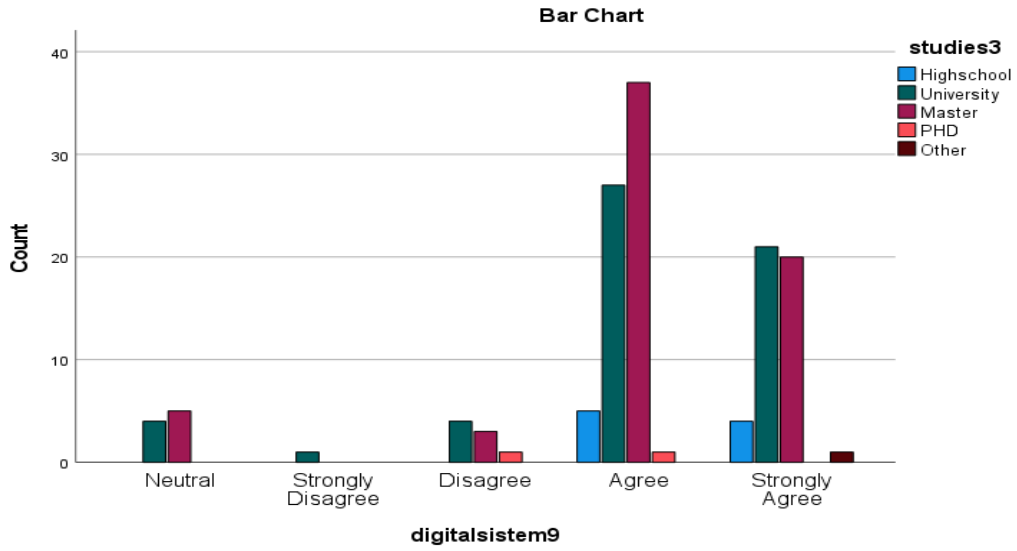

Table 7 - SPSS Crosstab report for responses classified by studies (Source: by author, 2021)

Having established through validated answers that digital services are desired, this is the point we are able to introduce blockchain into the questionnaire and to the respondents, with the purpose of identifying if they are familiar with it, if they like it, if they would us it.

4.2 Blockchain popularity and its acceptance rate for online vehicle registry

Blockchain as a technology gathers more and more popularity, a principle demonstrated in earlier literary review chapter, and it has an increasing role in setting services on online platforms. As this research aims to determine if people will accept blockchain for DRPCIV (or similar platforms), if they are willing to pay for these services and how it will all impact different parties.

One of the arguments in asking students how they would feel about blockchain for a vehicle registry platform was their affinity for all Internet and software related topics. This also comes on top of an already rising appetite amongst Internet users, as Romanian household users with access to Internet has risen in 2020 with 2,5% relative to the past year (Romanian Insider, 2020). Surely, the initial hypothesis was accurate, as results show (see **Table 8,** below) that more than half of them have moderate or strong information about blockchain.

familiarblockchain12 * studies3 Crosstabulation

Count

		studies3					Total
		Highschool	University	Master	PHD	Other	
familiarblockchain12	Weak to none, I don't have any information about this.	0	16	9	2	1	28
	Medium/moderate knowledge about this (like name, vague details)	5	28	35	0	0	68
	Strongly, I know very well the technology	4	13	21	0	0	38
Total		9	57	65	2	1	134

Table 8 – SPSS report for responses for question 12, sorted by studies (Source: by author, 2021)

As described in second chapter of the current study, current registration steps with DRPCIV have more shortcomings than advantages and this fact was mirrored in the answers gathered from the questionnaire. Considering answers to question 13 of the questionnaire (see **Table 9**, at the end of paragraph), it is safe to say that all respondents will happily register vehicles online rather than going in person to do this, as almost 83% answered affirmative, while only 0,7% chose the *go to the authorities in person* option. Connected with this general opinion extracted from the study is the large number of respondents who voted on time spent for vehicle registration: according to more than 100 students' answers for question number 14, until this moment the entire process registration required 2 working days (37 answers), 3 working days (24 answers) or even 1-2 weeks (39 answers).

regduration14 * vehicleowner4 Crosstabulation

Count

		vehicleowner4		
		No	Yes	Total
regduration14	1 working day (10-12 hours)	2	32	34
	2 working days (20-24 hours)	6	31	37
	3 working days (24-36 hours)	7	17	24
	1-2 weeks (over 36 hours)	12	27	39
Total		27	107	134

Table 9 - SPSS report for responses for question 14, sorted by vehicle owners (Source: by author, 2021)

Thus, we can only infer that, given their past experiences and available technologies, which can simplify the process, respondents are inclined to choose online registration services, if available.

4.3 Digitalized platform strong points findings

With help from question 15 of the study, there was a need to find out what the main concerns about a digital platform are. Among the hypothetical barriers that respondents chose, there were: fear that such a platform would be too expensive to use (14,9 %), lack of knowledge in using such a platform (35,8%) and the futility of such a platform (3,7%). In addition, 5,2% of them chose all of the barriers listed and 6% have other ideas about a digital platform's limitations.

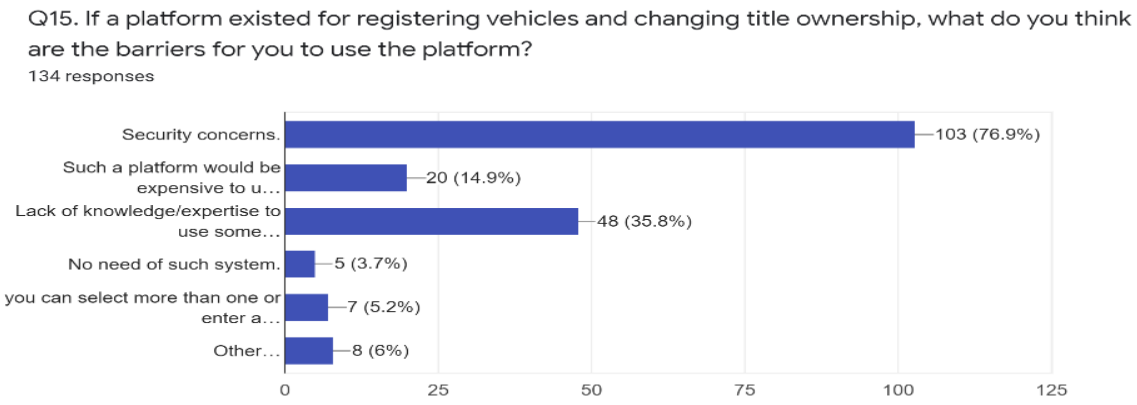

Figure 24 - Responses to question no. 15 from the questionnaire (Source: by author, 2021)

Strongly related to these findings is the information gathered from respondents through the 16th question (maybe one of the most important ones from the study): *If such platform existed, would this make any difference to you what type of technology uses in order to function for example blockchain or other technologies?* Here, the answers were tilted towards blockchain, as 30% of respondents would prefer blockchain for a DRPCIV, while 21,6% said they would care about the use of an appropriate technology, which will be able to securely process their personal information. These findings show that blockchain is popular as a name and technology, but people have ambiguous knowledge about it, as they have never had the chance of using it before.

For the same question, 45% of answers (smaller than the cumulative affirmative ones expressed towards specific technologies) were attributed to digital technologies of any sort, as long as the services would be available online. Again, in close connection to previous answers, a very small number of respondents (2%) have chosen the traditional infrastructure over to the online based one. More than this, an SPSS data report shows that the average age of the individuals who chose online technologies is somewhere around 30-35 years old (as show in the chart below).

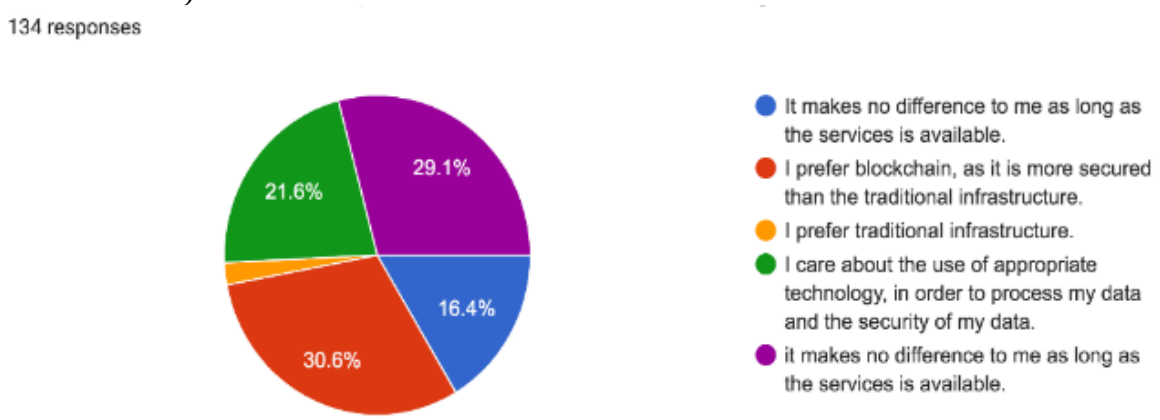

Figure 15- Responses to question no. 16 from the questionnaire (Source: by author, 2021)

blockchainorother16 * age1 Crosstabulation							
		age1					Total
		18-24	25-30	31-40	41-50	51 and above	
blockchainorother16	it makes no difference to me as long as the services is available	7	18	30	6	0	61
	I care about the use of appropriate technology, in order to process my data and the security of my data	3	9	13	4	0	29
	I prefer traditional infrastructure	2	0	1	0	0	3
	I prefer blockchain, as it is more secured than the traditional infrastructure	8	11	18	3	1	41
Total		20	38	62	13	1	134

Table 10 - SPSS report for responses for question 15, cross-referenced by age (Source: by author, 2021)

If, according to answers given we have established that Romanian citizens are eager to benefit from online vehicle registration, a few questions regarding fees and online payments were required. Starting with a basic request, aimed to find the amount of money people will be willing to pay for brokerage services in vehicle registration: *What would a fair fee look like for you*, the conclusions were somehow unexpected. Although one of the choices given as option was the "free" one (which a minority of 21,6% chose), individuals appreciated that they are ready to pay 100 to 150 Ron for brokerage services (39,6% of them), 151-200 Ron (32,1%) or 201-700 Ron (6,7%).

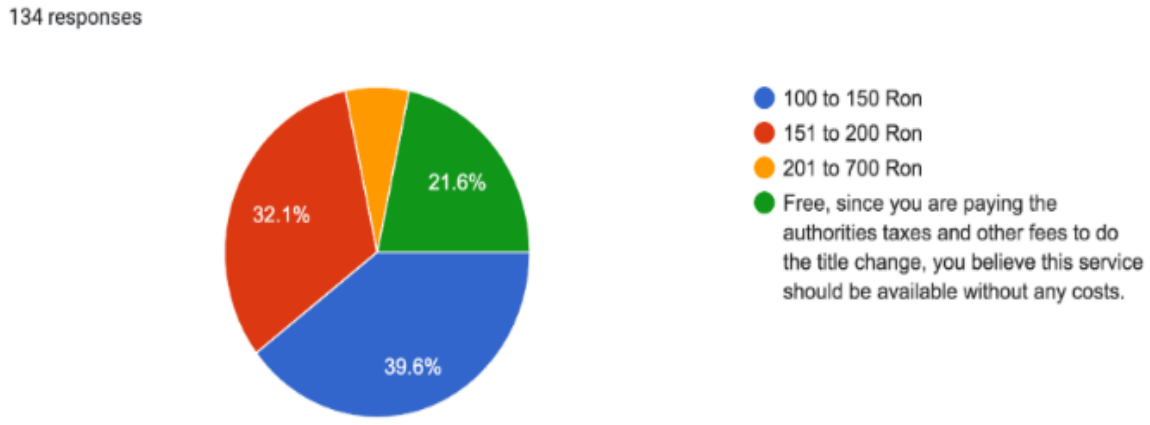

Figure 26 - Responses to question no. 17 from the questionnaire (Source: by author, 2021)

To be able to determine differences between answer, the one-way ANOVA test was run in SPSS for fees students are willing to pay online for vehicle registration services (question number 17). This test revealed there was a significant difference between age groups (as mean has a 2 to 10 points differences between fees categories – see report below). This could be read as a large disparity in opinions for respondents, who could not agree upon choosing a medium amount, they made distant choices on the matter of fees.

Bayesian Estimates of Coefficients[a,b,c,d]					
Parameter	Posterior			95% Credible Interval	
	Mode	Mean	Variance	Lower Bound	Upper Bound
fairfee17 = Free, since you are paying the authorities taxes and other fees	29,92	29,92	3,58	26,2	33,639
fairfee17 = 100 to 150 Ron	33,695	33,695	2,17	30,799	36,591
fairfee17 = 151 to 200 Ron	30,715	30,715	2,541	27,581	33,849
fairfee17 = 201 to 700 Ron	25,425	25,425	12,262	18,541	32,309
a. Dependent Variable: age1					
b. Model: fairfee17					
c. Regression Weight Variable: blockchainorother16					
d. Assume standard reference priors.					

Table 11 - SPSS report ANOVA on fees for DRPCIV blockchain (Source: by author, 2021)

Bayesian Estimates of Error Variance[a]

	Posterior			95% Credible Interval	
Parameter	Mode	Mean	Variance	Lower Bound	Upper Bound
Error variance	462,833	490,465	7401,719	350,121	685,691

a. Assume standard reference priors.

Table 12 - SPSS report error of variance on fees for DRPCIV blockchain (Source: by author, 2021)

Further analysing study results, when given the hypothetical opportunity to benefit from a strong, interconnected with other government agencies, which can drastically reduce registration time, students who took part in the study confirmed they would definitely use it (65% of responses Strongly Agree with this option). A deeper insight into this percentage, cross-referenced with question 14 responses (regarding current registration times) points out that the one respondent whom were unhappy with the long process are the ones who chose a valid, better platform, which will only take one hour of their time.

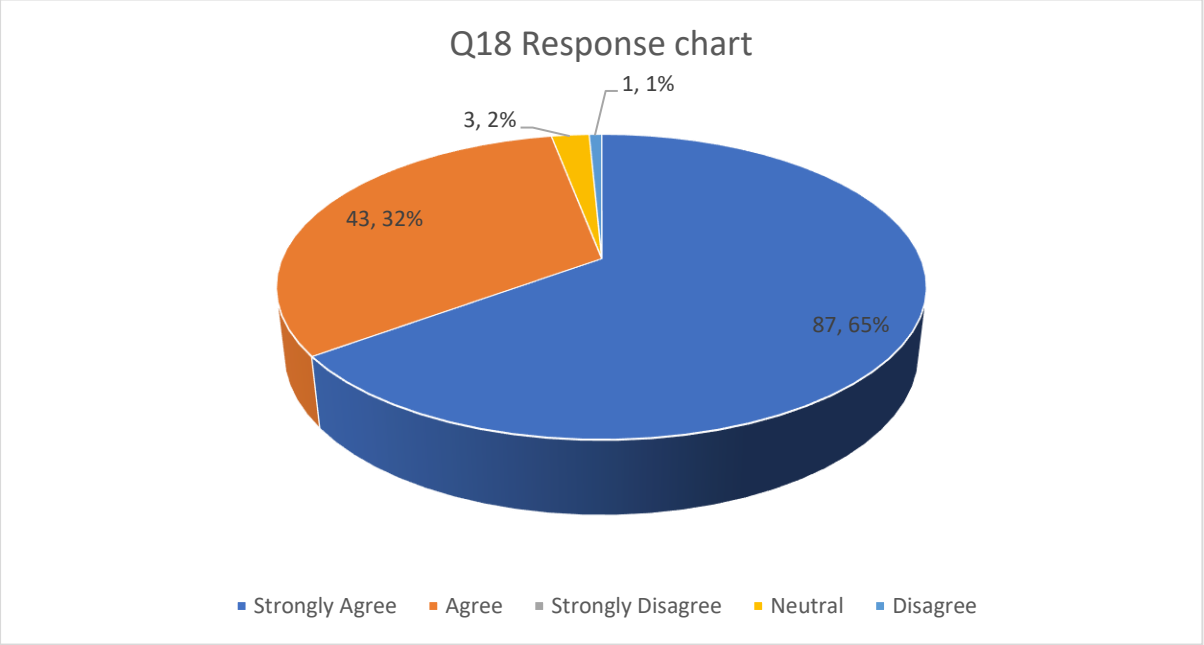

Figure 2 - Responses to question no. 18 from the questionnaire (Source: by author, 2021)

regduration14 * digitalandintercnnected18 Crosstabulation

Count

		digitalandintercnnected18			Total
		Neutral	Agree	Strongly Agree	
regduration14	1 working day (10-12 hours)	0	12	22	34
	2 working days (20-24 hours)	2	13	22	37
	3 working days (24-36 hours)	1	7	16	24
	1-2 weeks (over 36 hours)	0	12	27	39
Total		3	44	87	134

Table 13 - SPSS report on question 14, based on respondents who voted for a digital platform (Source: by author, 2021)

In direct connection with time and cost-reducing inquiries, there is the environmental aspect of redirecting vehicle registration services online, a matter that takes the form of question number 19. When asked if they believe that a unified platform, which can reduce time and public servants' interaction, may be of aid for the environment, the affirmative responses summed up 130 votes (85 of respondents strongly agree and 45 of them agree).

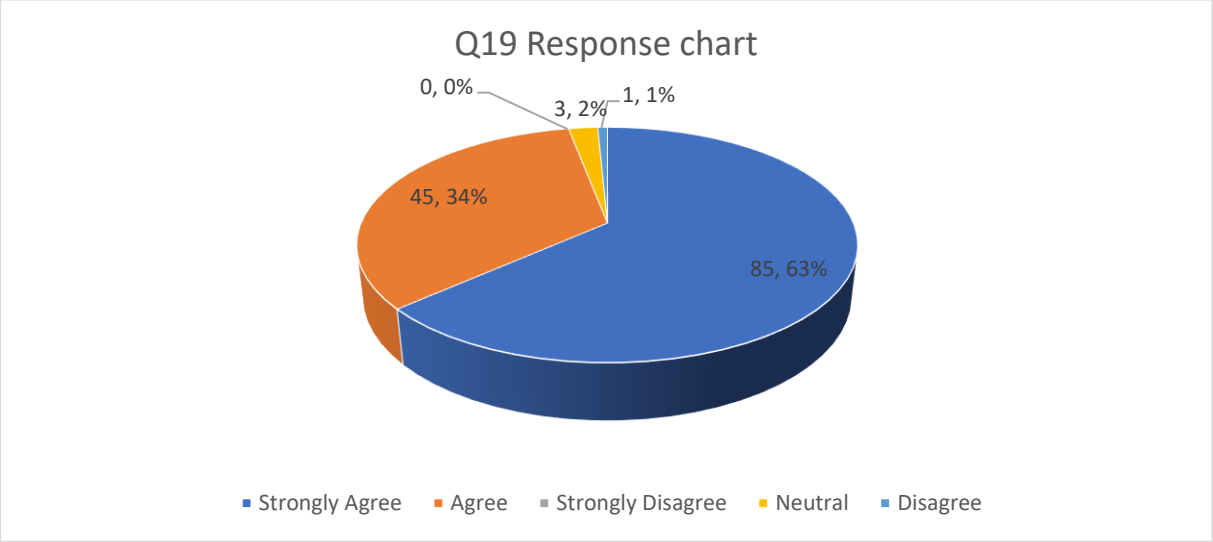

Figure 28 - Responses to question no. 19 from the questionnaire (Source: by author, 2021)

As the care for environmental issues keeps rising, this question united the individuals who took part in the study, as this is the highest percentage of pro votes from the entire study. As a carefully curated analysis from SPSS shows (**Table 14**, below), even the participants who are not vehicle owners believe that such a platform could help with environmental issues.

vehicleowner4 * environmenthelp19 Crosstabulation

Count

		environmenthelp19				
		Neutral	Disagree	Agree	Strongly Agree	Total
vehicleowner4	No	2	1	8	16	27
	Yes	1	0	37	69	107
Total		3	1	45	85	134

Table 14 - SPSS report on question 19, based on respondents who are vehicle owners (Source: by author, 2021)

At this point of study analysis, we are able to draw a partial conclusion: the results show that people would prefer to register a vehicle online, if a platform dedicated to this existed. Question number 21 helps support this statement, since it urges participants to choose top five functionalities they would like to discover and use inside an online vehicle registration system. The general top five attributes identified, and the options subjected to voting the following were preferred (**Table 15**, below):

NO.	TOP FIVE RESPONDENTS' PREFERRED DIGITAL PLATFORM ATTRIBUTES:
1	ITP mileage records history & validating that ITP is up to date to dates of purchase (100 votes out of 131) ;
2	Ownership history (65 votes) ;
3	Insurance claims and availability (98 votes) ;
4	Being able to do everything online in less than 1 hour (50 votes) ;
5	Vehicle manufacture serial numbers on chase & engine ;

NO.	OTHER DIGITAL PLATFORM ATTRIBUTES VOTED:
1	Outstanding fines;
2	Outstanding taxes;
3	All involved public services integrated, doing the checks and confirming all the above in a blink of an eye; confirming the ownership transfer instantly following your secure confirmation via mobile sent codes and own passwords;
4	Country of origin.

Table 15 - Top five digital platform attributes voted by respondents (Source: by author, 2021)

The purpose of next question was to establish if this sort of online application could actually save citizens' time. Here, the highest number of responses was attributed to the "Strongly Agree" option, with a 73,9% and to the "Agree" one, selected by 23,9% respondents. It is also important to mention that 0,7% chose to be neutral about this statement and 1,5% of them did not agree with it. These results help consolidate the idea of effectiveness for a blockchain based platform, presented to the demographic segment all along the study. Also, a review on age segmentation for this question shows the same average age of respondents for positive votes, as a cumulative 100 respondents are 25-30 or 31- 40 years old (see **Figure 30** and **Table 16**, below).

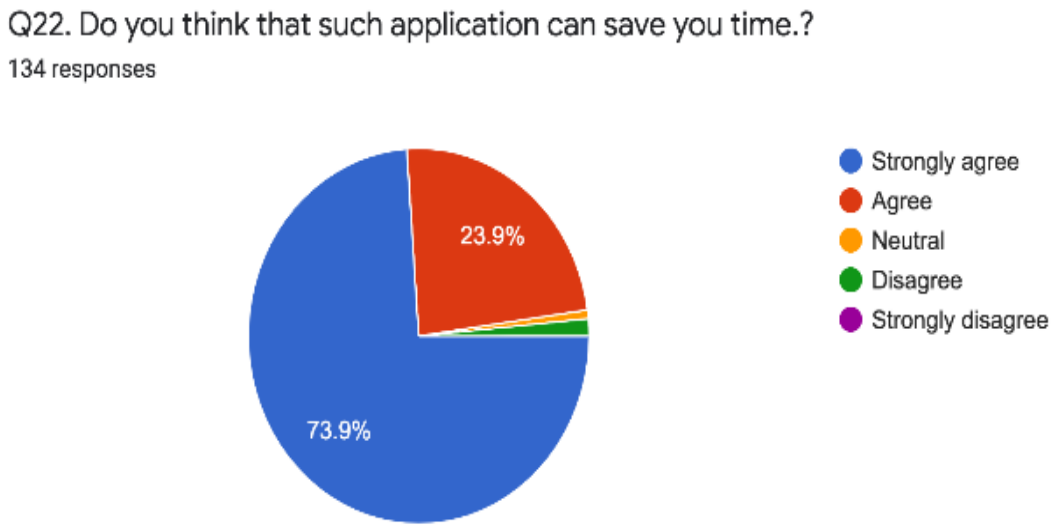

Figure 3 - Responses to question no. 19 from the questionnaire (Source: by author, 2021)

age1 * saveutime22 Crosstabulation

		saveutime22				
		Neutral	Disagree	Agree	Strongly Disagree	Total
age1	18-24	0	2	5	13	20
	25-30	0	0	9	29	38
	31-40	1	0	13	48	62
	41-50	0	0	5	8	13
	51 and above	0	0	0	1	1
Total		1	2	32	99	134

Table 16 - SPSS report on question 22, based on respondents' age (Source: by author, 2021)

As we further advance with questions related to blockchain and online platforms, we notice there is a relationship between them in terms of students' appetence for positive responses. Through **question number 23**, when asked if it would be beneficial if all service providers are gathered in a common online portal, 98,5 percent strongly agreed or agreed (66,4%; 32,1%) with the statement, while only 1,5% said they feel neutral about is. A general overview for the latter two questions, reveals a crowded are at the intersection, as an average 40 respondents chose to *Agree* with both answers and 44,5 votes say they *Strongly Agree* (see references below, courtesy of SPSS).

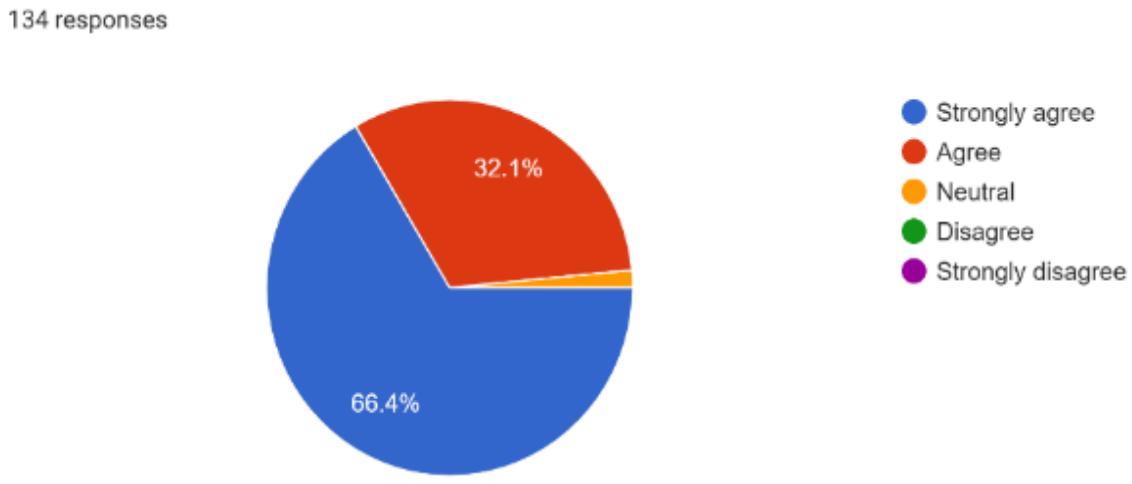

Figure 304 - Responses to question no. 23 from the questionnaire (Source: by author, 2021)

saveutime22 * allprovidersinone23 Crosstabulation					
		allprovidersinone23			
		Neutral	Agree	Strongly Agree	Total
saveutime22	Neutral	0	1	0	1
	Disagree	0	2	0	2
	Agree	2	28	2	32
	Strongly Disagree	0	12	87	99
Total		2	43	89	134

Table 17 - SPSS report on question 22, based on respondents who preferred question 23 (Source: by author, 2021)

In close relation with this question and the previous one is the inquiry about time-saving benefits for the government itself: Q.23: *Do you think that such a platform could save the government time and money and improve the quality of services that they provide for the Romanian citizens.* As we have already identified if this particular platform could save citizens time and money, there was a need to find out if it could possibly do the same for the authority administrating it (**24th question of this study**) and this incited only 7,5% *Neutral* responses and 0,7% *Disagree* votes, as the surprising majority chose answers that agree with this statement (61,2% - *Strongly Agree*; 30,6% - *Agree*)

Coming back to the payment details of a vehicle registration process, since we have already established that respondents were willing to pay for services rendered, the next step was to ask them if they will accept to pay online (regarding secure payment issues, time saving benefits, etc.). As results below show, 44,8% agreed to **online payments**, 41% of them strongly agreed and online 11,2% felt neutral about this option. It is important to mention that only 3% of responses inclined to disagree with online payments.

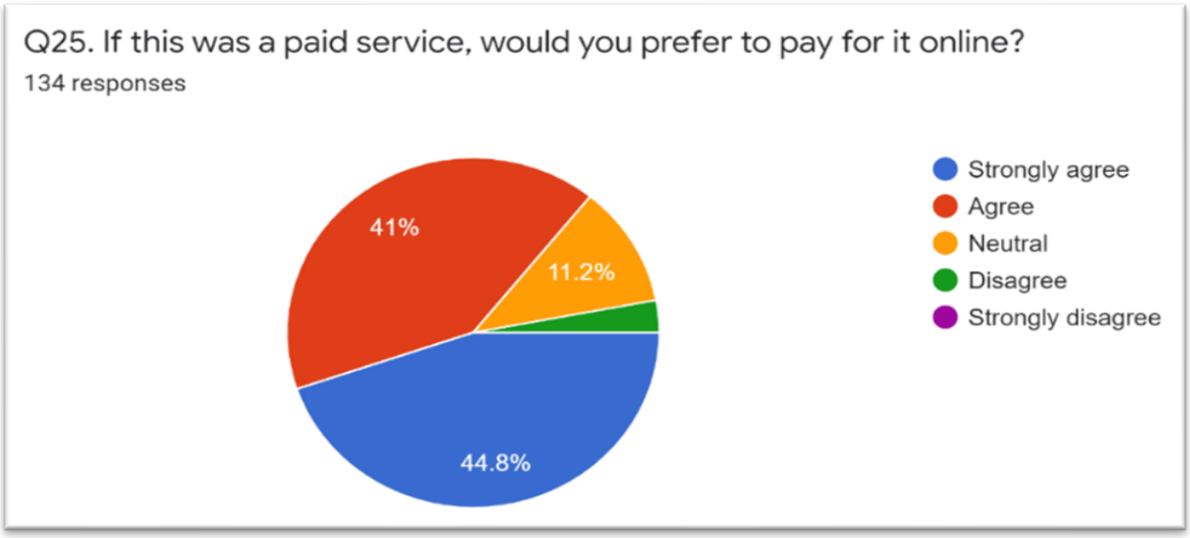

Figure 31 - Responses to question no. 23 from the questionnaire (Source: by author, 2021)

Questions 26 and 27 are taking into consideration the customer feedback aspect of an online platform: if people will want to leave online feedback and if they would rely on other citizens' responses. When given this option, about leaving an opinion online about the quality of services received, most of them (in total 91,1% in strong or simple agreement) accepted to do so and many agree they would rely on other users' opinion on the same matter (see analysis **Table 18** below).

feedbackchoice26 * customerfeedback27 Crosstabulation

Count

		customerfeedback27				
		Neutral	Disagree	Agree	Strongly Agree	Total
feedbackchoice26	Neutral	2	0	6	2	10
	Disagree	0	1	1	0	2
	Agree	0	1	51	6	58
	Strongly Agree	0	0	13	51	64
Total		2	2	71	59	134

Table 18 - SPSS report on question 22, based on respondents who preferred question 23 (Source: by author, 2021)

Other similarly important matters analysed during the study were public health and environmental issues, as they would be directly affected by moving vehicle registration services online. Thus, question **number 28** established that 91,8% respondents feel that an online platform would definitely improve public health and safety (especially during pandemics), while the final questions - **number 30 (**see **Figure 32,** below**)** – found that 88,8% votes were in complete agreement with the statement that *technology can help reduce the CO2 emissions by reducing the number of people traveling to access public services while it is available online.*

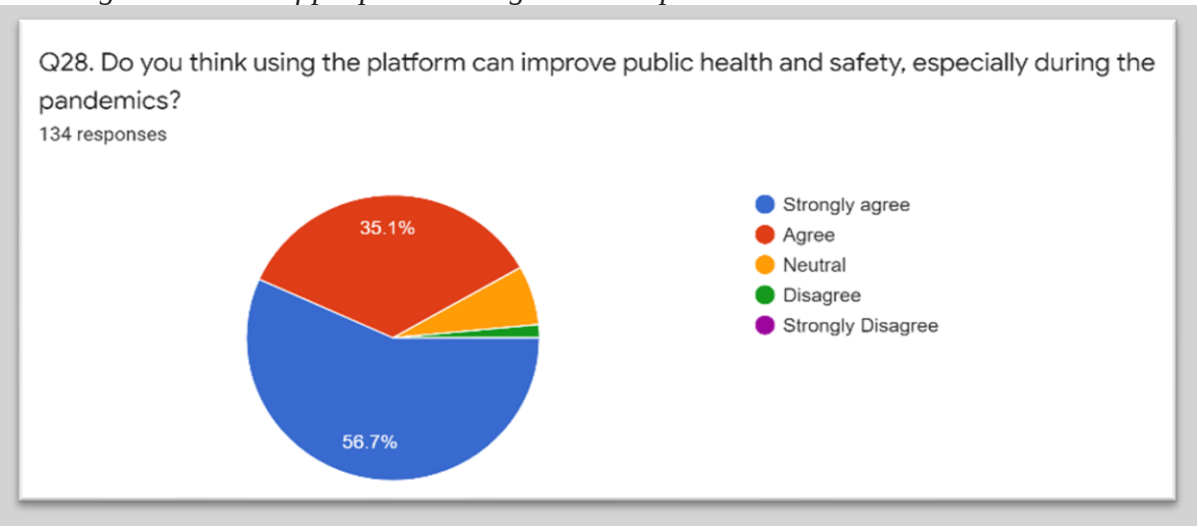

Figure 32 - Responses to question no. 28 from the questionnaire (Source: by author, 2021)

One of the concluding questions (**number 29, see Table 19, below**) was a generalized one: *Do you believe this type of projects should be available for all kind of public services?* as it aimed to find out if the broad perspective for online services is a positive or negative one. As only 6% answers were assigned to *Neutral* and 3% for the *Disagree* option, it is safe to say that

individuals believe (with 91% valid votes) it would be very helpful if all public services will be available online.

Table 19 - SPSS report on question 22, based on respondents who preferred question 29 (Source: by author, 2021)

saveutime22 * allpublicservices29 Crosstabulation

Count

		allpublicservices29				
		Neutral	Disagree	Agree	Strongly Agree	Total
saveutime22	Neutral	1	0	0	0	1
	Disagree	1	1	0	0	2
	Agree	3	3	21	5	32
	Strongly Disagree	3	0	25	71	99
Total		8	4	46	76	134

Of course, during this analysis, direct connections were identified among groups of questions, with relevance to the present study. For example, there are peaks for positive votes between two age categories and two study backgrounds, many of them were detailed in the previous paragraphs and a few are attached to this study – in the Annex chapter – for further consideration.

This concludes the data analysis, with points that match literature findings: blockchain is a suitable technology for public services (and private practices), it has a rising popularity worldwide and it can help improve Romanian DRPCIV. Among the strong points of blockchain identified through this study (with a range of 80-85% positive response rate), there are:

- Ease of use;
- Security for all parties involved (in this case, the Romanian citizens and the governmental agency, DRPCIV);
- Time-saving applications;
- Unlimited connecting options, with various other services, through secure lines;
- Public and health integrity issues;
- Environmental reasoning;

  This attests to the fact that, while blockchain is largely recognized by its connection with Bitcoin, recent advancements have begun investigating the notion of utilizing it for transfers, distribution contracts (Antonsen, 2017).

4.4 Contribution to academia and to the industry

Even from the literature documentation process, there was a clear indication that blockchain in not as popular as other technologies, as its implementation into various governmental facilities is rare, as it is mostly used for private endeavours. Also, since there aren't as many papers or studies related to this subject, the present research has a significant contribution to the subject. As blockchain is at its starting point, having an enormous role in advance technologies and digitization, as a global process (Epifanova et al. 2016). According to a worldwide analysis report (FINRA, 2017), until 2016, companies have invested more than 1.4 billion dollars in the study of blockchain and its applications in the financial industry.

Whereas for the contributions this research may have for future references, the first would be the empirical one: using a variable to determine or improve the relationship between two different constructs – blockchain and government services. Regarding theoretical reason of this

paper, it definitely improves the subject by proposing a valid hypothesis: blockchain is suitable for vehicle registration services in Romania. This study will contribute to academia by establishing valid empirical results on blockchain implementation and it may offer insights on future applications, as it takes into consideration an applicable example (blockchain for DRPCIV). It is safe to say that many academics will find this study and its results (in students' opinion and choices for this particular technology) relevant for the subject and they will find is might be essential for future developments in this area.

The continuously developing vehicle industry may benefit from this study, both for sales companies involved and for their clients. With the many examples for secure and successful blockchain implementation were taken into review, the general idea that emerges is that many businesses and public services entities could gain from blockchain.

4.5 Further research and recommendations

Although blockchain gains momentum in current digital markets and starts being implemented into various public or private practices, there is not enough research information on this subject. For example, according to studies Anon (2020) a few entities like Dubai state agencies, JPMorgan, MetLife have already implemented blockchain into various segments of activity.

Surely, this study has its limitations, one of which is the extent of the sample chosen for analysis – the student segment, as it may not paint a general overview of the Romanian citizens dealing with DRCPIV. Many concepts identified were extracted from online literature, general smart cities literature or other similar concepts.

Given the fact that yearly there are being developed new ways of introducing blockchain into various industries (banking, insurance, car sales, money transfers, etc.), many academic researches and various studies will be performed in the near future, as it has the ability to change businesses and overall improve traditional processes. The present study is proof that, although people have knowledge about the subject, they do not fully comprehend who it can generally improve their life. As the entire concept of blockchain implementation is already an idea which many researchers could find it has a lot of potential, we recommend further research on this area.

5. General Conclusions

Considering its involvement into Bitcoin, one of the most popular digital notions in the past few years, blockchain has become known to all social segments. As there is a lack of research on this subject, this new and complex technology is still ambiguous to the general public, in terms of technical details, characteristics, helpfulness and accessibility. Although one might say that, given its novelty aspect, the market might be straightened for technical specialists, core developers or some sort of other specialized personnel. Here, the element of surprise is the fact that knowledge and development for blockchain is not as difficult and may be easy to learn and elaborate.

5.1 Research questions and objectives fulfilment

In order to determine if the present practical endeavour had accomplished its purpose, we need to take into review the initial research questions, established in the first chapter. As blockchain is included in t**he digitalization process, the first question was meant to disclose how respondents see this process and if they will be able to use it properly**. Answers to questions 9 and 16 are related to this subject and respondents answered with a majority pro vote.

Generally, people view a digital or online platform as a security threat to their personal information (Tapscott and Tapscott, 2016) and the study revealed the same concern, with a majority of 76,9% respondents fearing this could be a barrier for online vehicle registration services.

Furthermore, the research findings show recurrent issues within governmental services (especially in DRPCIV), as they require physical documents, signatures and presence, which take time, effort and are difficult. All are rapidly solvable problems, if utilising the appropriate technology, in this case – blockchain. As proven in the previous data analysis chapter, individuals agree upon digitalization of public services, but are not particularly interested in what technology would be chosen, as long as the issues are resolved. This could be changed if people would have details about blockchain and how it can improve, not only the platform it would be integrated to, but also their lives.

Of course, question 17 helps check one of the research questions, as **students said they prefer online services and they will actually be willing to pay for set services.** Also, the other important questions were answered by the questionnaire responses gathered, as users helped create a **list of issues they have when registering a vehicle,** and this helps determine t**he main objectives when implementing the blockchain system** (as detailed in chapter 2).

Main research questions are:	Study results
1. How do different actors involved, such as vehicle owners and potential buyers, especially university students in Romania, see digitalization in this area? Will they be able to properly use this technology?	As blockchain is included in the digitalization process, the first question was meant to disclose how respondents see this process and if they will be able to use it properly. Answers to questions 9 and 16 are related to this subject and respondents answered with a majority pro vote. Generally, people view a digital or online platform as a security threat to their personal information (Tapscott and Tapscott, 2016) and the study revealed the same concern, with a majority of 76,9% respondents fearing this could be a barrier for online vehicle registration services.
2. Will they be able to sign and exchange private (like name, ownership documents) information online? Will they be able to pay a fee for this process or do they prefer it to be free?	Of course, question 17 helps check one of the research questions, as students said they prefer online services and they will actually be willing to pay for set services.
3. Which main issues do users/vehicle buyers have when dealing with vehicle registry?	Regarding current issues vehice buyers have when dealing with the registration are identified with help from questions number 21, 22, 23 and 24. While the first ones help identify current issues, question number 21 helps support this statement, since it urges participants to choose top five functionalities they would like to discover and use inside an online vehicle registration system.
4. Which are the main objectives in implementing the blockchain system?	Also, the other important research inquiries were answered by the questionnaire responses gathered through questions 23, 24, 26 and, as users helped create a list of issues they have when registering a vehicle and this helps determine the main objectives when implementing the blockchain system (as detailed in chapter 2).

5. How well can blockchain improve the processes of the Romanian vehicle registry? How much time, money will it save and how it can socially, financially impact users, government agencies, the city, the environment?	Thus, question number 28 established that 91,8% respondents feel that an online platform would definitely improve public health and safety (especially during pandemics), while the final questions - number 30 – found that 88,8% votes were in complete agreement with the statement that technology can help reduce the CO2 emissions by reducing the number of people traveling to access public services while it is available online. These results help answer research question number 5: How much time, money will it save and how it can socially, financially impact users, government agencies, the city, the environment?

Table 20 - Research questions and details about how study results represent the answers (Source: by author, 2021)

The results of this research broaden the spectrum of discussion on this matter, even if related to how can vehicle records may be improved or to the extent to which can blockchain help achieve this. When approaching the subject of digitally improvements, there are numerous aspects to analyse and unlimited results to obtain, as there are various systems to be used, which can definitely help save time, money and, in the end, the environment (Ross, 2017).

Based on the results of this study, the capabilities of blockchain could help improve public services, the relationship of the government with the citizens and, maybe bring other advantages to the system it would be integrated to. What the current research uncovered was that blockchain could successfully solve the current issues inside the Romanian vehicle registration agency and, of course, help overcome the current general fear of its digitization: security concerns.

Regarding DRPCIV, this department is still the least digitalized in the entire Romanian fiscal infrastructure. According to DRPCIV's (2020) press releases, online payment for vehicle registry taxes was implemented in late 2020, later than any other local state institution. High placed representatives for DRPCIV said in an interview (vrancea24.4ro, 2020) that they are currently working on solutions to simplify the registration process, that can soon be mostly done via an online platform. One final argument in closing is the fact that the researcher managed to answer the initial research questions and objectives. See below a detailed reference for study findings, in line with study objectives.

5.2 Research conclusions

The reality is that, even though it is a relatively new system, blockchain could present more advantages than other similar technologies. Considering this study underlines the flaws of a current governmental vehicle registry with 134 carefully gathered opinions, it is fair to say that many state affairs could be improved if taken into consideration upon analysing the blockchain option. See below, in **Table 21**, a detailed reference for study findings, in line with study objectives.

OBJECTIVES FULFILLED BY THE RESEARCH

Objective number 1:	To inquire about and get a deeper understanding of how different actors involved, vehicle owners and potential buyers of vehicles, see digitalization in this area – after reading the results for questions 9, 11, 12, 22, people clearly want digitalization, with an emphasis in governmental agencies, as they largely answered positive for these questions, with more than 50% affirmative response rates.
Objective number 2:	To identify if people will be able to use the solution and what are the terms for which they will be able to do this – Confirmed through questions related to this (no 10, 13, 15 or 17), which were important to the study analysis, as they generated conformational result to crosstab tests.
Objective number 3:	To identify which main issues do users/vehicle buyers have when dealing with vehicle registry for the first time - As established earlier in this paper, in later on, these will be the main objectives in implementing the blockchain system. Main issues identified through questionnaire are time and money spent now or these processes, difficulty in going through with the vehicle registration process, etc.
Objective number 4:	To detect how well can blockchain improve the processes: how much time, money will it save and how it can impact users, government agencies, the city, the environment – findings point out blockchain is able to completely change the current DRPCIV standards and processes, as respondents agreed on its use, its benefits, with a small percentage. Although people are familiar with blockchain, findings show they do not prefer it to other digital solutions, thus meaning they have not used before and they are sceptical about it until firstly using such a new technology.

Table 21 - Research questions and details about how study results represent the answers (Source: by author, 2021)

For further advancement within this direction, this study provides a full, comprehensive information about how blockchain works, how it would look like when implemented into a practical, active agency and presents a full quantitative research, with plenty of results to be taken into consideration in future research. The literature review chapters take into review blockchain functionality, its advantages against other technology and against current times, as it provides cyber security, facilitates online smart contracts and payments and it is resilient to online hacking. Of course, the latest governmental programs using blockchain, for the Dubai vehicle registry and Estonian tax payment platform are additional arguments to its power.

For future examination into blockchain, we recommend more research from the beneficiary's point of view – the government in this case. It would be very interesting to have an ample preview of how officials would perceive blockchain implementation and its numerous advantages.

Glossary of word abbreviations

BIM: Building Information Modelling.
CBDC: Central Bank Digital Currency
DRPCIV: Direcția Regim Permise de Conducere și Înmatriculare a Vehiculelor. Translated: Direction Regime for Driving Permits and Vehicle Registration.
ITP: Inspectia Tehnica Periodica. Translated: Periodic Technical Inspection.
ICT: Information and communications technology.
IOT: Internet of Things
NOC: No Objection Certificate
RAR: Registrul Auto Român

References

Aashish, S. (2019). How Blockchain and Big Data Complement Each Other. [online]. Available at: https://hackernoon.com/how-blockchain-and-big-data-complement-each-other-92a1b9f8b38d [Accesed January 15 2019].

Abdullah, N., Hakansson. (2017). Blockchain based approach to enhance big data authentication in distributed environment. *2017 Ninth International Conference on Ubiquitous and Future Networks (ICUFN)*.

Ahram, T., Sargolzaei, A., Sargolzaei, S., Daniels, J. and Amaba, B. (2017). Blockchain technology innovations. *In 2017 IEEE technology & engineering management conference (TEMSCON)*. p. 137-141.

Allessie, D., Sobolewski, M., Vaccari, L. and Pignatelli, F. (2019). Blockchain for digital government. *Publications Office of the European Union, Luxembourg*.

ANAF official website, OUG 38 din 2020; [online]. Available at https://static.anaf.ro/static/10/Anaf/legislatie/OUG_38_2020.pdf [Accessed February 26th 2021].

Anderloni, L. and Carluccio, E.M. (2007). Access to bank accounts and payment services. In New frontiers in banking services. *Springer, Berlin, Heidelberg*. p. 5-105.

Andersen, D. F., and Dawes, S. S. (1991). Government information management: A primer and casebook. *New Jersey: Prentice Hall*.

Andreev, R.A., Andreeva, P.A., Krotov, L.N. and Krotova, E.L. (2018). Review of blockchain technology: Types of blockchain and their application. *Intellekt. Sist. Proizv., 16(1)*, p. 11-14.

Anthopoulos, L. and Fitsilis, P. (2013). Using Classification and Roadmapping Techniques for smart city viability's realization. *Electronic Journal of e-Government, 11(1)*, p. 326.

Anthopoulos, L.G. (2015). Understanding the smart city domain: A literature review. *Transforming city governments for successful smart cities*, p. 9-21.

Antonsen, H. (2017). Platform Infrastructure as a Driver of Smart City Development. *Master Thesis*. University of Oslo, Norway. [online]. Available at https://www.datek.no/dv-cms/resources/masterhaakoaan-1.pdf [Accessed January 15 2021].

Autobild website (2020). Coadă la permise auto în București în ziua cu peste 1.300 de cazuri noi de coronavirus. [online]. Available at https://www.auto-bild.ro/stiri/coada-la-permise-auto-bucuresti-ziua-cu-peste-1-300-de-cazuri-noi-de-coronavirus-192102.html [accessed March 11, 2021].

Beard, E. , Dienes, Z. , Muirhead, C. , and West, R. (2016). Using Bayes factors for testing hypotheses about intervention effectiveness in addictions research. *Addiction*, (111), p. 2230–2247.

Beck, R., Stenum Czepluch, J., Lollike, N. and Malone, S. (2016). Blockchain–the gateway to trust-free cryptographic transactions. [online]. Available at: https://www.researchgate.net/publication/302589859_BLOCKCHAIN_-_THE_GATEWAY_TO_TRUST-FREE_CRYPTOGRAPHIC_TRANSACTIONS [Accesed January 15 2021]

Bernard Marr. (2021). *35* Amazing Real-World Examples Of How Blockchain Is Changing Our World. [online] Available at: <https://www.bernardmarr.com/default.asp?contentID=1302> [Accessed 10 February 2021].

Bigdeil, A. Z., Kamal, M., & de Cesare, S. (2013). Information sharing through inter-organisational systems in local government. *Transforming Government: People, Process and Policy*, 7(2), p. 148-176. [online]. Available at: http://www.emeraldinsight. [Accessed February 11 2021]

BOJANA KOTESKA, ELENA KARAFILOSKI and ANASTAS MISHEV, (2017). Blockchain Implementation Quality Challenges: A Literature Review, University SS.

Bordo, M.D. and Levin, A.T. (2017). Central bank digital currency and the future of monetary policy (No. w23711). National Bureau of Economic Research.

Bosomitu, Ș. (2017). Sociology in Communist Romania: an institutional and biographical overview. *Studia Universitatis Babes-Bolyai Sociologia*, *62*(1), p. 65-84.

C. Alexopoulos, Y. Charalabidis, A. Androutsopoulou, M. A. Loutsaris and Z. Lachana, (2019)."Benefits and obstacles of blockchain applications in e- government", *Proceedings of the 52nd Hawaii International Conference on System Sciences*.

Caputo, F., Walletzky, L. and Štepánek, P. (2019). Towards a systems thinking based view for the governance of a smart city's ecosystem. *Kybernetes*

Cencini, A. (2001). 'Chapter 3: Money, credit and banks', *Monetary Macroeconomics*, p. 62–87. Available at: http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=17442492&site=ehost-live (Accessed: 19 January 2021).

Changing Minds.org (2021). Snowball sampling, http://changingminds.org/explanations/research/sampling/snowball_sampling.html [Accessed February 27th 2021].

Chirileasa, A. (2021). Internet penetration and usage rates in Romania up 2-3p in (2020), Romanian Insider, January 2020; [Accesed March 8th 2020], [Availabe at https://www.romania-insider.com/internet-penetration-usage-romania-2020]
Conference on Parallel and Distributed Computing, Applications and Technologies (PDCAT), p. 360-367.

Country Economy. (2021). New motor vehicle registrations, [https://countryeconomy.com/business/car-registrations?dr=2021-02]

Cybersecurity and Infrastructure Security Agency. (2021). [https://us-cert.cisa.gov/ncas/tips/ST04-018] [Accesed Februry 26th 2021]

Cyril and Methodius, (2021). Faculty of Computer Science and Engineering, Skopje, Macedonia

Dawes SS, Nelson MR. (1995). Pool the risks, share the benefits: partnership in IT innovation. In: *Keyes J (ed) Technology trendlines, technology success stories from today's visionaries*. *Van Nostrand Reinhold*, New York, p. 125–135.

Dawes, S. S. (1996). Interagency Information Sharing: Expected Benefits, Manageable Risks. *Journal of Policy Analysis and Management*, 15(3), p. 377-394. Retrieved from http://www.jstor.org/stable/3325215.

Dawes, S. S. (1996). Interagency information sharing: Expected benefits, manageable risks. Journal of Policy Analysis and Management: *the Journal of the Association for Public Policy Analysis and Management*, 15(3), p. 377-394.

Di Pierro, M. (2017). What is the blockchain? *Computing in Science & Engineering*, 19(5), p. 92-95.

Drpciv.ro. (2021). Direcția regim permise de conducere și înmatriculare a vehiculelor. [online] Available at: <https://www.drpciv.ro/documents-and-forms/inmatriculari> [Accessed 10 January 2021]. https://www.drpciv.ro/balances-and-evaluations

Dușa, A. (2014). Elemente de analiză comparativă, Tritonic.

Encyclopedia Britannica. (2021). Romania | History, Map, & Facts. [online] Available at: <https://www.britannica.com/place/Romania> [Accessed 10 January 2021].

Engert, W. and Fung, B.S.C. (2017). Central bank digital currency: Motivations and implications, *Bank of Canada Staff Discussion Paper (No. 2017-16)*.

Euromoney official website. (2020). The rise of private blockchains, [https://www.euromoney.com/learning/blockchain-explained/the-rise-of-private-blockchains]

European Automobile Manufacturers' Association – ACEA (2021). EU car sales: COVID recovery expected to start in 2021, auto industry says; [Available at: https://www.acea.be/press-releases/article/eu-car-sales-covid-recovery-expected-to-start-in-2021-auto-industry-says]

European Commission official website (2021). [https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en] [Accessed February 27th 2021]

Fan, L. (2019). 'Sharing big data using blockchain technologies in local governments: Some technical, organizational and policy considerations', Information Polity: The International Journal of Government & Democracy in the Information Age, 24(4), p. 419–435.

Fan, L., Gil-Garcia, J.R., Werthmuller, D., Burke, G.B. and Hong, X. (2018). May.

Fawcett, J. and Buhle Jr, E.L. (1995). Using the Internet for data collection. An innovative electronic strategy. *Computers in nursing*, *13*(6), p.273-279.

FINRA. (2021). Distributed Ledger Technology Implications of Blockchain for the Securities Industry. Available online: https://www.finra.org/sites/default/files/FINRA_Blockchain_Report.pdf

Fung, B.S. and Halaburda, H. (2016). Central bank digital currencies: a framework for assessing why and how. Available at SSRN 2994052.

Gil-Garcia, J. R., Chun, S. A., & Janssen, M. (2009). Government information sharing and integration: Combining the social and the technical. *Information Polity*, 14(1-2), p. 1-10.

Grym, A., Heikkinen, P., Kauko, K. and Takala, K. (2017). Central bank digital currency.

Guo, R., Shi, H., Zhao, Q. and Zheng, D. (2018). Secure attribute-based signature scheme with multiple authorities for blockchain in electronic health records systems. *IEEE access*, *6*, p.11676-11686.

Hasib, A. (2019). Blockchain For Government Decentralization At The Core.

Haynes, R. Brian (2006). Forming research questions, *Journal of Clinical Epidemiology*. 59 (9): p. 881–886.

Hedges Company (2021). Automotive Trends: New Car Buyer Demographics 2021, Available at https://hedgescompany.com/blog/2019/01/new-car-buyer-demographics-2019/#new_car_ownership_by_age

Heinelt H. (2018). Political Leaders and Changing Local Democracy, Governance and Public Management, Available at: https://doi.org/10.1007/978-3-319-67410-0, (Accesed March 1st 2021).
Hildebrand, H.S. and Garcia, D.J.P. (2011) Guardian Data Storage LLC Security system for generating keys from access rules in a decentralized manner and methods therefor. U.S.

Horodnic, I.A. (2015). Academic Performance of Professors in Economic Field. Comparative Study by Romania Regions. *International Journal of Communication Research*, *5*(2), p.122.

Hossain, M.P., Khaled, M., Saju, S.A., Roy, S., Biswas, M. and Rahaman, M.A. (2020). Vehicle registration and information management using blockchain based distributed ledger from bangladesh perspective. In *2020 IEEE Region 10 Symposium (TENSYMP)*p. 900-903.

IBM Blockchain Technology (2019). Available at https://www.ibm.com/cz-en/blockchain?p1=Search&p4=43700053573496357&p5=b&gclid=CjwKCAiA4rGCBhAQEiwAelVti0a2AclwX9KYqPKyZUhO96aIS6nkYQ3i4sxPicrhAQqiJimitpL1yhoClNUQAvD_BwE&gclsrc=aw.ds

In Nakashima, H., Aghajan, H. and J.C. Augusto (eds), (2021). Handbook on Ambient Intelligence and Smart Environments. *Berlin Heidelberg: Springer-Verlag*.

INS (2021). Tendinte sociale – studiu, Available at https://www.insse.ro
International Conference on Networking Systems and Security (NSysS), p. 1-9.

International Transport Forum, Blockchain and Beyond: Encoding 21st Century Transport, Analysis, *International Transport Forum*, 2018.

Investigating blockchain as a data management tool for IoT devices in smart city initiatives. In *Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age* (p. 1-2).

Ishida, T., Aurigi, A., & Yasuoka, M. (2010). The Advancement of World Digital Cities.

Jaroszweski, David; Hooper Elizabeth; Chapman, Lee, (2017). The impact of climate change on urban transport resilience in a changing world, Available at https://journals.sagepub.com/doi/10.1177/0309133314538741

Kakavand, Hossein and De Sevres, Nicolette Kost (2016). The Blockchain Revolution: An Analysis of Regulation and Technology Related to Distributed Ledger Technologies.
Keydifferences.com (2021) General online article [https://keydifferences.com/difference-between-qualitative-and-quantitative-data.html] [Accesed February 26th, 2021]

Khan, Z., Abbasi, A. G. and Pervez, Z. (2020). 'Blockchain and edge computing–based architecture for participatory smart city applications', Concurrency & Computation: Practice & Experience, 32(12), p. 1–20.

Kothari, C.R. (2004). Research Methodology: Methods and Techniques, New Age International (P) Ltd., Publishers, p.3.

Lakshmanaprabu, S.K., Shankar, K., Rani, S.S., Abdulhay, E., Arunkumar, N., Ramirez, G. and Uthayakumar, J. (2019). An effect of big data technology with ant colony optimization based routing in vehicular ad hoc networks: Towards smart cities. *Journal of cleaner production*, *217*, p.584-593.

Lastovetska, A. (2021). Blockchain Architecture Explained: How It Works & How To Build. [online] Mlsdev.com. Available at: <https://mlsdev.com/blog/156-how-to-build-your-own-blockchain-architecture> [Accessed 31 December 2020].

Lin, I.C. and Liao, T.C. (2017). A survey of blockchain security issues and challenges. *IJ Network Security*, 19(5), p.653-659.

Loc.gov (2020). Regulation of Cryptocurrency Around the World. [online] Available at: <https://www.loc.gov/law/help/cryptocurrency/world-survey.php#romania> [Accessed 14 December 2020].

Local newspaper – Vrancea24 (2021). [https://www.vrancea24.ro/digitalizare-la-inmatricularea-autovehiculelor-si-dealerii-vor-putea-inmatricula-direct-masinile-noilor-proprietari/][https://static.anaf.ro/static/10/Anaf/legislatie/OUG_38_2020.pdf] [Accessed February 26th 2021]

M. Q. Patton, (2002). Qualitative Research and Evaluation Methods, Sage, London, UK.

Maassen, M.A., Tantau, A.D. and Smekalova, L. (2021). The Current Context of the Smart City Concept Development. Case Study: Romania. In *Business Revolution in a Digital Era*, p. 377-389. Springer, Cham.

Macrinici, D., Cartofeanu, C. and Gao, S. (2018). Smart contract applications within blockchain technology: A systematic mapping study. *Telematics and Informatics*, *35*(8), p.2337-2354.

Mansi, Bosamia, (2021). Figure 1 – An example of Merkle Tree, [online]. Available at: https://www.researchgate.net/figure/An-example-of-Merkle-Tree_fig1_327601654 [Accessed 20 December 2020].

Mapsofworld.com. (2021). Romania River Map. [online] Available at: <https://www.mapsofworld.com/romania/romania-river-map.html> [Accessed 1 March 2021].

Media.springernature.com (2021). [online] Available at: <https://media.springernature.com/original/springer-static/image/chp%3A10.1007%2F978-3-030-53149-2_11/MediaObjects/499376_1_En_11_Fig6_HTML.png> [Accessed 4 March 2021].

Mediafax (2020). este anul in care statul a inceput sa transforme cozile la ghisee in clickuri, Available at https://www.mediafax.ro/social/2020-este-anul-in-care-statul-a-inceput-sa-transforme-cozile-la-ghisee-in-clickuri-19838966

Medium (2018). Blockchain Key Characteristics And Conditions To Use It As A Solution. [online] Available at: <https://medium.com/swlh/blockchain-characteristics-and-its-suitability-as-a-technical-solution-bd65fc2c1ad1> [Accessed 19 December 2020].

Mell, P. and Grance, T. (2011). The NIST Definition of Cloud Computing (Draft). *National Institute of Standards and Technology*.

Ministerul Afacerilor Interne (2021). 2009-2018 Official Report, Available at: https://www.mai.gov.ro/inmatriculari-auto-anulate/

Mohite, A. and Acharya, A. (2018). Blockchain for government fund tracking using Hyperledger. In *2018 International Conference on Computational Techniques, Electronics and Mechanical Systems (CTEMS)* p. 231-234.

Mougayar, W. (2016). The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology, John Wiley & Sons.

Nathani, M. U. and Singh, J. S. K. (2020). 'Using Blockchain for Effective Risk Management in Supply Chain: A Qualitative Study', *Global Business & Management Research*, 12(3), p. 60–76. Available at:

http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=147724971&site=ehost-live (Accessed: 20 January 2021).

Niranjanamurthy, M., Nithya, B.N. and Jagannatha, S. (2019). Analysis of Blockchain technology: pros, cons and SWOT. *Cluster Computing*, 22(6), p.14743-14757.

Notheisen, B., Cholewa, J.B. and Shanmugam, A.P. (2017). Trading real-world assets on blockchain. *Business & Information Systems Engineering*, *59*(6), p.425-440.

O.N. Epifanova, D.D. Burkaleva, A.S. Tyulin. (2016). The Use of block-chain technology in the public sector. In the collection: *Electronic currency in the light of modern legal and economic challenges, the collection of materials of the International scientific and practical conference,* p. 88-97.

Official UAE website (2020). [https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/federal-governments-strategies-and-plans/emirates-blockchain-strategy-2021] [Accessed Februaru 27th 2021]

Ølnes, S., Ubacht, J., and Janssen, M. (2017). Blockchain in government: Benefits and implications of distributed ledger technology for information sharing. *Government Information Quarterly*, 34(3), p. 355-364.

Pardo, T. A., Gil-Garcia, J. R., and Burke, G. B. (2008). *Sustainable Cross-Boundary Information Sharing.* In D. H. Chen, P. M. L. Brandt, A. D. V. Gregg, P. R. Traunmüller.

Pedersen, A.B., Risius, M. and Beck, R., (2019). A ten-step decision path to determine when to use blockchain technologies. *MIS Quarterly Executive*, *18*(2), p.99-115.

Pilkington, M. (2016). Blockchain technology: principles and applications. In *Research handbook on digital transformations*. Edward Elgar Publishing.

Point Likert Scale (2020). Formplus Blog, Available at:
Price Waterhouse Cooper (2020) Creating the smart cities of the future, available online at https://www.pwc.com/us/en/industries/capital-projects-infrastructure/library/future-smart-cities.html

Promotor website (2020). Înmatriculare auto 2020: Care sunt pașii și ce acte sunt necesare, Available at https://www.promotor.ro/stiri-auto/inmatriculare-auto-2020-care-sunt-pasii-si-ce-acte-sunt-necesare-18631603

Puthal, D., Malik, N., Mohanty, S.P., Kougianos, E. and Das, G., (2018). Everything you wanted to know about the blockchain: Its promise, components, processes, and problems. *IEEE Consumer Electronics Magazine*, 7(4), p.6-14.

Ramadhani, A.M., Choi, H.R. and Kim, N.R. (2018). *Blockchain Implementation in Government: A Review*. *인터넷전자상거래연구*, *18*(2), p.35-48.

Reader.elsevier.com (2021). [online] Available at: <https://reader.elsevier.com/reader/sd/pii/S1478409218301298?token=75A1A9017B578ACA13048D846C213CB5C040824435C94863E112748EC1B339D86F83A391979472065B70A26348376A50&originRegion=eu-west-1&originCreation=20210404222403> [Accessed 4 February 2021].

Romania Insider (2021). Second hand car registrations reach all-time record in Romania in 2017. [online] Available at: <https://www.romania-insider.com/second-hand-car-registrations-record> [Accessed 6 January 2021].

RomanianStartups.com (2021). About Romania | RomanianStartups.com. [online] Available at: <https://www.romanianstartups.com/about-romania/> [Accessed 10 December 2020].

Rondinelli, D.A., Nellis, J.R. and Cheema, G.S. (1983) Decentralization in developing countries. *World Bank staff working paper*, *581*.

Ross, Jeanne (2017). Don't Confuse Digital With Digitization, MIT magazine, Available at: https://sloanreview.mit.edu/article/dont-confuse-digital-with-digitization/?gclid=Cj0KCQiAv6yCBhCLARIsABqJTjb5Pe62ELxFb4B3NY16bVVTBv66GC7zVOILgIyU5FgsX9mMm1ouG9kaArcCEALw_wcB

Rossijskoe pravo onlajn (2018). The Blockchain Technology in Performing Banking Operations Using Digital Financial Assets.

S. Roy, M. Ashaduzzaman, M. Hassan and A. R. Chowdhury (2018). "Blockchain for iot security and management: Current prospects challenges and future directions", *2018 5th*

Schmeiss, J., Hoelzle, K. and Tech, R.P. (2019). Designing governance mechanisms in platform ecosystems: Addressing the paradox of openness through blockchain technology. *California Management Review*, *62*(1), p.121-143.

Schmidt, C.G.; Wagner, S.M. (2019). Blockchain and supply chain relations: A transaction cost theory perspective.

Schwartz, Shalom H.; Bilsky, Wolfgang (2021). Personality Processes and Individual Differences. Toward a Theory of the Universal Content and Structure of Values: Extensions and Cross-Cultural Replications, *Journal of Personality and Social Psychology*, p. 550-562.

Skulmoski, G., Hartman, F. & Krahn, J. (2007). The Delphi Method for Graduate Research. *Journal of Information Technology Education*, 6.

Smart engines website (2020). Digital forgery prevention or document forgery detection, Available at: https://smartengines.com/digital-forgery-prevention/

Stănescu, I. (2018). Quality of life in Romania 1918–2018: An overview. *Calitatea vieţii*, *29*(2), p.107-144.

Sun, H., Mao, H., Bai, X., Chen, Z., Hu, K. and Yu, W. (2017). Multi-blockchain model for central bank digital currency. *In 2017 18th International*

Syeed, N. (2018). 'Security: Is Blockchain Voting the Future?', *Bloomberg Businessweek*, (4580), p. 43–44. Available at: http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=131157735&site=ehos

Tapscott, A. and Tapscott, D. (2017). How blockchain is changing finance. *Harvard Business Review*, 1(9), p.2-5.

Tapscott, D. and Tapscott, A. (2016). Blockchain Revolution: How the Technology behind Bitcoin Is Changing Money, Business, and the World. *Penguin, New York*. https://www.amazon.com/Blockchain-Revolution-Technology

Tashakkori, A. (1998). *Charles Teddlie*, Mixed Methodology: Combining Qualitative and Quantitative Approaches. *SAGE Publications*, Inc., p. 130.

Telleport (2020). Purchase of vehicles via Blockchain in Dubai at the end of this month [https://www.tellerreport.com/news/2020-12-13-%0A].

ASEAN Post (2021). Understanding blockchain. [online] Available at: <https://theaseanpost.com/article/understanding-blockchain> [Accessed 4 March 2021].t-live (Accessed: 20 January 2021).

Tuya, M. D., and Tuya, M. L. D. (2019). Creating Value Through Information and Knowledge Flow: Lessons from the Public Sector Applied to the Private Sector. *Journal of Creating Value*, 2394964319851951.

UAE Government (2018). Emirates blockchain strategy 2021, Available at https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/federal-governments-strategies-and-plans/emirates-blockchain-strategy-2021

University of Sheffield Library (2001). How to: Write a Problem Statement [online], Sheffield, University of Sheffield. Available at: https://www.sheffield.ac.uk/polopoly_fs/1.440722!/file/HowtoWriteaProblemStatement.pdf [Accessed March 4th 2021].

van Engelenburg, S., Janssen, M. and Klievink, B. (2018). A blockchain architecture for reducing the bullwhip effect. In *International Symposium on Business Modeling and Software Design*, p. 69-82. Springer, Cham.

Van Zoonen, L. (2016). Privacy concerns in smart cities. *Government Information Quarterly*, *33*(3), p.472-480.

vehicles-via-blockchain-in-dubai-at-the-end-of-this-month%0A--.ryMMT1-N3D.html] [Accessed February 27th 2021]

Wallstreet Romania (2019). Actele necesare pentru inmatricularea auto in 2019: noutati, costuri si etape, Available at https://www.wall-street.ro/articol/Auto/237958/actele-necesare-pentru-inmatricularea-auto-modificari-costuri-si-etape.html#gref

Walport, M. (2015). Re: Tehnologija raspredelennogo reestra: za ramkami blokchejn [Distributed ledger technology: beyond blockchain][Web report].

Watanabe, H., Fujimura, S., Nakadaira, A., Miyazaki, Y., Akutsu, A. and Kishigami, J., (2016). Blockchain contract: Securing a blockchain applied to smart contracts. In *2016 IEEE international conference on consumer electronics (ICCE)*, p. 467-468.

World Bank (2017). Overview. [online] Available at: https://www.worldbank.org/en/country/romania/overview.

World Bank (2021). Urban Development Portfolio in Romania. [online] Available at: <https://www.worldbank.org/en/country/romania/brief/romania-urban-development> [Accessed 13 January 2021].

Xiwei X, Cesare P, Liming Z, Vincent G, Alexander P, An Binh T, and Shiping C. (2016). The blockchain as a software connector. *In Software Architecture (WICSA)*, 2016 13th Working IEEE/IFIP Conference on. IEEE, p. 182–191.

Yaga, D., Mell, P., Roby, N. and Scarfone, K. (2019). Blockchain technology overview. arXiv preprint arXiv:1906.11078.

Yanagawa, N. and Yamaoka, H. (2019). Digital innovation, data revolution and Central Bank digital currency (p. 19-E-2).

Yang, T.M. and Wu, Y.J. (2014). Exploring the determinants of cross-boundary information sharing in the public sector: An e-Government case study in Taiwan. *Journal of Information Science*, *40*(5), p. 649-668.

Yang, T.-M., & Maxwell, T. A. (2011). Information-sharing in public organizations: A literature review of interpersonal, *i*ntra-organizational and inter-organizational success factors. *Government Information Quarterly*, 28(2), p. 164-175.