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## Conference Paper

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# Using blockchain as a tool for tracking and verification of official degrees: business model

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## Abstract

While the number of universities, tertiary education students and number of graduates per year constantly increase, the need to easily verify degree certificates generates new business opportunities. The irruption of blockchain, and its implementation based in the *blockcerts* software, provides a straightforward solution that demands to explore plausible business models. In this paper we project two financial models balancing where the price for the service is balanced between the graduate and the employer as the main stakeholders of that service. Students demand a proof-of-certification at low cost and easy to check, employers also demand quick and trustable verification of degrees when recruiting. Both models are projected for several geographic markets and shares to explore plausible ways to develop that business in the European Union.

## 1. Introduction

The blockchain technology opens today opportunities to deliver new business models on quite consolidated markets. The use of blockchain in the education sector is one of the most challenging areas where results in the mid and long term can be achieved [1][2][3][4][5]. The easy, trustable and cheap verification of official documents, such as university degrees, is one of the areas where blockchain can provide a timely and solid solution thanks to the use of widely extended cryptocurrencies. Bitcoin, Ethereum or Swarm are consolidated cryptocurrencies that offer a stable public blockchain that can be used for secondary uses such as a verification tool in several markets. Here, the selection of an appropriate public blockchain in terms of availability, flexibility and cost is crucial to develop a sustainable business model on top.

In this paper we analyse the problem to develop an economically sustainable solution to automatically verify university degrees. Several institutions have been developing tools that use blockchain to track and certify their titles (In Cyprus, University of Nicosia developed a solution for MOOCS<sup>1</sup>; or the Medialab at MIT developed a platform Blockcerts<sup>2</sup> to implement blockchain in educational programs).

The increasing number of university degrees worldwide generates a need to have a blockchain-based verifiable platform allowing a completely distributed, costly feasible and

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<sup>1</sup> <https://medium.com/universablockchain/blockchain-in-education-49ad413b9e12>

<sup>2</sup> <http://blockcerts.org>

trustable. According to Eurostat<sup>3</sup>, every year graduates from tertiary education (Universities and higher education institutions) in Europe are over 4.5 million, being France and UK the leading countries with more than 740.000 graduates per year [5]. The fraction of people with a university degree between 30 and 34 years old almost doubled in fourteen years, going from a 23% in 2002 to a 39% in 2016. These figures confirm a continuous increasing and solid base where to market solutions to verify the authenticity of those university degrees.

Based on the previous statements, we formulate the following research questions: is it economically feasible to develop a blockchain-based app? Which are the pros and cons of this technologically intensive business model? Which could be an estimation of the needed market (regional/national/European) to make it viable?

The paper first introduces the main concepts of blockchain and the particular implementation of *Blockcerts* as an opensource solution devoted to the certification and verification of documents. In the following section we briefly introduce the Higher Education market in Europe to determine the volume, geography and trend of the economic sector to address the developed solution. Competitors and current solutions in the area of verification of official degrees, not blockchain-based, are introduced in the third section. Finally, we make an analysis of the costs and the minimum potential market needed to make it viable and scale up to Europe before concluding the work before concluding and setting up next steps.

## 2. Blockchain technology features

Blockchain [1] is a novel technology enabling new forms of distributed software architectures, where components can find agreements on their shared states for decentralized and transactional data sharing across a large network of untrusted participants, without relying on a central integration point that should be trusted by every component within the system.

The blockchain data structure is a time-stamped list of blocks, which records and aggregates data about transactions that have ever occurred within the blockchain network. Thus, the blockchain provides an immutable data storage, which only allows inserting transactions without updating or deleting any existing transaction on the blockchain to prevent tampering and revision.

The most famous application of Blockchain are cryptocurrencies, which have been a huge phenomenon during the last year because of their promising use of the technology. The biggest and most important of them is Bitcoin [6], and along with newer ones like Ethereum, they are leading the cryptocurrency market with more than 1.600 different currencies<sup>4</sup> at the moment, with a market cap that has been close to a trillion dollars last year, now sitting over 300 billion. As stated in the original Bitcoin paper [6], Satoshi Nakamoto remarks:

*A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital*

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<sup>3</sup> <http://ec.europa.eu/eurostat>

<sup>4</sup> <https://www.fool.com/investing/2018/03/16/how-many-cryptocurrencies-are-there.aspx>

signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.

Bitcoin implements and uses the concept of Blockchain in order to allow transactions to be verified by the majority of computational power in a network, to ensure that every transaction is confirmed and verified by the majority of nodes that are actively computing transactions in the network. Then, the verified transactions are stacked in a sequence that cannot be altered. All computers that have been using computational resources to verify a data block receive some cryptocurrency as reward. In this way, all transactions are verified by a considerable number of computers, so it is practically impossible to manipulate the verification of a transaction, since it would require an unrealistic amount of computational power in order to gain the majority of the network's verification process.

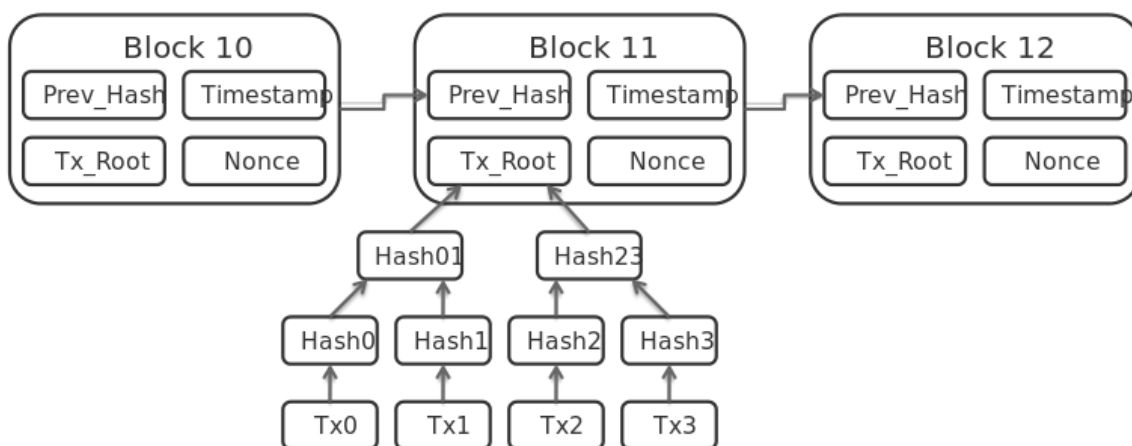


Figure 2.1: Structure of transactions and data blocks linked in a blockchain

In summary, blockchain seems an adequate technology to fulfill the specifications required to verify degree certificates due to the following facts:

- The information is verified by a decentralized network of computers, so there is no need to manual verification of the transactions.
- The information is permanently kept in the blockchain, so there is no need for additional security services to avoid potential deletes.
- It is not feasible to falsify or modify any transaction in the blockchain, so if we have a control of the hashes of the certificates that are valid, no one can modify this information or upload a false hash into the network.

Blockchain technology creates a competitive space, where specific implementations like Ethereum offer a way to manage data transactions in a fast and cheap way, and creating a huge infrastructure to build applications using its own public blockchain. Also, Ethereum allows "smart contracts" [7], documents that can be digitally facilitated, signed and verified in the blockchain, being able to represent much more than a simple economic transaction. Ethereum has been an emerging platform that lead to the creation of most of the existing cryptocurrencies under this concept of smart contracts.

## [Blockcerts.org](https://blockcerts.org)

*Blockcerts* is an open-source platform that is currently in development by the Massachusetts Institute of Technology (MIT) [8], that mainly focuses on issuing and verifying official certificates using blockchain. It mainly uses the Bitcoin blockchain, since it is the most used and most solid one, but Ethereum support is being implemented as well and can be used for testing purposes at the moment. The *blockcerts* project solves the current issues of the official certificates validation process in our country, so it is very interesting to base our development adapting *blockcerts* into our platform, analysing the ways we can be improved to create a global solution for the European market.

*Blockcerts* allows to manage single certificates to be issued into the blockchain, but also supports the management of batches of certificates adding hashing mechanisms which allows for example to add all the certificates from an academic cohort using one single hash. This is something critic that will reduce the cost of the transactions, as well as simplifying the work of the issuer and the platform when handling the connections with the blockchain for multiple certificates.

Therefore, the use of a solution based on *blockcerts* accomplishes the main objectives for a global certification and verification mechanism at European level. Since it has been in development and tested in several environments, the level of maturity of the open source software is proved to work, so our effort can be focused on making sure that the application and connection with *blockcerts* work perfectly, as well as creating improvements on the platform that are adjustable to our particular use case, hopefully helping this project become an international reference for decentralized certificates validation.

Blockcerts uses different layers that work together in order to create the hashes for every batch of certificates, issuing them into the blockchain, and later allowing web platforms to print the certificates using JSON objects and verifying them against the Blockchain. The name of the different layers that will perform those jobs are "cert-tools", "cert-issuer", "cert-web-component" and "cert-verifier", respectively.

The workflow of operation will be the following:

In a first step the university, or higher education institution, needs to request the students to send their blockchain wallet's address and personal information. This information will be used to generate the batch of certificates using "cert-tools".

Then, "cert-issuer" is used to push the batch of certificates, now computed into a hash, into the Blockchain using a cryptocurrency transaction. This hash will be include in the

transaction details, so there is no need to allocate extra data or to build a "smart contract" to use the Blockcerts issuer.

Finally, the "cert-web-component" will be able to print certificates using client-side code, showing the information present in the JSON files that compose the Blockcerts certificates. "cert-verifier" will perform the Blockchain connection in the inverse way than "cert-issuer", checking if the JSON issued exists in the Blockchain, and therefore notifying if the selected certificate is valid or not.

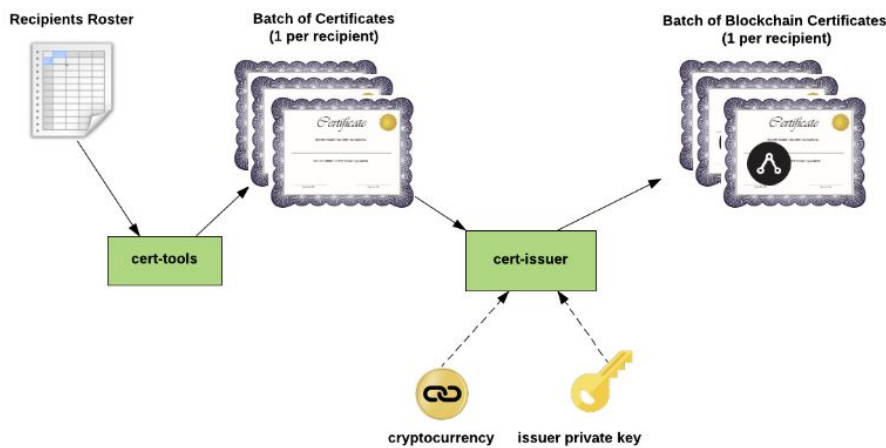


Figure 2.2: Issuing a certificate, general overview

### 3. Higher Education in Europe: certificate for a degree

In this section we will introduce the actual procedure that European universities tend to use when issuing degrees. We will look in more depth the Higher Education institutions in Spain assuming that in other states will be similar due to the convergence of the European Higher Education Area towards the Bologna model. Also we will focus on the security issues that those procedures may have and which ways we have actually to make a document safer and also which ones use the system actually.

Then with this general overview of the higher education system and the safety options we will move to the companies that are working actually on the verification of titles which is not straightforward. Finally, we will detail the technologies selected and their compatibility with the current system and how are they being used actually in the education sector.

The actual contract to reach a degree of bachelor in the educational system starts when you apply for a degree of your choice and you pay the fees in order enroll a number of European Credit Transfer and Accumulation System (ECTS) [9] every year. Once the student achieves the required amount of ECTS, 240 or 180 in case of a bachelor degree, he or she is able to apply for a degree certificate. The following figure summarizes the timeline for a degree assuming 240 ECTS in 4-year set up:

1st Year	College Tuition. Typically in 4 years accomplish all the 240
4th Year	ECTS credits Apply for the degree title over the internet. Collect the physical degree title
5th Year	(Optional) claim the digital version of the title.

Figure 3.1: Procedure for degree fulfillment and application

The process continues with the Figure 3.2 where is shown what are the possibilities for a graduate after submitting the application for the degree certificate and getting a receipt (or guard of payment as shown in the figure). Then, the process follows as:

- Some students update their social networks, such as their LinkedIn profile, to become candidate for a job in the marketplace, once graduated. In this first step, the graduate is only having the receipt of application which is completely unreliable because it lacks of any security mechanism to proof that the univeristy certificate is in progress.
- One option, not very well known, is to claim for a digital copy of the title called e-Title (Electronic Title) but this can only be claimed once the graduate receives the title, not the receipt, which can be delayed for up to two years in Spain.
- Regarding to employers, approximately half of the organizations base their job recruiting in the experience of the user and they do not regularly check the certificate credentials of the candidates. A common practice among the organizations that usually check the certificates, which tend to be large organizations, is the use of external services to check the process.
- Finally, it is mandatory to claim the degree certificate if the graduate is interested in follow up studies applying for a Master degree or a PhD.

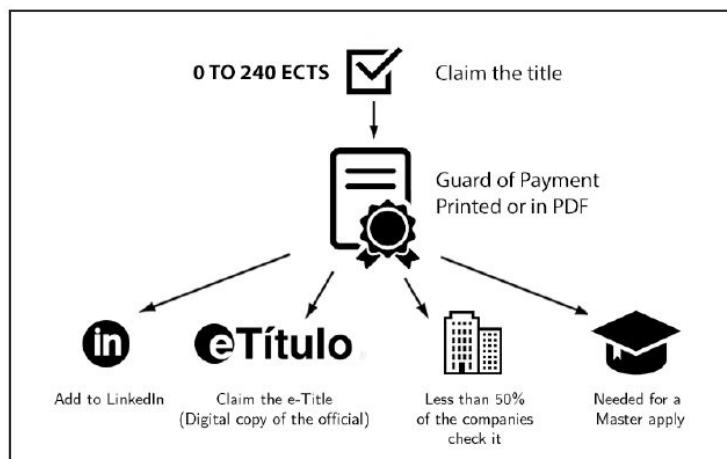


Figure 3.2 Common needs for a student after graduation

For a particular case of the Universitat Pompeu Fabra, the process is detailed in the application [10] where the student can claim the title.

## 4. Higher Education in Europe: benchmark of current solutions for verification

In this section we introduce the current mechanisms and systems used in Spain and other European states to ensure that the documents are official and not tampered.

### **CSV (Codigo Seguro de Verificación or Verification Secure Code)**

The CSV is a tool developed by the Spanish Government, more precisely the Ministry of Justice, that generates a security code that is attached to the official document and allows anyone to verify it in its official website [11]. The CSV tool works essentially as a hash function that generates a set of data of fixed-length that depends of all the content in the document, so any alteration will be detected automatically. This hash result is attached to the right inferior lateral of the signed document and provides a link for verification.

### **Digital ID Certificate**

Another option to secure digital document actually which is used in the e-title, explained shown below, is the digital certification of the document. This type of certifications allows to obtain a trusted source of the document, validates that the signer's identity is valid and makes a time stamp on the creation of the document. It also avoids third parties to modify the document. This service is centralized in the government database.

### **E-Title**

Finally if we sum up the last two choices, the CSV and the digital ID certificate, we find the e-title, developed by SIGNE, the company that prints the official degree certificates in Spain [12]. The e-title generates a PDF document with the original paper-certificate that includes a digital signature and a CSV to easily check on the Internet that the document exists in the database. It also has a digital signature of the academic responsible.

Currently, only 4 of the 11, a 36% of Catalan universities and 18 of the 83, a 21% of Spanish Universities are using e-title technology.

### **UK Higher Education Degree Datacheck**

We find other solutions in terms of validation of degrees in Europe. In United Kingdom, the solution is based on the so-called HEDD "Higher Education Degree Datacheck". This system allows the companies, employers, embassy's and universities to check or verify titles through the HEDD Website. The price of the confirmation starts on £12 and can increase depending on the organization that one is interested in validating.

### **Companies offering verification services in the Higher Education Area**

The mechanisms shown are offered by the public administration or by the universities issuing the degrees. The service provided is often limited and not easy to adopt systematically in recruiting procedures by organizations. We can find some companies



commercializing similar services in this growing up sector, so we present some examples below:

### **Prospects - UK Service**

Prospects<sup>5</sup> is a company established in the UK that develops services for the students that finish their studies in that country. As we mentioned before, one of the important services is the HEDD's database that helps the companies to check the graduations of the students in every university and college. But also one of the largest services offered by Prospects Platform which, in partnership with the government and the universities, helps the graduated students to find jobs.

That services are sustained by the recruiting companies but together they offer a friendly environment in order to help the growth of the country and the improvement of the job opportunities for graduated students that have an easy way to validate their studies.

### **Qualification Check - Worldwide Service**

Qualification Check<sup>6</sup> is another company playing in the job-search market that makes easy the process of verification through the universities and for the companies. Qualification Check offers an easy way that avoids the bureaucracy in terms of contacting to the university and the prices are usually quite low starting at £15 in Europe countries. The actual coverage of Qualification Check around the world is really huge with most developed countries.

### **National Student Clearinghouse - USA Service**

In the USA, National Student Clearinghouse<sup>7</sup> is another example of company offering services of verification of the current enrollment, verification of degrees and attendance, and the verification of professional certifications.

## **4. Certification and verification of degrees based in Blockchain/Blockcerts**

In this section we will explain a general overview of the process shown on Figure 2.1 looking at the process from the user/student's perspective providing more details for every step. The certification and verification mechanism is based, as stated in sections 2 and 3, in three main parts or components: the cert-tools, the cert-issuer and the cert-verifier.

Once a learner finishes the degree and claim the title the process starts, so the organization in our case the University or higher education institution, will prompt the students to invite them to have their fresh title set on the Blockchain. Once we have all the student's replies, we can build a list using the the *cert-tools* to create the so-called batch of certificates which includes all the information to be stamped as the second step in the process using the cert-issuer. The cert-issuer works but in this general overview we will only think about is the

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<sup>5</sup> <https://www.prospects.ac.uk/>

<sup>6</sup> <https://www.qualificationcheck.com/>

<sup>7</sup> <http://www.studentclearinghouse.org/>

step that manages everything to convert the batch of unsigned certificates to a batch of signed in blockchain certificates. This step also involves having some cryptocurrencies like Bitcoin or Ethereum in a wallet in order to pay for the blockchain transaction that will contain all the information related to our Certificates.

The last main part cert-verifier-js is not used in the issue process but is very important to mention, because is the one that manages this whole process in an inverse way, performing all the steps to check if the certificate is signed and linked to the claimer, in this case the graduated student.

### **Student's usage**

The same process seen from the student perspective will be easier since the major part of the process of issuing the certificate is done by the organization. The steps that have to made the student interested in having their certificate on the blockchain are very simple. Once the system starts the process of issuing the title the University will send an email to the student in order to record their wallet data and link the certificate to his wallet. The student wallet will have like every wallet in the blockchain a public key and a private key. The student will be responsible to save in a secure vault the pass phrase that creates the private key and works as a wallet generator, every time the student lose the information of the pass phrase, it will have to generate a new wallet and claim again the issue of the title. Also the system will only need the public key to issue the title, which will work like a personal and unique identity linked to the student. To be more easy to understand, the student will be the person in charge to create their own ID on the blockchain, and only will give to the system the number that identifies it. All the other data will be not stored in the system or Blockchain and this is what makes the process more secure, when finally the title is only hold by the student.

### **University/issuer's side**

The university will provide a complete service based on the blockcerts platform. In order to achieve this, it will need a server to host the following services:

- Verification website
- Back-End service with Docker to host the Blockcerts Platform
- Back-End service for making easy the management of titles through the Blockcerts platform with and easy interface.

A list of the students that had been graduated during the year and their name and email and mailing list to collect the public keys of the students.

The university's unit in charge of the service will carry all the legal responsibilities that imply the fact of giving any certification, so it will have to choose a person of truth to make this process even dough is very automated in order to verify all the given certificates with this technology. Also this person in charge will be the one that will hold the private and public keys of the university wallet and will need to manage the balance of this account (in bitcoin). In terms of data protection the system will be working within the information that the university haves from the students, only it will be added the information provided by the student relative to their Wallet Public Key to the university database.

### **From the Third Parties/employees side**

Finally the process taken from the third parties perspective will be the easier one. Third parties will only need to ask the students to send their verification links and see through the blockcerts university app that the student have the certification and not revoked by the university.

## **5. Market analysis of graduates from Higher Education in Europe**

In this section we explore the volume of the potential market for certification and verification of university-higher education degrees in Europe. The size of the market will allow to project some business scenarios as well as how to address the business model internationally.

According to Eurostat<sup>8</sup>, in the EU there were over 19,5M of tertiary education students, including university students in the last report from 2015. The distribution of this students among the three main levels is: 7.2% for short-cycle, the gross of 61.4% for bachelor's degrees, 27.8% for master's degrees, and 3.7% for PhD.

Looking at per-country statistics, Germany appears as the largest country with 3.0M of tertiary education students in 2015, which represents a 15% of the total EU. The list of countries with more students are France (12%), United Kingdom (12%), Spain (10%), Italy (9%), Poland (8%) and the Netherlands (4%).

The gross of the students are enrolled in bachelor's degrees, from where represented more than three quarters of all tertiary educations students as in Macedonia (93%), Serbia (80%), Greece (88%), Lithuania (77%), the Netherlands (77%) and Ireland (75%). Master's and PhD's degrees are far below bachelor's figures representing at most one third of all tertiary students.

The number if graduated students from tertiary education establishments in 2015 in EU is close to 4.7M. The figure is hard to estimate due to the lack of yearly update from each member state. France is leading the list of tertiary graduates (752.000) in 2015, followed by the United Kingdom (740.000), Germany (545.000) and Poland (517.000).

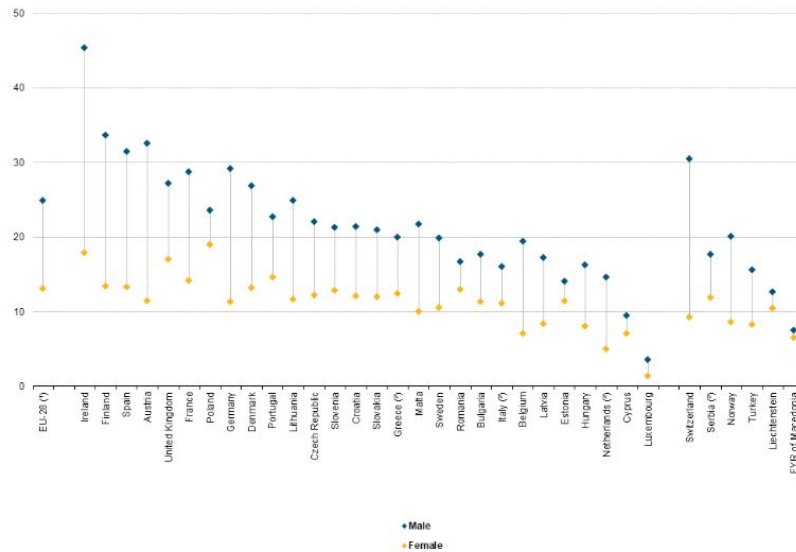
If we look at the fields of graduation shows that over one third (33.8 %) had graduated in social sciences, journalism, information, business, administration or law. In the fields of health and welfare, the figure is 13.7 % of graduates and in the field of education studies is of 9.3%. In the areas of engineering, manufacturing and construction-related studies we got 13.9% of graduates, in natural sciences, mathematics, statistics, and information and communication technologies a 10.3% of graduates, and finally in arts and humanities an 11.0% of graduates.

The mentioned figures seems to be quite stable, or with a smooth increase, over time having in mind the market projections for each country/state member of the EU.

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<sup>8</sup> Eurostat, Tertiary education statistics:

[http://ec.europa.eu/eurostat/statistics-explained/index.php/Tertiary\\_education\\_statistics](http://ec.europa.eu/eurostat/statistics-explained/index.php/Tertiary_education_statistics)



Note: ranked on the ratio for total ratio (for men and women).  
 (\*) Estimates.  
 (\*) 2014.  
 Source: Eurostat (online data code: educ\_grad04)

Figure 5.1: Number of students graduating from tertiary education in science, mathematics, computing, engineering, manufacturing and construction, 2015 (number per 1.000 inhabitants aged 20-29 years). Source: [Eurostat](#)

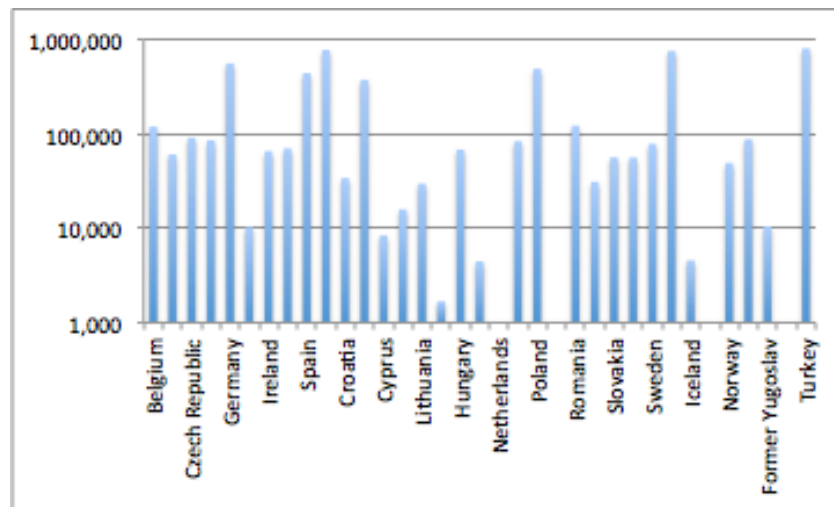


Figure 5.2: Number of students graduating from tertiary education (levels 5-8), 2016 in log scale. Source: [Eurostat database](#), own elaboration.

## 6. Business model, cost analysis and market share projections

According to the market analysis data and targeting a set geographic scenarios within Europe, in this section we do a first exploration and financial projections assuming a simplified costs for running a business model based on a pay-per-certificate plus a pay-per-verification. We assume a fixed costs to deploy the tool per country, assuming not only the marketing campaign but also the adaptation to a multi-language platform, and having a central headquarters all across the continent. The projections are done based on a

business model that balances the price between the graduate or the potential employer interested in verifying one or a set of degrees.

### Business model

The business model proposed is based in charging both the graduated and the employee by a certification and a verification fee, respectively. The way to balance those values is tuneable depending on the final model adopted. On one hand, one may assume to charge once the gross of the cost to the graduated student, to have the certificate on the blockchain forever and being potentially verified by future employers. On the other hand, one may assume that is more reasonable to charge the employer due to its high perception of the value of the service of verification in a recruiting process. In this business model we consider both scenarios.

In extreme scenarios the complete price would be charged on one or another side. For example, charging once the graduate and consequently providing the service for free to recruiters; or charging only for verification and allowing the graduates to store their certificates in the blockchain for free, would be the those extremes.

From the business perspective, charging the employer seems more interesting to keep getting income everytime the graduated is changing her job to a new organization that is interested in checking credentials.

In order to provide financials for specific scenarios, we avoid the extreme scenarios and we prefer to unbalance the expenses in a 80%/20% weights. The following table summarizes both models:

Business model	Fraction of income from certification	Fraction of income from verification
Certification-centered	80%	20%
Verification-centered	20%	80%

Table 6.1: Business model details

### Cost analysis

In the following tables we state the different components for the cost model. First we detail the elements to figure out the initial and recurrent costs, and summarize them depending on the three explored scenarios. At the end of this subsection we distribute the overall costs among the marketed degrees to for different market shares. Those values allow us to develop the business model changing how to repercute those costs on the certification and verification steps, and see plausible prices to market the certification and verification services.

The main expenses are the ones detailed in the following table:

Concept	Estimated cost (K€)	Comment
<b>Marketing, initial investment</b>	100	per targeted State
<b>Marketing yearly exp.</b>	75	per targeted State
<b>Server Platform</b>	75	
<b>Software development</b>	125	
<b>Language adaptation</b>	50	per targeted State/language
<b>Personnel costs</b>	150	plus 25% per targeted State
<b>Operational costs</b>	25	
<b>Indirect costs</b>	90	A 15% of the estimated costs

Table 6.2: Summary of expenses

Using the expenses shown in the previous table, and using three scenarios targeting one single state with three states or the whole European Union we foresee the following expenses grouped into initial and yearly:

Scenarios	Initial investment (K€)	Yearly expenses (K€)
<b>Single State</b>	545	287
<b>Three States</b>	1.120	416
<b>All-28-EU</b>	4.283	891

Table 6.3: Scenarios: initial investment and yearly expenses

According to the data collected in the previous section, we assume a targeted market of 300.000 students graduated per country in the first and second scenarios, while in the third one we assume the gross of 4,5M of graduates.

To make a more realistic approach, we also assume a set of market shares of 1%, 5% or 10% of all the graduates at the end of year. Using the mentioned cost, we project a cost per degree for each scenario as shown in the tables below:

Market share	One State scenario (cost per degree)			
1%	€ 230,00	€ 162,92	€ 140,56	€ 129,38
5%	€ 46,00	€ 32,58	€ 28,11	€ 25,88
10%	€ 23,00	€ 16,29	€ 14,06	€ 12,94

Market share	Three State scenario (cost per degree)			
1%	€ 129,38	€ 87,85	€ 74,00	€ 67,08
5%	€ 25,88	€ 17,57	€ 14,80	€ 13,42
10%	€ 12,94	€ 8,78	€ 7,40	€ 6,71

Market share	All EU scenario (cost per degree)			
1%	€ 84,20	€ 52,71	€ 42,21	€ 36,96
5%	€ 16,84	€ 10,54	€ 8,44	€ 7,39
10%	€ 8,42	€ 5,27	€ 4,22	€ 3,70

Table 6.4: Cost per degree depending on the scenario and market share

### Expenses-Income projections for targeted scenarios

To maintain our analysis in a simplified model, we assume that every certificate will be verified every two years as part of recruiting processes where the graduate is being involved.

To make a more realistic approach, we also assume a market ramp up of 20%, 40%, 80% and 100% per year to achieve the designated market share. In relationship to the market share we explore getting 1%, 5% or 10% of all the graduates at the end of year four with the designated ramp up.

In the following tables we set the price per certification of 25€ and 5€ per verification when we apply the certification-entered business model, and the price per certification of 5€ and 25€ per verification when we apply the verification-entered one.

**Certification-centered****One-State scenario**

ramp up

Accumulated Income	20%	40%	80%	100%
market share: 1%	18.003 €	63.003 €	205.503 €	460.503 €
5%	90.003 €	315.003 €	660.005 €	1.185.005 €
10%	225.000 €	675.000 €	1.500.000 €	2.550.000 €
Income-Expenses				
market share: 1%	-671.998 €	-914.498 €	-1.059.498 €	-1.091.998 €
5%	-599.998 €	-662.498 €	-604.995 €	-367.495 €
10%	-465.000 €	-302.500 €	235.000 €	997.500 €

**Verification-centered****One-State scenario**

ramp up

Accumulated Income	20%	40%	80%	100%
market share: 1%	40.500 €	90.000 €	201.000 €	373.500 €
5%	202.500 €	450.000 €	1.005.000 €	1.867.500 €
10%	405.000 €	900.000 €	2.010.000 €	3.735.000 €
Income-Expenses				
market share: 1%	-649.500 €	-887.500 €	-1.064.000 €	-1.179.000 €
5%	-487.500 €	-527.500 €	-260.000 €	315.000 €
10%	-285.000 €	-77.500 €	745.000 €	2.182.500 €

Table 6.5: Financial projections for the One-State scenario



**Certification-centered Three-State scenario**

ramp up

Accumulated Income	20%	40%	80%	100%
market share: 1%	49.500 €	198.000 €	594.000 €	990.000 €
5%	247.500 €	990.000 €	2.970.000 €	4.950.000 €
10%	495.000 €	1.980.000 €	5.940.000 €	9.900.000 €
Income-Expenses				
market share: 1%	-1.114.875 €	-1.383.250 €	-1.404.125 €	-1.425.000 €
5%	-916.875 €	-591.250 €	971.875 €	2.535.000 €
10%	-669.375 €	398.750 €	3.941.875 €	7.485.000 €

**Verification-centered Three-State scenario**

ramp up

Accumulated Income	20%	40%	80%	100%
market share: 1%	189.000 €	756.000 €	2.268.000 €	3.780.000 €
5%	945.000 €	3.780.000 €	11.340.000 €	18.900.000 €
10%	1.890.000 €	7.560.000 €	22.680.000 €	37.800.000 €
Income-Expenses				
market share: 1%	-975.375 €	-825.250 €	269.875 €	1.365.000 €
5%	-219.375 €	2.198.750 €	9.341.875 €	16.485.000 €
10%	725.625 €	5.978.750 €	20.681.875 €	35.385.000 €

Table 6.6: Financial projections for the Three-State scenario

**Certification-centered All EU scenario**

ramp up

Accumulated Income	20%	40%	80%	100%
market share: 1%	462.000 €	1.848.000 €	5.544.000 €	9.240.000 €
5%	2.310.000 €	9.240.000 €	27.720.000 €	46.200.000 €
10%	4.620.000 €	18.480.000 €	55.440.000 €	92.400.000 €

market share: 1%	-6.093.000 €	-6.202.000 €	-4.001.000 €	-1.800.000 €
5%	-4.245.000 €	1.190.000 €	18.175.000 €	35.160.000 €
10%	-1.935.000 €	10.430.000 €	45.895.000 €	81.360.000 €

**Verification-centered All EU scenario**

ramp up

Accumulated Income	20%	40%	80%	100%
market share: 1%	1.764.000 €	7.056.000 €	21.168.000 €	35.280.000 €
5%	8.820.000 €	35.280.000 €	105.840.000 €	176.400.000 €
10%	17.640.000 €	70.560.000 €	211.680.000 €	352.800.000 €

Income-Expenses

market share: 1%	-4.791.000 €	-994.000 €	11.623.000 €	24.240.000 €
5%	2.265.000 €	27.230.000 €	96.295.000 €	165.360.000 €
10%	11.085.000 €	62.510.000 €	202.135.000 €	341.760.000 €

Table 6.6: Financial projections for the All EU scenario

The results show interesting results even for the single-State scenario. Here, the certification-based business model only provide positive results in the most aggressive scenario (10% of market penetration) with 235K€ at the end of the third year of operations. The verification-centered approach relaxes the break even getting benefits in both the 5% (year 4) and 10% (year 3) of market share scenarios.

Increasing the size of the market up to three States, the model allows a relaxation of the break even, reaching positive benefits in year 3 (5% of market share) and year 2 (10% of market share) for the certification-based model. If we move to the verification-income model, even in the less optimistic scenario in terms of market share (1%) we get benefits at the end of year 3.

Finally, if we extend the business to all European Union, the financials gets benefits from the economies of scale and both business models provide positively substantial numbers in all scenarios but the certification-oriented when the share is only 1%.

With this results we can now answer the research questions formulated in this paper:

### **Is it economically feasible to develop a blockchain-based app?**

Due to the growing education market in Europe and the similarities in the procedures for certification and verification of degrees, the data collected shows that developing a blockchain-based solutions provides a set of competitive advantages in front of existing solutions. Although it may seem economically feasible, it is important to remark that the business model analysed needs a critical mass of graduates per year to have enough margin of operation and become finally feasible. That critical mass is estimated over half million of graduates per year from where the break even is reached in the second or third year of operations depending on the market share acquired.

The costs for development are reasonable, and the economies of scale only demand minor adaptations of the service to satisfy state particularities and local language translation as well as specific marketing actions to cover several states.

### **Which are the pros and cons of this technologically intensive business model?**

The level of maturity of blockerts software together with the existing community of developers, the first pilots used with real certificates plus our experience adapting that solution for the UPF site shows low risks on the side of the technology.

Probably the dependence of an external open and public blockchain, such as Bitcoin or Ethereum where to set the certificates generates reasonable doubts and risks such as the costs incurred to set transactions and to trust in the evolution of cryptocurrency which is always unceart. However, the possibility to move to other open public blockchains relaxes this particular risk.

### **Which could be an estimation of the needed market (regional/national/European) to make it viable?**

According to the financial projections established in this study, and taking into consideration the exploratory status of this research, we can conclude that facing the business of certification and verification at regional or national levels is too risky to become profitable and sustainable in the mid term of four or five years. Even in the cases of the states offering a higher number of graduates per year such as France, UK, Germany or Poland. So that, aggregation of markets from different member states seems the only reasonable way to achieve the business with less risks.

## 7. Conclusions

In this paper we have explored the financials to deploy two different business models to develop a strategy for higher education certification and verification of degrees. Both business models are based on a pay per certification and pay per certification balancing the income in one another issue.

Under a set of plausible assumptions to deploy that business and basing the business strategy in the Education sector in the European Union, we have projected a basic calculations to prospect the market for a blockchain based service.

We conclude that the certification and verification business of degrees using blockchain technology is a massive market that really may perform in a sustainable way when getting advantage of the commonalities from aggregating member states from the EU. Aggregation reduces financial risk, however it increases the complexity of the business development in terms of market strategy, translation costs and service distribution.

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