MASTER THESIS

Blockchain certificates: the impact on the organization of public values in higher education

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Abstract

Blockchain is a popular emerging technology and its application is considered in higher education. Certificates is a major area in higher education where blockchain is to be integrated. Whereas certificates are stored by universities, blockchain promises ownership to the students. It offers opportunities to universities to take more authority in accreditation to the institutions. Blockchain promises exclusion of the third party from interactions, self-sovereignty, transparency and security. As blockchain comes with a set of promises and expectations, its embedding in higher education raises questions about the discourse of public values. It is expected to change organization of public values in higher education. While the authority lies with governmental institutions, public value organization is delegated to the universities through a principal-agent relationship. Hence, the research question of this paper is: *"How will blockchain certificates change the socio-technical regime, and thereby affect the governmental organization of public values?"* A methodology is used that includes empirical investigations of actual initiatives, analyzed through two approaches: the Actor-Network Theory and the Multi-Level Perspective. This brings the pre- and post-blockchain socio-technical configuration into picture, and explains the overarching framework of long-term developments, actor interests and niche technologies. The five case studies of blockchain certificates are: 1) Europass, 2) EUSL, EUBBC, and Concordia H2020, 3) BadgeCollect, 4) EduCTX, and 5) Blockcerts. The findings show there are two fundamental characteristics in the embedding of blockchain certificate: governmental involvement in the consortium of the initiative, and the type of educational innovation that underlies blockchain certificates. Moreover, it shows a direct and indirect impact of blockchain certificates on the organization of public values. While educational innovation affects public values directly, governmental involvement determines the division of responsibilities in organizing public values. These findings suggest that the principal-agent relationship between the national government and universities becomes more asymmetrical, resulting in a shift of power, depending on governmental involvement. It suggests that governmental involvement produces more beneficial restructuring of actor relations and responsibilities.

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1. Introduction

Blockchain is an emerging technology that is expected to "disrupt" the present systems of certificates in higher education (Grech and Camilleri, 2017; p. 8). The distributive ledger technology has gained popularity in recent years, mainly through the cryptocurrency Bitcoin. The wide range of promises creates a widely imagined perspective on technological replacement. Characteristics such as direct transactions without the third party, transparency, and security are among the reasons that blockchain is gaining traction. In the case of higher education certificates, it is asserted blockchain might give students ownership and access to their certificates, while also shrinking the administrative burden of issuing, viewing, verifying and validating a certificate. The expectation is that blockchain will soon become the underlying technology behind higher education certificates. Since blockchain certificates are an emerging technology, they have not been embedded in higher education yet. Many of its properties are still unknown, such as user experience, the future network in higher education, the feasibility of implementing a new technology to using it as part of a wider innovation.

While blockchain certificates as a group of systems are still in its infancy, its prospect is not the only interest of this research. From a governance angle, the relationship between governmental and higher education institutions is considered. The national government is responsible for providing students with public universities that meet demands for quality education, while the universities are agents that are financed and evaluated by the government for their performances. One of these responsibilities are public values. The way in which these public values are organized in higher education is subject to that relationship. The question therefore is whether future developments will disrupt this organization. Arguably, blockchain certificates are a next step in the digitalization of higher education. This is where questions about the organization of Dutch higher education, and questions about blockchain certificates, come together.
There are a few goals to be achieved in this research. The first goal is to get an understanding of the organization of public values in higher education, and the main public values themselves. The second goal is to understand the background of blockchain certificates and its current and future trajectory in higher education. The third goal is to combine organization of public values and blockchain certificates together and find out whether blockchain certificates are going to alter public values and the organization of them. Hence, the focus of this research is on the organization of public values in higher education on the one hand, and blockchain certificates on the other. This leads to the following research question:

"How will blockchain certificates change the socio-technical regime, and thereby affect the governmental organization of public values?"

In order to answer the research question, the following methodology is applied. Firstly, a literature review is conducted to build the theoretical framework of blockchain certificates, public values, and digitalization. In this literature review, the public values that play the most important role in Dutch governance are identified, and the way in which these are organized are discussed. Then, digitalization and blockchain certificates are discussed. This should give a sufficient overview of digitalization as the overarching phenomenon behind blockchain certificates. The empirical aspect of the methodology is developed by analyzing blockchain certificate initiatives. These are already in existence or still in development. The development of the case studies is supported through interviews with people involved in the initiatives, research documents, and other significant reports. After conducting the case studies, two approaches are used to structure the findings. These are the

Actor-Network Theory, and the Multi-Level Perspective. Using these two approaches in particular gives a picture of the current socio-technical configuration, and the overarching framework of developments and actor interests. An overview the current organization of the public values is developed, which will streamline the findings from the case studies. Through this methodology, the impact of blockchain certificates on the organization of public values is presented.

2. Organizing Public Values in Higher Education

2.1 Introduction

In this chapter, what is currently seen as public values in higher education policy in the Netherlands is identified. It is discussed how they are defined in policy documents, how they relate to each other, and how the government, the universities or other actors ascertain these values. After the main values are discussed, the compatibility of these values is discussed. At last, how public values are currently organized in higher education is discussed, with special regards to two actors in particular: the national government and higher education institutions in the Netherlands. Although, as is shown further on in this research, many of the blockchain applications are not limited to the Netherlands, the focus however is limited to that country.

2.2 Public values

There are many public values that are relevant in the context of Dutch higher education. These include, but are not limited to, integrity, effectivity, transparency, efficiency, democracy, legitimacy and legality. Many of them are also mentioned in the Codes of Conduct for higher education (de Graaf, 2016; p. 3), which deals with research integrity among others. This shows that public values are relevant in the Netherlands. Although there are many different public values that can be selected for analysis, the amount of values that is investigated is limited, because the focus is on the role of the government in organizing values. According to Nieuwenhuis et al (2012), the three main public values in Dutch higher education are quality of education, efficiency of institutions, and accessibility of higher education. Furthermore, these three public values are also explicitly mentioned in the WHW (Wet op het hoger onderwijs en wetenschappelijk onderzoek) in article 1.7a (Overheid.nl, 2021). Hence, these are the public values that are further analyzed, together with the organization of these values.

2.2.1 Quality

The first public value is quality of education is quite relevant. This value is quite relevant, since the government wants to certify a certain level of quality. However, the question is what quality exactly refers to? The answer to that question is quite ambiguous. Quality policies in Dutch higher education, according to some, is too much of a one-sided vision on quality (Leest et al, 2015; p. 7). According to the same report, the focus is too much placed on quantitative measurements such as efficiency and drop-out, with too little space for other visions on quality, such as the development of student talents (p. 10).

Guaranteeing quality in Dutch higher education is called the *'kwaliteitszorg'* (care for quality). Taking care of quality is, as is discussed further on, a role the government takes in higher education, albeit that responsibility for quality is divided on the institution level, the education level, and the system level (Leest et al, 2015; p. 15). The main example is the accreditation authority that has the mandate to recognize institutions and study programmes, which means that the universities have to live up to a certain standard in order for their programmes to be accredited. Therefore, an individual student cannot demand financing from the government when that student is enrolling in a study programme abroad, as article 1.19 of the WHW stipulates (Overheid.nl, 2021). The reason why is that financial support for students is restricted to those students that follow a program that is accredited and study at one of the institutes recognized by law. If quality-related criteria are met, the minister allocates to the institution, according to article 2.6.6 (Overheid.nl, 2021). The public value of maintaining a sufficient quality of education is mainly regulated through the accreditation system in the Netherlands. From a philosophical angle, the small scope of definitions of quality that is used by

the national government opens up discussion. Although they are very useful from a governance perspective, the question is whether the limited scope is sufficient. The governance perspective includes a focus on higher education succeeding in preparing students for a professional life (p. 26). This seems to be the main and ultimate definition of quality that is important.

2.1.2 Efficiency

The second public value the government aims at is efficiency. In public administration theory, efficiency can be guaranteed in three ways. From a traditional public administration approach, efficiency is mainly about creating procedures that employees have to follow. In the case of new public management (NPM), it is about creating a "setting of tough performance tasks" (Stoker, 2005; p. 50) that become the aim of an organization. In the case of public value management, efficiency is defined by looking at the "broader goals" (p. 51) of achieving public values. According to Nieuwenhuis et al (2012), the main approach that is used by the Dutch government in higher education is akin to the new public management (NPM) model, in which the market is used as an example of how the government should function. This relates quite well to the principal-agent relationship that was discussed in 2.2. It is even said to be "to some extent a response to the administrative inefficiencies associated with traditional public administration" (Stoker, 2005; p. 42). This implies that the NPM model was implemented motivated by the public value of efficiency, and for this particular reason the national government operates through implementing market-mechanisms into governmental agencies and relations. It is suggested that public service organizations, such as higher education institutions, "tend to be dominated by producer interests" (p. 45), and therefore these organizations became quite inefficient. Therefore, the focus is put on performance rather than procedures, and governmental bureaucracies are transformed into "lean, flat, autonomous organizations drawn from the public and private sectors" (p. 46). The definition of efficiency that is used is the setting of tough performance tasks. Efficiency is often in conflict with quality. One example that De Graaf (2016) notes, is showing why public values that most people would ascribe to can cause a conflict. If the universities are struggling with a labor shortage, meaning that there are too few academic teachers available, then a conflictual situation arises. On the one hand, following the public value of quality, qualified academic teachers would have to teach to larger classes and take responsibility for more students than usual. On the other hand, if efficiency is aimed at, less knowledgeable, experienced and qualified teachers would be assigned to student, meaning the quality of education is likely to become less.

2.1.3 Accessibility

The third public value is accessibility, which has become a major public value in the past years. Accessibility means that anyone, regardless of their background, should have equal access to public goods. In higher education, this is not the case, since universities are only admitting students who have the required qualifications. The question then is, what is meant with higher education being accessible? In the Netherlands, accessibility in higher education usually refers to universities being accessible for students with valid certifications of a legally-accredited pre-education. For example students from vocational programs moving to universities of applied science, and students from the latter moving to universities after they graduated, but also students moving from middle education to higher education (Inspectie van het Onderwijs, 2019; p. 12). It means that people who are qualified to partake in a study program have an equal opportunity to do so.

A main issue with accessibility in higher education that has become important in recent years, is the introduction of a new financing system for students. The '*leenstelsel*' (student loan system), was implemented through the *Wet studievoorschot hoger onderwijs* in 2015. This system

has replaced the previous system in which students received a basic grant from the national government, which they did not have to pay back if they met certain criteria, e.g. a minimum amount of study points. Since 2015 students can get a study loan from the national government. This results in a steadily increasing student debt and raised concerns about a decreasing accessibility to higher education. A study of the Centraal Planbureau (Netherlands Bureau for Economic Policy Analysis on the effects of the new system on accessibility to higher education concluded that the influx of students from all income groups have remained the same. That is the same percentage of middle education students move to higher education as it was the case with the old financing system. Therefore, they concluded that the *Wet studievoorschot hoger onderwijs* (2015) has no effect on the accessibility of higher education for students from middle school (Centraal Planbureau, 2020). However, the study did not investigate the effect of the *Wet studievoorschot hoger onderwijs* on the influx of students from the middle vocational education institutions (MBO) to the universities of applied science, and from the latter to academic universities.

One study reports a decrease in influx of MBO students to the universities of applied science, and assigns this decrease to the introduction of the new system (Van den Broek et al, 2020). Reasons for this decrease include a fear of loaning, not wanting to build a study debt, other financial motives, such as an obligation to pay back the supplementary grant that was assigned to them. Furthermore, the influx of male students and students from immigrant families is reported to be even lower. Thus, the current financial system in higher education has not led to a decrease accessibility from middle school to universities (i.e. the preparatory programs), but it has led to a decrease of influx of students from lower education. Another factor that was expected to decrease accessibility of higher education programs for Dutch students was the influx of international students. However, such expectations were not supported by the findings of the report from the Dutch education inspection (Inspectie van het Onderwijs, 2019; p. 52). Thus, there are two groups of students that are focused at when discussing accessibility in higher education. Firstly, it refers to higher education being accessible for students from secondary education, who qualify for higher education through their secondary school degrees. Secondly, it refers to students who have completed a tertiary school degree, for example at an university of applied science, who want to join a university.

2.3 Trilemma

While the law states that the government is responsible for these three public values without any priority of one over the other, in practice there are tensions between the values. Think about the relationship between quality of education and efficiency. In a NPM model, including its definition of efficiency, then prolonging efficiency, including a post-bureaucratic and competitive structure (Broucker et al, 2018; p. 234), is counteracting effort to promote a higher quality of education. Reducing finances might lead to more efficiency in higher education, but often having qualified teachers whose purpose is not limited to students only passing their courses requires greater investments which renders it less efficient. This is not the only conflict between public values. Both quality of education and efficiency are also colliding with accessibility. On the one hand, optimizing accessibility of higher education could mean taking away barriers that currently prevent unqualified or poorly-performing students in secondary education or vocational education to enter higher education. The *numerus fixus* is one example where quality of education is protected by decreasing accessibility to the particular study program. Quality referring to the students being sufficiently prepared for a professional life, which becomes harder when there are students who, on average, perform less. When a university has placed a numerus fixus on a particular program, only a limited amount of students can partake in it for that year. Determining which students are admitted is in some cases dependent upon a randomized draw, but often an assessment is made of the individual

students competencies, through a matriculation examination or middle school results. Through this system, students who would otherwise be qualified to join a study program, are now barred from partaking, meaning that accessibility is directly interfered with. Furthermore, as it was demonstrated, accessibility is also affected by efficiency, which can be witnessed with the example of the loaning system implemented in 2015. This new system was said to lead to a decrease of influx of students who attended lower education into higher education (either academic universities or universities of applied science) (Centraal Planbureau, 2020). In conclusion, although the national government has a role in guaranteeing the three main public values in higher education, guaranteeing one could lead to difficulty in guaranteeing the other, meaning that public values are often incommensurable with each other.

2.4 Reflection of other public values

As public values in higher education are not just limited to the three mentioned in this section, namely quality, efficiency, and accessibility, it is noteworthy to briefly mention other public values. Since these also play a role in higher education, these are also public values that the national government has an interest organizing in. De Graaf (2016) briefly mentioned some of the other public values, and these include integrity, effectivity, transparency, democracy, legitimacy, and legality (p. 3). Moreover, normative concerns are integrated in a policy, for example, by including them in the Netherlands Code of Conduct for Research Integrity. This Code of Conduct has stated five principles that researchers in the Netherlands should abide by. These are respectively honesty, scrupulousness, transparency, independence, and responsibility (Netherlands Code of Conduct for Research Integrity, 2018; p. 13). The trilemma of conflicting public values, namely that between quality, efficiency, and accessibility, is not just limited to those three values. In fact, values are said to be continuously conflicting with each other (p. 5). Furthermore, besides the values conflicting and being incompatible with each other, De Graaf also argues that there is a sense of incommensurability, which means that a rational assessment would be very difficult. Since a value tradeoff would not necessarily apply to all conflicting public values, there is no one single solution that the national government can just tap into and apply in the entire field of higher education. This and the discussion on the trilemma have shown that the organization of public values is a complex task that requires a different approach to successfully support all public values, most notably quality, efficiency, and accessibility, without the approach becoming a tradeoff or one-way stream.

2.5 Public value or public good?

The governmental structure that regulates higher education in the Netherlands demonstrates a clear dependency of the universities on the national government, which ban be seen as a principal-agent relationship. This dependency is regarded as necessary from the perspective of the national government. Through this dependency, the national government sees itself able to organize public values. It has a vested interest in higher education as higher education can be regarded, at least to some extent, as a public good (Birkland, 2011; p. 135), as every citizen has access to higher education, if qualified. Although, since higher education is not nonexclusive, the institutions are public and, in most cases, allow access when someone is qualified. It would therefore be more appropriate to understand higher education as an institution through which public values are promoted, and the national government is invested in higher education for this particular reason as well. In contrast to public goods, public values are “more [focused] on the political and institutional process by which … [they] are identified” (Rainey, 2014; p. 64). Furthermore, public goods can be created in two ways: utilize the “money and authority” (p. 65) that the government has to create value for the public, and by creating public institutions that meets the demands of citizens. Following

this definition which, the government has the ability to create public value. According to Jørgensen & Bozeman (2007), there are three conditions in order for a public value to exist, which is that they "provide normative consensus" (Rainey, 2014; p. 67) about the rights and obligations that citizens have, and the principles of the state. Since higher education is contributing to the education level of the population, while creating new generations of scientists, it promotes public values, such as self-development, productivity, the public interest and democracy. Higher education can therefore considered to be contributing to public values.

The national government has a particular role in guaranteeing public values in higher education (Nieuwenhuis et al, 2012). According to the authors, the public value, combined with a "license to operate" (p. 2) and "tools for effectiveness" (p. 2), are unified by processes of steering mechanisms, organization processes and accountability. In this process, the national government is considered to be the "agent of the public value", and by this role they can negotiate with mandated actors (license to operate) (p. 2). This relation leads to four responsibilities of the national government: product-definitions, accountability mechanisms, finance models, and allocation models. The primary examples of this are the aforementioned WHW and the NVAO, which are the actors in this network that are mandated by the national government. Although it should not be assumed that the national government therefore is the entity that creates public values. As Jørgensen & Bozeman (2007) note, the "government has a special role as guarantor of public values, but public values are not the exclusive province of government, nor is government the only set of institutions having public value obligations" (p. 373-374). This quite well summarizes the role the national government has in higher education considering public values.

2.6 Organization of public values

Organizing public values in higher education is an important topic, considering that it basically is a governmental responsibility. Most universities in the Netherlands are publicly funded, and regulated by the national government. Specifically, the organization and regulation of higher education is determined by the Dutch WHW, which is a national law introduced on October 8th, 1992 (Overheid.nl, 2021). is divided into several chapters, dealing with various issues of higher education. The universities in the Netherlands that are subject to this law are the public universities of Leiden, Groningen, Amsterdam, Utrecht, Delft, Wageningen, Eindhoven, Enschede, Rotterdam, and Maastricht. Besides these publicly funded universities, the private universities of Amsterdam, Nijmegen, and Tilburg are also subject to this law. These are regulated through foundations, and not through the national government in the first place. Lastly, universities of applied science, *Hoger Beroepsonderwijs* in the Netherlands, are also subject to this law. The law stipulates that universities are focused on "taking care of scientific education and the exercise of scientific research" (Overheid.nl, 2021).

A major part of the government-university relationship consists of the universities having to write a six-year institution plan on the policies they want to implement, which includes goals for scientific research, and the financial, personal, material and organizational conditions that need to be met. After this plan is created, it is sent to the Ministry of Education. The Ministry, in turn, creates a four-year education and research plan, which will then be confirmed in the Dutch parliament. Through this structure, the universities take responsibility for their results to the national government. This is one way in which the relation between the national government and Dutch universities is regulated. While the universities are mainly responsible for their results, the national government is responsible for the financing of universities. For example, in Article 2.5 of the WHW the governmental financing of higher education institutions is determined. One of the main conditions for receiving funds is that financial budget is only allocated to recognized institutions,

which is determined in the WHW (Overheid.nl, 2021), and the recognizing of institutions itself is delegated to the NVAO (Nederlands-Vlaamse Accreditatie Organisatie). This is a process called accreditation, which is a "written recognition by an independent institution that the quality of work fits the posed criteria" (Dijkstra, 2001; p. 237). This means, according to Dijkstra, that the accreditation process is pivotal. Accreditation determines whether the study programme of an institution will be financed, and whether the particular institution is able to provide certificates to students (p. 237). In the WHW, criteria for quality assessment of new institutions are captured. In this way, the national government has the ability to determine which study programmes are legitimate and which are not. From this structure, it becomes clear that the Dutch universities, as public institutions, are subject to the authority of the national government. The national government regulates financing of higher education institutions, and it determines, through the NVAO, which institutions and which study programmes are recognized (and thus qualify for financing), while the universities have to take responsibility for their results and have to create a six-year institution plan to justify their intents.

The role that the national government of the Netherlands takes in guaranteeing quality of education is much like the principal-agent model (Leest et al, 2015; p. 25). In this model, the national government, the principal delegates authorities to agencies, the universities, that provide the service, in this case higher education. The main gist of the principal-agent relationship is that the agent has more specific knowledge than the principal has, which often leads to an asymmetrical relationship. This is said to be the reason why evaluation of the agent institutions is an important task for the national government (p. 25). For quality of education, the national government delegates the *kwaliteitszorg* to universities, who in turn are monitored and evaluated by the national government. Taking care of organizing and guaranteeing public values is a task that both the national government and universities have their role in.

3. Digitalization of Public Services

3.1 Introduction

The current era is marked as the era of digital transition (Rathenau Instituut, 2019; p. 17), in which data is converted to digital data stored in computers and similar technologies. For the purpose of the case study, namely blockchain certificate systems in higher education, it is interesting to discuss the phenomenon of digitalization, as blockchain itself is a technology that digitalizes data, although in the case of certification such data was already digitalized. The goal is to find parallels between digitalization and blockchain that allows for a deeper analysis to be conducted later on. Specifically, digitalization and the rise of the platform society is discussed in this section.

The phenomenon of digitalization has also found its way to higher education. It is said to be a correlating factor with the internationalization of education (de Wit, 2020; p. 2), as the ability to produce online education increases the accessibility of education for international students. There are roughly four ways in which digitalization is influencing higher education specifically, which are using information and communication technologies (ICT): 1) in the logistics of higher education, such as administrative tasks, 2) in the learning process, which include online courses that have especially become relevant in the COVID-19 era, 3) in the curriculum, as digitalization means students should be able to be skilled with technological systems in their future occupations, and 4) in the organization of education, including accreditation, flexibilization, and lifelong learning (Rathenau Instituut, 2019; p. 2).

3.2 Rise of platform infrastructure

Digitalization is not just merely about replacing existing technologies with their digital successors, but includes also the rise of online platform infrastructure. Platforms have become leading companies, especially in the social media sphere, where platforms such as Twitter, Facebook, and YouTube, have risen to incredible heights. Platforms are not just limited to social media, but also part of governance. Big data is the newest question for governmental institutions of dealing with digitalized personal data. In fact, dealing with such issues leads to a data-driven economy and society (van Est et al, 2018; p. 87).

Platforms are distinguishing themselves from other online services (Poell, 2016; p. 17), because they automatically gather an enormous amount of personal data from users (contributing to big data). Access to this data is given to third parties, who process user data through the use of algorithms, and form economical configurations that link commercial pursuits to an individual user (p. 18-19). Access to third parties is provided through the open structure of blockchain in which any transaction can be traced (Christidis & Devetsikiotis, 2016; p. 2298). Furthermore, algorithms are used to create hash values that are unique to a certain transaction or user (Casino et al, 2019; p. 70). It can be argued that higher education blockchain certificates are a platform infrastructure. Blockchain systems can potentially store much data, and become widely used platforms (Koteska et al, 2017; p. 5). The tendency with scalable platforms is that they can become near-monopolies. Examples of near-monopolies are big tech giants such as Google, Microsoft, Amazon, Apple, and Facebook.

Poell (2016) has identified three main mechanisms that are fundamental to platforms, although these mechanisms function differently in the public sector compared to the private sector. These are datafication, commodification, and selection (p. 38). Datafication refers to the aforementioned process of turning phenomena into digital data, but also includes tracing, interpreting and predicting these phenomena as data (p. 39). Secondly, commodification is the process in which digital data is commercialized and thus changed into tradeable goods and products.

One notable example of this is Facebook selling user data to commercial parties (BBC, 2018). Thirdly, platforms make use of selection mechanisms through which trust in platforms can be organized (p. 76). An important reason for including these selection mechanisms is the prediction that platforms will replace traditional supervision from the government on the long term.

3.3 Digitalization and public values

The main three public values, namely quality, efficiency, and accessibility, were discussed in the first chapter. These are not just public values relevant in higher education, but the national government has an interest in guaranteeing these values in digitalization as well. In the 'Agenda Digital Government', titled *NL DIGIbeter 2020,* which is the Dutch national governmental agenda for digitalization, the governance of digitalization is combined with ethical issues concerning innovation, public values, and fundamental rights. Digitalization is not just considered as a mere technical matter or a private enterprise, but it is combined with societal issues to lead to the best outcome.

The second chapter of the Agenda Digital Government specifically deals with the protection of fundamental rights and public values in digitalization. However, accessibility, identified as one of the three main public values before, is dealt with in a separate chapter. In the case of digitalization, the government has already developed several instruments that help policy makers in guiding digitalization in an ethically responsible way, such as the *Ethisch Verantwoord Innoveren* toolbox (NL DIGIbeter, 2020; p. 44), which gives specific advice to policy makers on each of seven core principles or public values. It seems that the approach taken by the national government is mostly focused on accessibility, inclusivity, privacy, safety, and democracy. The fact that efficiency is mostly ignored could be a signal of an implicit assumption that digitalization is leading to higher efficiency. Efficiency of platforms is seen as a consequence of innovation in the organization of human transport, as it leads to a more efficient use of (digital) infrastructure (Poell, 2016; p. 81-82). Furthermore, digital applications can make learning and organizing of higher education more efficient, for example through platforms such as learning management systems, albeit that a certain part of the efficiency can be credited to the revenue models of digital enterprises (Rathenau Instituut, 2019; p. 4).

It seems that accessibility is one of the more important public values in digitalization, regarding policy reports and agendas, such as *NL DIGIbeter 2020*, the *Actieplan Open Overheid 2020-2022,* and the Rathenau Institute report on digitalization ('*Waardevol digitaliseren*'). Here, accessibility specifically means that digital services provided by the national government should be accessible to all citizens, and meet inclusivity standards. The question is whether it should be considered a public good, but services within the digital government, such as the DigiD, is accessible to all citizens. That is why accessibility of public services is an important public value. Since 2018, governmental institutions are obliged by law to take measurements necessary to guarantee accessibility of the digital platforms, such as websites, that are part of the public service they provide (NL Digibeter, 2020; p. 62). This is effectuated through the *Toegankelijkheidsverklaring* (Accessibility declaration), which means governmental institutions are accountable for the accessibility of their public services. This shows active governmental policy in the organization of accessibility and a pursuit to digitalize from public values as the starting point.

The necessity of such an approach becomes clear when looking at the potential downsides of digitalization. Implementing digital technologies might be costly, and therefore only the institutions with a larger financial budget are able to implement new technologies (Rathenau Instituut, 2019; p. 5). In higher education, universities with a larger budget are able to outcompete those with smaller budgets, generating more inequality between them (p. 5). For public services, such concerns are also raised on the level of the individual citizen. Primary school education, in contrast to higher education institutions, is a public good, as every child in the Netherlands has access to it. In primary schools,

personalized education actually supports students who have already a certain level of knowledge better than those who do not (p. 5). Since public services are public goods, no one can be a priori excluded from them. Even though digital public services might be equally accessible, there is still a basic level of capability required to actually have access. In simple terms, someone who does not know how to use the internet can have 'equal access' to a digitalized public service, e.g. in health care, education, or public transport, but is not able to make use of the service because he lacks the capability to do so. This type of accessibility is defined by Amartya Sen as 'basic capability equality' (Sen, 1979), and this concept is relevant in regard to digitalization, since organizing and guaranteeing accessibility to digital public services might not decrease inequality between citizens when they do not have the necessary basic capabilities to use the digital public service.

In regard to the public value of quality, an increase in social inequality, caused by digitalization, can lead to a decrease in quality of education (Rathenau Instituut, 2019; p. 5). One of the reasons why digitalization can lead to a lower quality of education, is that digital applications are not executed properly. While digitalization offers more possibilities for personalized education, there is still a basic capability required from the user, which is the student in higher education. If this capability is absent or present to a lesser degree than average, not only is inequality between students increasing, but it would be difficult to deliver education in the same degree as previously. Students who are not able to use digital infrastructure correctly, or students who are for some reason not resonating with this new type of education, are less able to study and complete their study programs. Here it does not matter whether quality is strictly defined as successfully preparing students for a professional life, or loosely defined. Quality of education is decreasing regardless of which definition.

This effect of digitalization is not limited to students only. If lecturers and teachers are not sufficiently prepared for a particular transition, they cannot be expected to deliver the same quality of education as in a non- or less digitalized environment (Rathenau Instituut, 2020; p. 3). Moreover, there are a couple of related issues to a poor execution of digitalization that decrease quality of education. According to the Rathenau Institute, 'learning on distance' has created issues for the workload of lecturers, organizing and overviewing exams, and social interaction (p. 3). A decreased capability of students is problematic, but equally harmful is decreased capability of lecturers, as the workload is increasing and there is less interaction with students in online lectures. Furthermore, concerns about home exams are also expressed. It is impossible to have a supervisor that monitors the students for cheating and other practices when exams are made from home, using proctor software has been suggested as a solution to this problem. An ethical controversy sparked with the introduction of proctor software, it being said to be an intrusion on privacy and has even been described as a kind of "spyware that we just legitimize" (Lawson, 2020). Besides it being relatively easy to circumvent such software by using multiple digital devices. If digitalization causes quality of education to decrease, the consequences is universities being unable to hold up to quality criteria and standards and lowering them, which is an undesirable outcome. It leads to Dutch degrees devaluating compared to foreign degrees. Therefore, poorly executing digitalization in higher education can become a real danger to quality education.

4. Blockchain in Higher Education

4.1 Blockchain technology

Blockchain is a relatively new technology, which was introduced for the first time through the cryptocurrency known as Bitcoin back in 2008. With the breakthrough of cryptocurrencies such as Bitcoin and Ethereum, the technology became more prominent and found its way to other domains. What started as a technology for one specific application, is now considered to be integrated in systems of both public organizations and private enterprises. This has led to an inevitable consideration of integrating blockchain technology in the realm of higher education. Without going too much into detail about how blockchain works, this section gives a brief explanation. Blockchain, or distributive ledger technology, exists of a network of nodes (Christidis and Devetsikiotis, 2016; p. 2293). Any user can join a particular blockchain network and receives a key, that exists of a numerical hash value, which is a unique, encrypted number. After completing a transaction, the transaction is ordered and put "into a timestamped candidate block" (p. 2293), and this block is consequently verified and becomes a part of the chain. This process forms the basis of all other blockchain applications.

Since the rise of blockchain in 2008, three stages of development can be identified (Alammary et al, 2019; p. 1). The first stage is specifically related to cryptocurrencies, where blockchain introduced several changes to existing non-crypto currencies. The second stage is centered around the introduction of smart contracts into blockchain, which have allowed for procedural changes through the storing of scripts in the blockchain (Christidis and Devetsikiotis, 2016; p. 2296), which further strengthened the benefits of blockchain-based cryptocurrencies in contrast to regular currencies. The current stage is marked by solving the issue of scalability, which is a significant problem. As more transactions happen the blocks get larger and transactions get slower. Scalability is a big challenge, and is one of the most mentioned challenges that blockchain developers are currently facing (Alammary et al, 2019 p. 7)

4.2 Blockchain and higher education

There are various ways in which blockchain technology can be integrated in existing systems within higher education. Grech and Camilleri (2017) have developed eight different scenarios for implementing blockchain in higher education. The focus is specifically on the second scenario, which is the scenario about "using blockchains to verify multi-step accreditation" (p. 95). However, it is interesting to briefly mention the seven other scenarios that are developed. These are a blockchain-based public certificate system (p. 95), a blockchain system for automatic credit transfer for ECTS (p. 96), the idea of a blockchain-based lifelong learning passport in which a user is able to build his own course portfolio (p. 97), a blockchain system to guarantee the integrity of intellectual property which can tackle plagiarism by rewarding or sanctioning use of that property (p. 98), using blockchain-based for study payments in cryptocurrencies (p. 99), creating vouchers in a blockchain system that serve as the condition for student funding thus creating a merit-based funding system (p. 99), and a blockchain system for student identification in which students transfer personal data for an identity certification (p. 100).

This study focuses on the second scenario in which blockchain is used as a way to verify multi-step accreditation. Grech and Camilleri start by describing the current situation of accreditation in Europe. They state that there are currently many different ways in which study programmes are accredited in Europe. Besides that, the various accreditation processes across Europe are "an extremely time-consuming and technical process" (p. 96). Because there are different systems in European countries, it takes a lot of effort to find out whether the certificate was actually issued by

the university in question, whether this certificate was issued by the accreditation organization to the university, and whether the accreditation organization is authorized to accredit university programs and by whom. Moreover, the quality of a similar degree varies from country to country, which means that a degree that was obtained in a university in one country, could display different competencies than a similar degree from elsewhere. However, this is not just an international question; there are also national concerns about certificates. One recent example is the Dutch education institution NCOI, which helps adults to in retraining and tutoring. Although education programs from the NCOI are accredited by the NVAO, the Dutch-Flemish accreditation organization, it is a private organization that issues degrees that are not actual vocational or higher education degrees (Muntz et al, 2021). Although their degrees are accredited, the NVAO does not consider them equal to vocational or higher education degrees from public universities. It demonstrates the problem at hand: an employer that wants to verify the degree of an applicant goes through a lengthy process to find out what the quality of such a degree is, if it is found at all.

Blockchain certificates that are able to simplify the fundamental administrative process is therefore needed. What is interesting about the scenario as developed, is that it leaves space for the direction that is to be taken with blockchain certificates. If simplifying the administrative process across Europe is the main goal, then the socio-technical regime of a country like the Netherlands is not going to be altered that much, except for the technological infrastructure being replaced by blockchain. If, on the other hand, blockchain certificates are developed and implemented with the intention to create a unified framework of standards, European blockchain certificates is a possible alternative.

The European co-operation for Accreditation (EA) was founded for that particular reason. It is a not-for-profit association that commissioned by the European Commission to carry out Regulation 765/2008 of the European Parliament and the Council, created on July, 9th, 2008 (Official Journal of the European Union, 2008). The overarching goal of this regulation, and consequently the European co-operation for Accreditation, is to "develop and maintain a multilateral agreement of mutual recognition, the EA MLA, based on a harmonized accreditation infrastructure" (European co-operation for Accreditation, 2021). Accreditation of study programs happens through many different ways in Europe, as it is part of the domain of the national government. This has led to differences in quality measurement, not just between countries, but also between forms of education within a country. The regulation stipulates that "the lack of common rules […] has resulted in different approaches and differing systems throughout the [European] Community, with the result that the degree of rigour applied in the performance of accreditation has varied between Member States" (Official Journal of the European Union, 2008; p. 2). It shows that there is a European interest to deal with the vastly varying forms of accreditation across Europe, and they want to deal with this by "develop[ing] a comprehensive framework for accreditation" (p. 2) and by "lay[ing] down at Community Level the principles for its operation and organisation" (p. 2). Combined with the recent development of blockchain certificates, it is likely that the scenario will be subject to regulation that determines accreditation moving towards a European standard. However, and it is very important to stress this point, the regulation does not imply a European accreditation system. It clearly states that "the establishment of a uniform national accreditation body should be without prejudice to the allocation of functions within Member States" (p. 2). Hence, it does not seem that blockchain certificates necessarily become part of a European accreditation system, and the various Member States are accountable to the European Union by abiding to the "requirements and obligations" (p. 3) that are part of the regulation. From this regulation and the association that was founded accordingly, it is clear that simplifying the administrative process is not the main interest. It seems that besides the wish for reducing administrative costs, which leads to more efficiency, the desire for harmonizing the widely differing accreditation standards, is present.

4.3 Promises and expectations

The way blockchain is built and the way it operates to support cryptocurrencies has attracted a lot of attention from technology developers, political and financial institutions, and other actors. Mainly since blockchain technology offers promises and expectations that are attractive to these actors. Although there is a significant difference between blockchain generally, and blockchain certificates specifically, the changes that it generally offers are also specifically part of blockchain certificates. Generally, there are a couple of advantages of blockchain that are mentioned often. These usually include transparency, security, decentralization, reliability, trust, self-sovereignty, and immutability (Sun et al, 2018; p. 255) (Christidis and Devetsikiotis, 2016; p. 2298) (Grech and Camilleri, 2017; p. 8). Security and transparency were among the three most mentioned benefits of blockchain in higher education (Alammary et al, 2019; p. 8). It is interesting to see promises surrounding blockchain supporting public values, such as transparency, because this means that there is a direct relationship between the technology itself and public values.

Decentralization is key in blockchain technology. It relies on a decentralized peer-to-peer network, which means that there is no need for a "central node to verify and supervise transaction data" (Sun et al, 2018; p. 255). Whereas accreditation data is currently stored by third parties, these will be obsolete with blockchain, since it allows data to be directly exchanged through the system of trust. Sun et al state that this structure of blockchain "improves the efficiency of data exchange" (p. 255). Security is an important advantage of blockchain, which is extensively discussed by Li et al (2017). However, they also state that there are threats to blockchain in terms of security, usually through hacking. The major element of the security of blockchain technology is the cryptographic key, as every key has an unique encrypted hash value (p. 843), meaning that a node cannot be easily compromised. The decentralized structure of blockchain supports security, since the compromission of one node does not affect the network in its entirety, meaning that it is very difficult to damage the blockchain network from outside. Moreover, all transactions by users are anonymous and traceable (Li et al, 2017; p. 843), supporting the privacy of users. The latter is not always guaranteed, as there exist "de-anonymization approaches" by which someone can trace back the actual user behind an transaction (Casino et al, 2019; p. 71). Security and decentralization lead to another major advantage of blockchain technology, which is transparency. This transparency is an important benefit of blockchain certificates in particular, as it is easily verifiable whether a degree has been accredited or not, and what the process leading up to the accreditation looked like. Every transaction on the blockchain can be traced back.

Reliability is another advantage of blockchain technology. According to Sun et al (2018), "the blockchain database adopts distributed storage" (p. 255), which means that each node in the network "can obtain a copy of all transaction data" (p. 255). This way of storing data in the blockchain, including timestamping transactions in the blockchain, makes blockchain both transparent and reliable, besides it not being possible to modify data stored in the blockchain, rendering it immutable. In this sense, reliability is connected to transparency. The decentralized structure of blockchain, namely the absence of a third party in transaction, is also said to increase trust among users. According to Grech and Camilleri (2017), there are two principles on which online trust is based, namely 1) authentication, and 2) authorization (p. 20). Trust is improved because of "the use of decentralized public ledgers as well as cryptographic algorithms that can guarantee approved transactions cannot be altered after being validated" (p. 20). The transparency, reliability, and security of blockchain technology leads to more trust between users. Lastly, blockchain makes it possible for a user to "own and control his or her own identity online" (p. 19). Users are the owners of their personal data, instead of a third party supporting an identity database. Many of the mentioned promises and expectations of general blockchain technology support each other. For

example, reliability and transparency are connected, and trust is created by increasing transparency, reliability, and security. These are in turn the product of the decentralized structure of blockchain.

Besides these general promises and expectations of blockchain, there are also context-related promises and expectations of blockchain certificates. In the Grech and Camilleri report (2017), these specific promises and expectations are mentioned. Through implementing blockchain certificates, higher education institutions are able to verify a degree by only taking a look in the chain. This massively reduces process costs that are currently needed for "issuing certificates, verifying certificates" (Sood et al, 2020; p. 233). This promise of blockchain certificates is simplifying the administrative process. Blockchain therefore supports efficiency, albeit efficiency in the verification process. There is an implicit assumption that technology, and digitalization and blockchain more specifically, are automatically increasing efficiency of (public) organizations. If the wish for increasing efficiency is one of the driving forces behind digitalization, then the wish for the implementation of blockchain can be reasonably argued from that angle. Moreover, Grech and Camilleri mention that "a fully-automated process would then be able to visualize the accreditation chain and verify that certificates had indeed been issues, and (critically) that they were still valid for each step of the chain" (p. 96). There are also disadvantages connected to blockchain certificates. The major of these disadvantages is that human accreditors are still needed for accreditation. Blockchain cannot accredit programs by itself; it needs human actors that store accreditation data (Booij et al, 2018; p. 8). As stated, only the outcome of the accreditation process is stored in the blockchain. This is primarily a technical disadvantage nevertheless.

All in all, blockchain is rising in higher education. It offers many advantages that are attractive to actors, and blockchain certificates can simplify the verification process. However, implementing blockchain in certificate systems is not simply a change in technology used. It is unclear what motivations and interests are coming out on top and having the greatest influence on the development and implementation of blockchain certificates in the socio-technical regime. Following the general promises and expectations of blockchain, increasing efficiency is expected to be the main interest. Looking at the European regulation on accreditation gives a different impression of what blockchain certificates will be used for, namely to harmonize accreditation standards across Europe. Finding out whether a mere technological replacement is the goal or whether there are other interests fueling the development and implementation of blockchain in higher education is the topic of the next chapter. It could range from a minimal replacement of the technological infrastructure in the socio-technical regime, to a disruptive innovation changing the entire regime.

5. Case Studies

5.1 Introduction

In the first three sections, the way in which public values are currently organized, digitalization of public services, and the rise of blockchain in higher education were discussed. In this chapter, five case studies are selected and empirically analyzed. These consist of initiatives that are developed with the goal of digitalizing credentials. They are particularly selected on the basis of significance (they should be serious alternatives to current certificates), availability of records (research documents or interviews) and relevance to Dutch higher education. In chronological order, these are 1) the Europass framework for digital credentials, 2) the EUSL, EUBBC, and Concordia H2020 initiatives for joint study programs, 3) the BadgeCollect Open Badges, 4) the EduCTX digital credit platform, and 5) the Blockcerts project for issuing, viewing, verifying and validating certificates. In order to find empirical data about these initiatives, three interviews were conducted, and policy documents, reports, and websites were analyzed. The focus is the operation of the system, the major actors and motivations behind the system, and the main promises and expectations. In order to structure the case studies, two different methods are used. These are the Actor-Network Theory (ANT), and the Multi-Level Perspective (MLP). The ANT and MLP methods are used to bring major actors, both human and non-human, and the socio-technical system into picture. These are supported by ANT, by mapping out the pre- and post-innovation network, and MLP, by explaining the current socio-technical regime and how landscape developments influence both actor interests and the technological niche of blockchain certificates. The two methods will also be used in the next chapter, where three scenarios are developed based on the findings and the methods.

5.2 Methodology

The first method that is used is the Actor-Network Theory (ANT). This method has been developed by sociologists Michel Callon, John Law, and Bruno Latour. It is a framework that takes both human and non-human actants into account and does not separate them, which the theorists behind this framework call “generalized symmetry” (Kamp, 2018; p. 780). This distinction that ANT has compared to other frameworks is important to the specific context of this study, namely organizing public values in an era of blockchain certificates. On the one hand, ANT does not regard technology as merely instrumental, which means agency is allocated to both human and non-human actants. A purely instrumental view implies that all consequences of the technology in question are the result of human interests. On the other hand, the deterministic view of technology as forcing the human actors into new patterns of behavior is also not mainly held. Instead, ANT regards that “both humans and non-humans form associations, linking with other actors to form networks” (Sismondo, 2010; p. 81). This aspect of ANT fits well with the Multi-Level Perspective, which also integrates non-human actors, such as technologies, in the socio-technical regime. If technology is either instrumentalist or deterministic, then either blockchain certificates are subjected to human interests, or human actors are subjected to the structure and operation of blockchain certificates. It can be argued that it moves in both directions, and therefore taking into account the interplay between human and non-human actors is necessary. By applying ANT, nuance is present by interests of human actants influencing the way blockchain will be integrated in certificate systems, without assigning a mere instrumental role to it. In the case of this research, ANT is selected because it removes the separation between human and non-human actors. This allows us to look at human actors, technologies and frameworks moving into new socio-technical configurations.

The second method is the Multi-Level Perspective. This method is used to structure our vision on the embedding of technological niche in the socio-technical regime. In MLP, the socio-

technical system consists of three levels. Firstly, Geels (2004) identifies the 'socio-technical regime' as the core part of the socio-technical system (p. 910). This regime consists of a "semi-coherent set of rules that orient and coordinate the activities of the social groups that reproduce the various elements of socio-technical regimes" (Geels, 2011; p. 27). Geels has also labeled this regime as the "deep structure" (p. 27) that keeps the current socio-technical system stable. The stability of the regime means that there is an interplay between actors and the regime rules. The socio-technical regime exists in terms of "science, technology, politics, markets, user preferences and cultural meanings" (p. 27). In the context of organizing public values in the blockchain certificates-era, there are basically two regimes that can be focused on: 1) the accreditation regime, and 2) the organization of public values, although different regimes "also interpenetrate and co-evolve with each other" (p. 27), meaning that while emphasizing the distinction between the two is important, they are still subject to similar movements. Both the current accreditation regime of the Netherlands and the organization of public values were discussed in this research.

Below the socio-technical regime is what Geels calls 'niches', which are defined as "protected spaces […] or small market niches where users have special demands and are willing to support emerging innovations" (p. 27). In contrast to the socio-technical regime, rules in a technological niche "are less articulated and clear-cut" (Geels, 2004; p. 912). This is basically the area where radical deviations to the current socio-technical regime arise. Arguably, certificate systems based on blockchain technology belong to the technological niche, as they are an innovation that has not been embedded in the socio-technical regime yet. Moreover, there is the upper level defined as the socio-technical landscape (Geels, 2011; p. 28), which is, within the current socio-technical system, the "wider exogenous environment" (Geels, 2004; p. 913). The main feature that separates landscape developments from rules ingrained in the socio-technical regime and technological niches, is that actors cannot directly influence them.

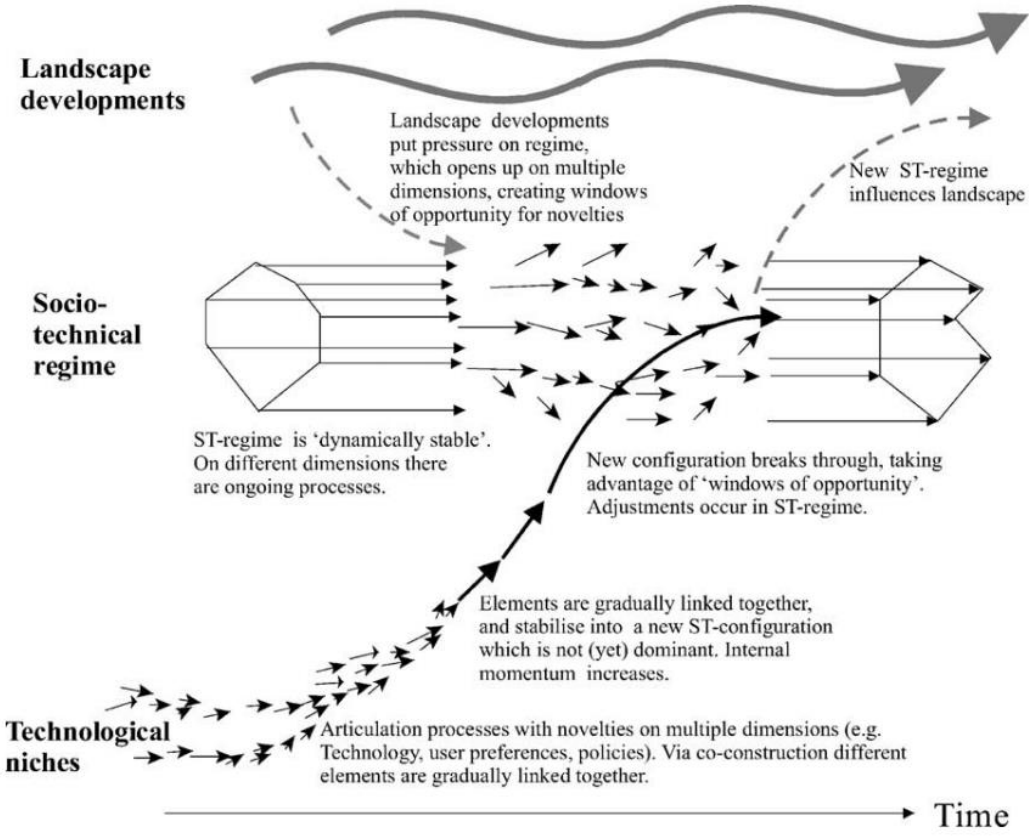

Figure 1. An overview of the socio-technical system in the multi-level perspective (Geels, 2004; p. 915)

According to Geels (2011), Figure 1 represents an overview of the ideal workings of the socio-technical system. To cite Geels on the basic operation of the socio-technical system through the multi-level perspective approach: "the general dynamic pattern is characterized by transitions resulting from the interaction between processes at different levels: (a) niche-innovations build up internal momentum, (b) changes at the landscape level create pressure on the regime, and (c) destabilization of the regime creates windows of opportunity for niche-innovations" (p. 29). In the case of this research, this means trying to identify the landscape developments that put pressure on the socio-technical regime, and therefore create opportunities for blockchain certificates to become embedded. In the next section, the five case studies are discussed and analyzed. The interviews that were held are semi-structured, according to eight topics that were important to discover (see Appendix 9.1, p. 43).

5.3 Findings

5.3.1 Case Study 1: Europass

The Europass is a framework for digitally-signed credentials, that is developed in order to digitalize existing and future credentials for citizens within the European Union. This framework is developed to facilitate mutual recognition of the value of degrees between European Union Member States, universities, and employers. The Europass framework can be placed in a long-term movement towards both digitalization and harmonization of certificate standards. Especially noteworthy in this regard is that the European Union, through EU Decision 2018/646, has stipulated that "Europass shall support authentication services for any digital documents or representations of information on skills and qualifications" (Official Journal of the European Union, 2018). The Europass framework that is discussed in this section is actually known as Europass2. The first Europass framework was implemented in 2004 in order "to achieve better transparency of qualifications and competences" (1). However, a new Europass framework was necessary in order to deal with the challenges surrounding digitalization. This framework was implemented in 2018 and became known as Europass2, but for simplicity it will be referred to as Europass. According to the European Commission report from 2018, there are four main goals for developing this framework, which are 1) to integrate digital certificates into the current regime, 2) to create a certification system that correctly expresses the benefits of blockchain, such as security and transparency, 3) to create "a common understanding of qualifications and types of certifications" (European Commission, 2018; p. 2) between European Union Member States, and 4) to further support the development of 'lifelong learning' by creating a system that also recognizes achievements outside higher education. The third and fourth goal of the Europass framework imply transforming higher education in two ways: 1) simplification of the validation process of degrees between universities on an international scale, and 2) the replacement of degrees attached to one study program or one university by a system of lifelong learning which includes "formal, informal, and/or non-formal learning process[es]" p. 3).

On the website of Europass (europa.eu/europass), learners can create their own Europass profile, which they can use for education or profession. They can add their certificates to their profile, which is useful when considering an educational program or job within the European Union. The Europass framework supports the Europass profile by digitalizing credentials of learners through the blockchain system. In this way, the learners can prove their skills, competencies and certificates without them having a paper certificate of those things. According to the report, the Europass framework will fully line up with the European Classification of Skills, Competences, Qualifications and Occupations (ESCO) and the European Qualifications Framework for Lifelong Learning (EFQ) (p.

2). Both of these are already established EU-level classifications and credit systems, and the reason for aligning the Europass framework with these two classifications is so that “qualifications, competences and skills can be easily identified and understood by any EU Member States” (p. 4), which is one of the goals of Europass. Furthermore, it is built on an open standard, since they “facilitate interoperability and data exchange, while fostering a cooperative approach to maintain and further develop them, and contributing to its adoption” (p. 10). The framework is embedded in an existing network that includes a wide variety of actors, such as the European Union, its Member States, students, universities, faculty members, and others, and pre-existing frameworks such as the ESCO and EFQ, but also the Digital Education Action Plan. It is therefore likely that Europass, embedded in pre-existing frameworks, will be the main framework in which digitalization of credentials will happen within the European Union.

Considering the driving forces behind Europass, much is revealed in the Europass report, where it states that the European Commission is considered the vanguard of introducing digital certificates, with the European Union Member States being responsible for creating the right circumstances for its implementation (p. 5). Although these actors are considered to have a supportive role, it essentially is an approach in which the principle of subsidiarity is central. This principle fits well with the promise of decentralization that blockchain produces. It shows a clear intend by the European Union to regulate blockchain certificates by guiding the development in the niche to integrate it in the socio-technical regime. The European interests are fueled by two landscape developments, which are digitalization and Europeanization. As the report states, the Europass framework was adopted “considering the growing needs of a digital society and the challenges faced to reach out to all potential users” (p. 1). Europeanization is expressed in two manners. Firstly, the wish to reach a common understanding of certificates means creating a standard in which qualifications are viewed through a European framework, thus ‘Europeanizing’ the validation process. Secondly, the principles of the framework are aligned with general European Union principles, such as the aforementioned principle of subsidiarity, and proportionality and interoperability, but also public values such as accessibility (p. 8). It is not stated in the report whether Europass seeks to replace the accreditation system. Instead, it seems that it aims at harmonization of accreditation criteria. Moreover, considerations of financial and political consequences are not dealt with, which implies that blockchain certificates are not widely implemented yet, meaning that it is still a niche technology.

5.3.2 Case Study 2: EUSL, EUBBC, and Concordia H2020

The second case study consists of the EUSL, EUBBC, and Concordia H2020 initiatives. These are grouped together, because these are initiatives from the University of Twente, and they share similar characteristics in the way they are organized. Firstly, EUSL (Europe Sri Lanka Capacity Building in Energy Circular Economy) is a joint project between universities in the European Union and in Sri Lanka for an integrated collaboration to create a student-centered joint Master program in the energy transition sector with specific tracks per university (EUSL-Energy, 2021). EUBBC (Europe Brazil Cuba Capacity Building) is has the same goal, but between universities in the European Union and those in Cuba and Brazil (Grant Holders Meeting CBHE, 2021). Thirdly, the Concordia H2020 project is an EU-funded project on cybersecurity in which blockchain programs for open badges, credentials and Master certificates are developed. For this case study, an interview was held with Robert Marinescu-Muster, who is a researcher at the University of Twente and task leader of EUSL-Energy, and Sjoerd de Vries, who is an assistant professor at the University of Twente, and work package leader of EUSL-Energy.

The main target groups are identified on the website of EUSL. These include teachers, who "further enhance their international profile" through EUSL (EUSL Energy, 2021), students, who collaborate with students at foreign universities and have access to broader materials, faculty members, whose digital skills are expected to be enhanced, engineers that are involved in the collaboration and others (EUSL Energy, 2021). It offers benefits for Sri Lanka specifically, such as introducing a "student-centered and challenge-based education" system, which is co-built by universities from the European Union (EUSL Energy, 2021). In EUBBC the same actors are targeted for participation in the initiative. In the Concordia H2020 project, the main stakeholder groups were the National Cybersecurity Competence Centers and Agencies Stakeholders Groups (NSG), the Observer Stakeholders Group (OSG), and the Liaisons Stakeholders Group (LSG) (Concordia H2020, 2021). The NSG consists of the current national cybersecurity agencies that are expected to increase coordination and awareness across the EU. The OSG consist of accreditation organizations, while the LSG exists to make institutions such as the ENISA, EDA, Europol and ECB participate.

One of the researchers, Robert Marinescu-Muster, sees these initiatives of blockchain certificates moving towards a consensus-based consortium of universities that are responsible for validating degrees and setting the criteria for joining the consortium and degree validation (Marinescu-Muster, 2021). The main example of such a consortium can be seen in the Concordia H2020 initiative. The University of Twente, together with more than fifteen universities and organizations in several European countries and Israel, is a member of this consortium. In the Concordia H2020 initiative, learning resources will become publicly available, which arguably is a form of open education, relating to lifelong learning. In the case of lifelong learning, students manage their own learning portfolios that includes formal, informal and non-formal education (Grech & Camilleri, 2017; p. 98). In this consortium, all universities that participate get a chair. The members of the consortium are consequently able to set up the rules for joining the consortium and quality standards for certificate validation. This approach would make use of trust in the consortium by distributing it across the network, since only universities participate that qualify through the established criteria. Being part of the consortium means that a university is 1) accredited and 2) has qualified for the consortium. A major difference compared to the socio-technical regime of accreditation is that, instead of the NVAO accrediting a study program, they are accrediting universities. The national government currently uses accreditation to organize public values in higher education, which would change as a result of the consortium. This shift in actor roles transfers more power to the consortium of universities from the national government and the NVAO, the task of the latter being to accredit universities only. As Sjoerd de Vries noted, when blockchain certification systems become embedded, mediators such as the NVAO can become obsolete, which makes blockchain certificates a disruptive innovation (De Vries, 2021). The consortium develops its own criteria for validation, which changes the role of the national government from accrediting study programs to only accrediting the institutions, relying on the trust that exists between the consortium members.

Regarding the trajectory of this consensus-based consortium, Robert Marinescu-Muster stated that the national or supranational government will only step in once the technological niche has gained momentum. At that point, the government will try to regulate blockchain certificates, and likely lead the innovation process resulting in one blockchain system with a new actor-network (Marinescu-Muster, 2021). Such a trajectory can already be witnessed in the case of the Europass framework, where the European Union has stepped in to build the framework for the integration of blockchain certificates in the socio-technical regime. Although the European Union is involved as a financier in Concordia H2020, and the EUSL/EUBBC are also EU-funded projects, real governmental intervention is not found. Instead, universities can apply for participation through being admitted by the consortium, in which the government is currently not involved. It appears that the EUSL, EUBBC and Concordia H2020 initiatives do expect the government to step in at some time, but for the

moment this is not the case. It was also not clear how they are going to make the government change their accreditation procedures whilst not being involved.

5.3.3 Case Study 3: BadgeCollect

The third case study is the BadgeCollect initiative. This is an initiative that is based on 'Open Badges', which are digitalized certificates through which a learner can prove competencies and knowledge. The initiative is developed by the Dutch company Coinversable. The same company was also involved in the development of Edubadges, which are Open Badges for higher education specifically. For this case study, a conversation was held with Steven Verkuil, who is the co-founder of Coinversable and who has worked on both BadgeCollect and Edubadges. Firstly, it is important to discuss the Edubadges project before the BadgeCollect project, as it provides context to the initiative. Initially, Edubadges were developed by a company called SURF, which is a Dutch company that develops ICT platforms for higher education. The network in which SURF is involved consists of more than one hundred education institutions in the Netherlands (Orr et al, 2020, p. 81). However, in order to keep Edubadges mutually intelligible on a European level, it is aligned with European frameworks such as the Europass framework and is keeping an eye on developments there. In the Edubadges project, SURF has developed a "national infrastructure that enables all Dutch higher education institutions to issue open badges to their students" (p. 81). This means that students can prove their skills and competencies by achieving badges. Students can register their eduID profile, through which they can request an Edubadges. The main advantage of Edubadges for students is that there is no dependency on paper certificates or universities store certificate data, but it is accessible without those parties. This makes it easy to prove to an employer that a student has the right certificates. In the first pilot, sixteen Dutch higher education institutions used the Edubadges infrastructure in order to become familiar with digitalized credentials, while using the infrastructure for different purposes as well (p. 84). This infrastructure consists of open source software, making use of the *Badgr* technology for open source blockchain (p. 89). The pilot went relatively successful, as "several of the participating institutions viewed the pilot as a prelude to issuing badges for units of accredited education (i.e. micro-credentials) in the longer term" (p. 83).

In the conversation with Steven Verkuil, the BadgeCollect initiative was argued to be a solution to the mismatch that exists between business and education. Whereas Edubadges were specifically focused on higher education, BadgeCollect is focused on vocational education and businesses as well, leaving higher education to SURF (Verkuil, 2021). In principle, BadgeCollect offers similar benefits as Edubadges, but it applies to informal and non-formal learning. Whereas Edubadges are mainly about formal certificates, BadgeCollect offers recording skills and competencies that are valuable in professional life. In the case of vocational education, BadgeCollect produces certificates that prove specific skills that have been achieved through practice, whereas current certificates only prove the student has completed a study program. BadgeCollect is built on the Validana blockchain, which is a blockchain platform specifically developed for micro-credentials, or digitalized credentials. It operates on an open standard, which means that many different systems can become compatible when they make use of the open standard. BadgeCollect has also added several features to the Validana blockchain. One significant feature is the 'certificate' feature. This feature especially makes BadgeCollect more similar to the current higher education system than Edubadges. Through a smart contract in the BadgeCollect blockchain, a student receives a certificate when all necessary badges are received. This feature makes it possible for study programs and their courses to be digitalized directly. In this respect it also offers perspective for higher education.

One important finding from the conversation was that a mere technological replacement, in this case replacing current certificates with blockchain, is not considered to be realistic. In fact, only

when the blockchain system is introduced as part of a wider educational innovation is when it can succeed (Verkuil, 2021). For example, if the educational innovation is creating a type of education, or an alteration to education, which closes the gap between business and education, blockchain can become a supportive actant. Although BadgeCollect offers a simplification of the administrative process as well, the main goal is not improving efficiency, but supplying companies with a demand for better verifiable skills and competencies and mastery of those skills.

5.3.4 Case Study 4: EduCTX

The fourth case study is an initiative called EduCTX, which is a global higher education credit platform developed by researchers from the Blockchain Lab of the University of Maribor in Slovenia. EduCTX is a decentralized credit platform for higher education, based on blockchain technology (Turkanović et al, 2018; p. 5113). Besides EduCTX, the Blockchain Lab is also involved in the Concordia H2020 project that was discussed in the second case study. The platform is first launched at the University of Maribor. In the EduCTX system, a student gets rewarded with ECTX tokens when the student has completed a course at an accredited university. These tokens resemble the same value as the ECTS credits for European students (p. 5516). The responsibility for distributing tokens to the ECTX blockchain wallet of students who completed a course lies with the higher education institution. These higher education institutions need to be accredited to join the network. As it states that only accredited higher education institutions can join, it assumes that the task of the national government is to accredit an institution instead of a study program or course. It is not stated, however, whether guaranteeing quality of education lies with the network of higher education institutions or the national government. In fact, it could very well be the case that accrediting study programs will still be within the domain of the NVAO, but this has not been specified. EduCTX also consists of a consortium-based network, because a higher education institution can join the EduCTX network by being "voted into the delegate network by other trustworthy HEIs [higher education institutions]" (p. 5123). The platform "will be based on DPoS consensus protocol" (p. 5116), meaning that it is a consensus-based blockchain, similar to a consortium. The higher education institutions that are part of the network can register themselves as a potential delegate and will be voted in or out by the community of institutions. The institution with the most votes "will confirm transactions and seal blocks" (p. 5116).

The verification of course completion is done by the professor, who will register it in order to make it stored. Consequently the professor will send the student the ECTX tokens that the student is entitled to (p. 5119). The transaction becomes visible in the blockchain, meaning that the EduCTX system relies on the competencies of the professor, both in regards to his assessment of a student's performance, and in terms of the being able to operate within the blockchain system. This means that the relationship between professors and students has an additional dimension. Certification is done by the professor as a representative of the university, turning the professor into an issuer, which is quite distinct from the current practice, where universities are the issuers. According to Turkanović et al (2018), the verification of a student's certificate starts with the student sending to the verifier his blockchain address, the 2-2 multi-signature address which exists for security reasons, disabling students from transferring ECTX tokens to a different address, and the redeem script (p. 5119). After validating the student has the correct amount of ECTX tokens and therefore has the necessary credentials, the student has to verify its identity. Then the certificate is verified. This is shortly how the validation process works.

The EduCTX initiative promises to simplify the validation process of certificates by using blockchain, as it provides both security that the certificate is in fact valid, and the transparency to check whether the certificate is valid. Currently, there are four universities part of the EduCTX

network that have an EduCTX node, which are the Brno University of Technology (Czech Republic), the University of Maribor (Slovenia), the FH Bielefeld University of Applied Sciences (Germany), and the Electrotechnical Faculty of the University of Sarajevo (Bosnia and Herzegovina. It is still a technological niche in which higher education institutions can join, while the (national) government is not a part of that network yet. Although the Blockchain Lab from Maribor is a member of the EU-funded Digital Europe For All (DE4A) consortium, EduCTX is not directly regulated by the government. This shows that although governmental regulation and intervention from the European Union is somewhat visible, it has used the ECTS framework as the underlying standard, instead of the Europass framework. Furthermore, the idea of lifelong learning is not explicitly mentioned in the EduCTX initiative, nor is the transitioning of higher education into open education mentioned. Although the EduCTX initiative still faces various challenges related to its technical operation (Kamišalić et al. 2019; p. 8), it offers an opportunity for universities who want to adopt blockchain for certificate management and join an established network of accredited universities and higher education institutions.

On the future prospects of the EduCTX system, the researchers are quite clear by stating that "the EduCTX initiative's intent is not to completely change and transform the current credit and grading systems established in various countries, but to facilitate it by adding transparency and automaton in order to optimize administrative processes related to the higher education system on a global scale" (p. 5124). The main reason for aiming at this scenario of co-existence is the legal framework existing in a variety of countries that makes complete transition difficult. Additionally, it allows more room for the EduCTX initiative to develop itself. Comparing it to the other case studies, it seems that the same promise as Europass and EUSL/EUBBC of simplifying the certificate validation process is made. However, in contrast to these initiatives, it is not a project funded by the European Union, and not guided within a European Union framework, but instead an initiative based on the European Credit Transfer and Accumulation System (ECTS) as the underlying framework.

5.3.5 Case Study 5: Blockcerts

The fifth case study is the Blockcerts initiative. Blockcerts is a project that was initiated by the Maltese government in 2017, in which the government intended to digitalize academic credentials through blockchain. For this purpose, the Blockcerts initiative was introduced (Allessie et al, 2019; p. 22). Blockcerts is an open standard and open source-community for "creating, issuing, viewing, and verifying certificates" (p. 24). Research of the Blockcerts project started back in 2015 at the MIT Media Lab, and while MIT is not currently involved in the development of Blockcerts, Hyland Credentials has taken up the role of main developer (Blockcerts.org, 2021). Currently, Hyland Credentials, which is an American software developer, is developing the Blockcerts initiative together with the Maltese government, who is funding the development, implementation and integration of this system. In the first stage of Blockcerts, certificate data was stored in the Bitcoin blockchain, because Bitcoin was at that moment the "most tested and reliable blockchain to date" back in 2015 (MIT Media Lab, 2016). In the second stage, the Bitcoin blockchain is partially replaced by the Merkle tree, which is more efficient in storage. In this stage, it was still built on the Bitcoin blockchain. In 2017, Blockcerts Wallet made its introduction at the Massachusetts Institute of Technology (MIT), where 111 graduates from the MIT received their certificate on a Smartphone app (Durant & Trachy, 2017). According to the news article, the outcome of the 2017 pilot was said to be satisfactory. Moreover, the introduction of Blockcerts at the MIT was partially driven by "an evolving need" for "a comprehensive record of lifelong learning" (Durant & Trachy, 2017).

In the Blockcerts system, students and alumni can demonstrate to employers that their credentials are valid. The system is expected to give more autonomy to students. They are the

owners of their credentials, and therefore able to decide who can see their credentials (p. 24). The Blockcerts system makes the third party or issuer obsolete in the validation and verification processes that happens after the issuing of a certificate (Community.Blockcerts.org, 2017). Through the verification process, the higher education institution can issue a certificate that is created with the public key of the student, signed with the student's private key and then stored in the blockchain. The student then receives the Blockcerts URL, and, in combination with the certificate, can grant access to credentials that are stored in the Blockcerts blockchain (p. 22). The verification process is benefiting from the transparency of blockchain technology, as it can be done through the Blockcerts universal verifier which is accessible to anyone who wants to verify a degree (p. 23). Blockcerts offers a simplification of the validation process and the issuing process (p. 24).

Blockcerts open standard for Maltese certificate management consists of a consortium, which takes a hybrid form (Allessie et al, 2019; p. 23). It currently consists of three higher education institutions located in Malta, and the Ministry for Education and Employment of Malta. This consortium is limited to the country of Malta only, meaning that it is a nationally-oriented consortium with a specific role for the Education ministry of Malta in the network. In the report, the driving reasons behind initiating blockchain certificates by the Maltese government are stated. One of the reasons is that the Maltese government sees in blockchain an opportunity to position itself as the "frontrunner" (p. 25) in this area. A second reason is the increased autonomy of students, as they are now able to own and distribute their own credentials. This means that the Blockcerts project promises a transfer of power from institutions to students, since blockchain technology promises to cut off the third party from the interactions, which is shown by the universities becoming the issuers and verifiers themselves. However, due to difficulties to scale the Blockcerts system to an international level (p. 25), the Blockcerts system in Malta is expected to develop within its national context and not scale up internationally. However, the report does state that, because of the open standard of Blockcerts, it is possible for other countries to create their own certificate management system on distributed ledger technology based on the initiative in Malta (p. 24). One other benefit was mentioned on the Blockcerts Community webpage, which is that for the student, credentials stored in the Blockcerts blockchain are permanent (community.blockcerts.org, 2017).

5.4 Reflection on the case studies

Looking at the case studies, several similarities become visible. Firstly, the initiatives share the same general characteristics of blockchain technology. This means that they roughly offer the same technical benefits. Promises such as transparency, self-sovereignty of users/learners, and the simplified administrative process and costs are among the often mentioned benefits of blockchain technology that were found back in the case studies. Secondly, the idea of lifelong learning was expressed in all of the case studies, although the way in which it is expressed differs. This ranges from thinking about enabling open education by digitalizing learning resources to receiving open badges for completing course, workshops, study programs and achieving skills. Lifelong learning is not just an idea, but it is an educational innovation in the case studies. In one way or another, a wider innovation in higher education behind the initiatives is the main reason for implementing blockchain. While the technical benefits might provide some interest for embedding blockchain in the regime, a one-on-one technical replacement does not seem to be the goal of the initiatives discussed. This is the third similarity that was found. They do not just aim at a technological replacement. Technological replacement is not even the main goal of these initiatives.

There seems to be a type of educational innovation that is fundamental in the initiatives. It would be unlikely that there is an initiative in which blockchain is implemented without the fundamental innovation in education. Hence, blockchain should be regarded as a byproduct of a type

of educational innovation. This finding fits quite well with the Multi-Level Perspective, as windows of opportunity are created when landscape developments put pressure on the socio-technical regime. Thus, blockchain certificates, as a technological niche, are embedded once another innovation or development has created a window of opportunity. Fourthly, many of the systems are based on an open standard. This supports the interoperability and compatibility of different systems, and opens up the possibility for adopting the same system in case one of the initiatives becomes successful. The major similarity is the driving force behind blockchain, which is a wider innovation that integrates blockchain.

Moreover, there seem to be two particular differences between the case studies that are important. The first main difference is the driving forces behind each initiative. The similarity was that the initiatives all shared an educational innovation that is driving the development and implementation of blockchain. However, the type of educational innovation is different. Even though the concept of lifelong learning is shared among the initiatives, the concrete idea of lifelong learning differs. In the Europass framework, the main actor is the European Union, and blockchain certificates are considered to be supporting lifelong learning. They aim to regulate the niche technology, both for technical benefits of blockchain technology, and because of actor interests such as the mutual recognition of qualifications across universities in the European Union. The latter is expressed in Regulation 765/2008 of the European Parliament and the Council, which calls for the development of a "multilateral agreement of mutual recognition, the EA MLA, based on a harmonized accreditation infrastructure" (European co-operation for Accreditation, 2021). In the BadgeCollect initiative, blockchain certificates as open badges are considered to be a solution to the mismatch between business and education, with a focus on certifying non-formal or informal learning processes. Although both can be considered to be lifelong learning, it is not defined the same.

Secondly, the level of governmental involvement varies between the case studies. The Europass framework and the Blockcerts initiative were respectively initiated by the European Union and the national government of Malta. At this stage, EduCTX and the initiatives from the second case study are focused on a network between universities with neither the national or European government being involved. The main difference is that Europass is a European framework for building consortia between universities, Blockcerts a national framework, while the EUSL, EUBBC, Concordia H2020, EduCTX, and BadgeCollect initiatives do not have a governmental framework in which the network is built. This means that there are roughly three types of governmental involvement, namely supranational, national, and non-governmental. Alternatively, this is regarded as a difference in the type of consortium that defines the network. This difference might be crucial when considering the organization of public values. Since the public values of quality, efficiency and accessibility are organized through the principal-agent relationship between the national government and the universities, excluding the principal from the consortium that validates degrees might lead to a greater information asymmetry. The consortium takes a certain level of authority over the accreditation process in their own hands.

6. Scenarios

In this chapter, the theoretical framework together with the findings from the case studies is assessed in order to answer the question: *"How will blockchain certificates change the socio-technical regime, and thereby affect the governmental organization of public values?"* In order to do so, three scenarios are developed based on the main difference between the case studies in terms of governance of public values. The first question that is answered is which relations in the Actor-Network are changing in each of the three scenarios? For each scenario a graphical overview of the current Actor-Network is given, together with an explanation of why relationships between actants have changed as a consequence of the scenario. In the Actor-Network, relationships between actants are marked with a red line, while relationships that have changed as a consequence of the scenario or through the introduction of new actants are marked in yellow. The relationship between national governments and higher education institutions is marked in blue. The second question is which landscape developments are dominant and which actors would make use of the windows of opportunity in the socio-technical regime? While landscape developments can explain actor behavior and the technology development, the interests of actors are important since they explain the other part of the puzzle. Thirdly, after the changes to the Actor-Network are identified, and the Multi-Level Perspective is applied to each of the scenarios, the research question can be answered for each of the scenarios, which is *"How will blockchain certificates change the socio-technical regime, and thereby affect the governmental organization of public values?"*

6.1 Scenarios

6.1.1 Scenario 0: the current socio-technical regime

Based on the theoretical framework and the findings from the case studies, the following Actor-Network is developed. This actor-network consists of the current socio-technical regime and the actors involved there. The relationship between the national government and higher education institutions is regulated through the legal framework, with the NVAO being the governmentally authorized organization that deals with accreditation of higher education institutions. The higher education institutions, in particular the public universities, are financed by the national government, and they are responsible for their own results. Students have a relationship with the higher education institutions where they study, the national government that they are financed by, and the employer that they will apply to after graduating. In the current certificate verification process, the employer needs to contact the higher education institution, since they hold the certificates in their database. On a European level, there is the European Union, of which the national government of the Netherlands is a member of, and the European co-operation for Accreditation, which is one of the organizations that is set up by the 2008 Regulation to harmonize accreditation standards, thus it having a relationship with the NVAO. Blockchain certificates are not a part of the Actor-Network yet, meaning that a new socio-technical configuration between this new actant and present actants are not present. Furthermore, main two landscape developments, namely Europeanization and digitalization, might have created windows of opportunity for actors to connect themselves to blockchain certificates in the niche, but this has not happened yet.

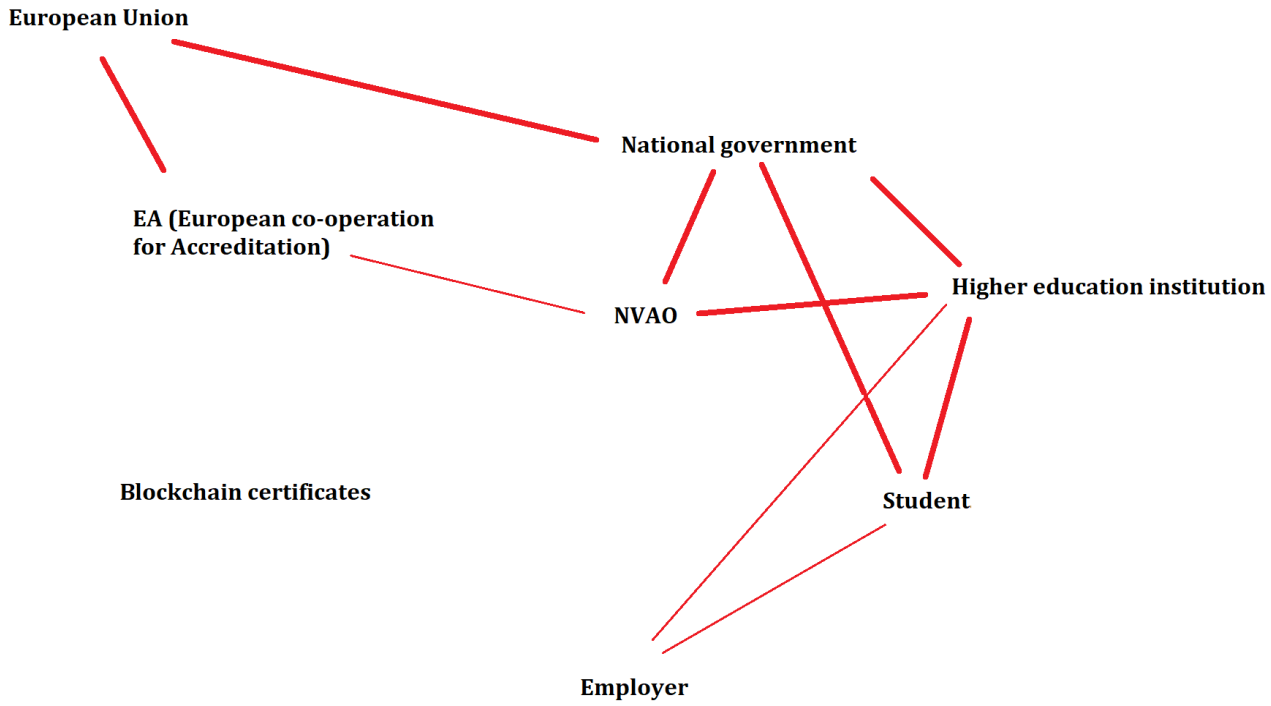

Figure 2. The Actor-Network in the current socio-technical regime

6.1.2 Scenario 1: European Consortium

In the first scenario, the European Union has stepped in to regulate blockchain certificates. This is exemplified in the case study of the Europass framework. In this scenario, the European Union has introduced a new framework, in which rules are established for the embedding of blockchain certificates. The landscape developments of digitalization and Europeanization have created windows of opportunity that are taken advantage of by the European Union. On the one hand, the demand for more digitalized services creates a window for blockchain certificates which is now introduced as an actant in the Actor-Network, while Europeanization creates a window for a European approach on the other. By linking multiple European frameworks, such as the ESCO and EFQ together, a new European framework is created for blockchain certificates. The European Union could be driven by its desire to harmonize accreditation standards, but, as it was found in the case studies, a type of educational innovation could also be playing a role, such as supporting lifelong learning. In this scenario, blockchain certificates are linked to both harmonization of accreditation standards and a movement towards lifelong learning, since non-formal and informal learning processes are also included. While the European Union sets up the framework, this does not necessarily mean that it will create one unified European consensus-based consortium of universities. If this was the case, then hundreds of educational institutions across Europe would be part of a consensus-based consortium, which is practically very inefficient. There are roughly two alternatives: either universities and technology developers themselves can create consortia that make use of the new blockchain infrastructure, or the European Union creates one consortia which would be more like a peer-community. The accreditation authority itself would still be with the national government, with the validation of study programs and degrees being performed by the consortium.

In the Actor-Network, several relationships have changed. Blockchain certificates are introduced and embedded in the socio-technical regime. Students can directly verify their certificates to employers, which means that employers do not need to consult higher education institutions. The relationship between the NVAO and higher education institutions has changed, as the former will

only accredit institutions and not study programs. That piece of '*kwaliteitszorg'* (quality care) is now in the domain of the consortium of higher education institutions. Blockchain certificates are configured with the European co-operation for Accreditation, which is the organization that deals with creating harmonized infrastructure for accreditation. Students and higher education institutions become involved with blockchain certificates as respectively the learners and the issuers. Furthermore, the Europass framework aligns with the ESCO and EFQ frameworks, meaning that these become part of the Actor-Network as well.

In organizing public values in higher education, the accreditation process is particularly important. Since a part of this process is delegated to the consortium of universities, regardless of it being consensus-based or a peer-community, with it becoming responsible validating degrees, the national government would lose some of its power in accreditation. Moreover, the European framework makes it very likely that harmonized accreditation infrastructure will be embedded in the socio-technical regime, meaning that the national government would be required to uphold the standards for quality, but also for efficiency and accessibility, that are formed through this European framework. This means that the role of the NVAO would move towards a delegate organization from the European co-operation for Accreditation, and the national government a delegate from the European Union that accredits institutions only.

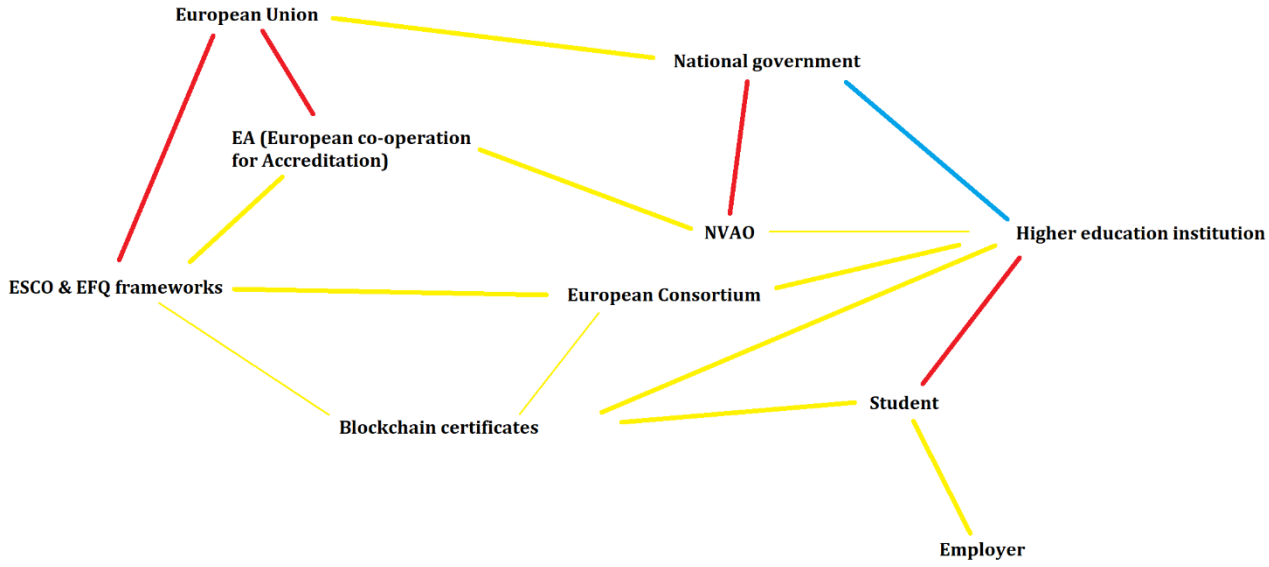

Figure 3. The Actor-Network in the first scenario: European Consortium

The relationship in the Actor-Network figure that is marked in blue is the important relationship considering the organization of public values. A consortium within a European framework is taking a part of the accreditation process from national governments. As stated before, the new division of responsibilities means that national governments accredit a higher education institution, and higher education institutions, now organized in a consortium, are co-responsible for validating degrees. Therefore, a part of the 'kwaliteitszorg' (quality assurance) has been shifted from national governments to universities. As accreditation is an important tool that the national government has to organize and guarantee public values in higher education, its ability to safeguard public values will decrease. The question then is whether the blockchain certificates will support public values or not? In the Europass framework, quality of education, efficiency, and accessibility were all discussed. Firstly, the EFQ and ESCO frameworks and the European co-operation for Accreditation exist to harmonize accreditation standards. This already implies that quality of education is measured

sufficiently, otherwise harmonization would be based on unknown standards of quality. In the conceptual model, standards for quality were named as one of the "four main components" of the framework (European Commission, 2018; p. i), although referring usually to standards for the operation of blockchain certificates and not quality of higher education in general. Efficiency and accessibility are explicitly named as principles of the Europass framework, with the former being supported by the technical benefits of blockchain, such as simplifying the administrative process. This simplification can be argued to be fitting with the conception of efficiency as cutting administrative inefficiencies. Accessibility is explicitly mentioned, as the Europass framework should be "accessible to all individuals […] regardless of their level of digital skills" (p. 8). This aligns pretty well with the idea of 'basic capability equality' by Amartya Sen. In conclusion, the second scenario of a consortium within a European framework will lead to a weakened role of national governments in organizing public values in higher education, while blockchain certificates itself is said to support the main public values, albeit not according to the exact same definition of those values.

6.1.3 Scenario 2: National Consortium

In the second scenario, national governments initiate a blockchain certificates initiative, or participate in an existing initiative. This scenario is exemplified in the case study of Blockcerts, in which national governments have initiated digital credential infrastructure. In this scenario, national governments, in the Blockcerts case study through the Ministry of Education, are a member of the consensus-based consortium, together with the accredited higher education institutions that exist within the country. From a Multi-Level Perspective framework, this scenario is guided by interests from national governments, such as wanting to become a 'forerunner' in the area of blockchain in higher education by the Maltese government in the Blockcerts case study. Europeanization and digitalization both create windows of opportunity, but it are national governments that make use of this window and connects itself to the niche technology. Actor interests from national governments are determining the course of blockchain certificates, which is a sign of co-evolution. In this sense, the actor interest of national governments in the socio-technical regime is prevailing over the European interest of creating a blockchain framework that applies to all Member States, and through which European-level interests can be expressed. Therefore, there is a destabilization of the socio-technical regime, and national governments step in to take the lead in the development of blockchain certificates. The niche-innovation that rises through the windows of opportunity caused by the destabilization of the regime are embedded by national governments. Here, educational innovation is linked to blockchain certificates, as it is the case with the first scenario, it only being moved into a national framework. The Actor-Network is also changed in this scenario. The embedding of blockchain certificates in the socio-technical regime results in students being able to verify their own degrees to an employer, removing the direct relationship between higher education institutions and employers. In contrast to the first scenario, here the European Union and the EA would not be involved, leaving their relationships unchanged. National governments, through the NVAO, accredit study programs from higher education institutions, as they are members of the consortium. Even if this task delegated to the consortium, national governments would still be part of that consortium, thus leaving the quality assurance within the domain of the national government. Looking at the organization of public values, not much would change as a consequence of the nationally-led consortium. Thus, the existing national governance structure stays in place.

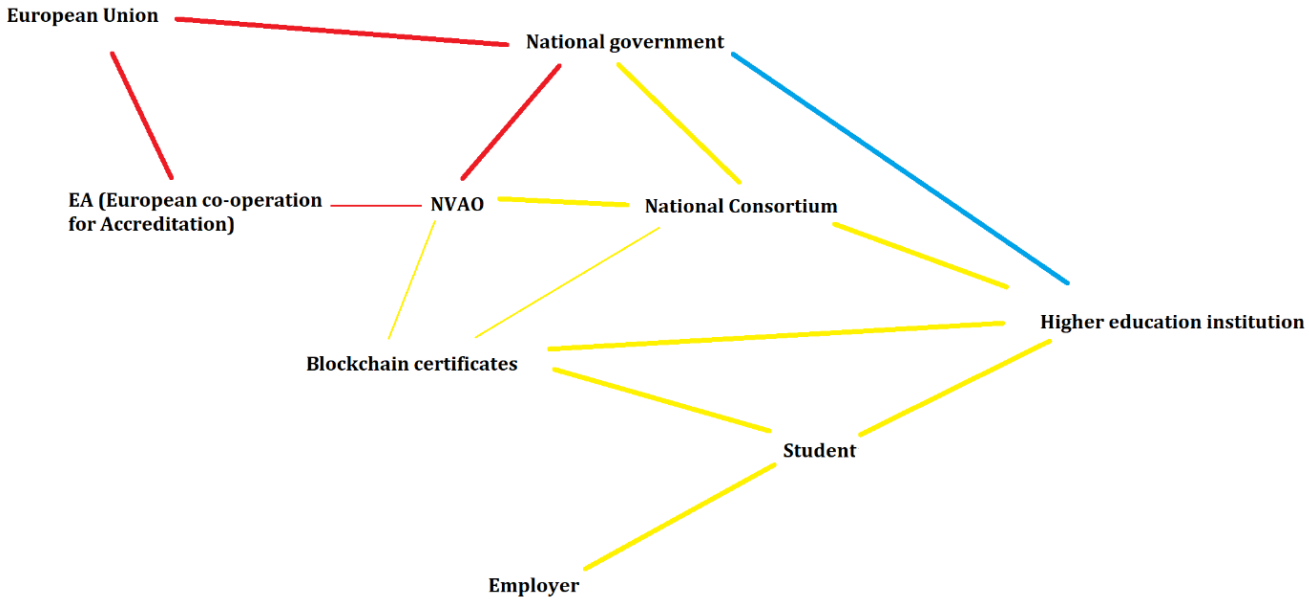

Figure 4. The Actor-Network in the second scenario: National Consortium

While blockchain certificates are promising to grant more self-sovereignty to students, as the Blockcerts initiative has done, the accreditation process is still within the domain of the national governments. Therefore, universities in the consortium are not expected to take the validation of degrees away, which would lead to a diminishing role of national governments in organizing public values. On the contrary, national governments will set up the consortium, lead the initiative of blockchain certificates, and keep the 'kwaliteitszorg' (quality assurance) as its own responsibility Considering the three public values, the blockchain system(s) itself promise certain benefits. According to the Allessie et al report (2019), the Blockcerts initiative promises "efficiency gains" (52). Accessibility and quality of education are not mentioned in the report. The main cost and benefit analysis is focused on the operation of the system itself, thus certificate management, which does not necessarily improve the quality of education that is determining the value of a certificate. Only accessibility can be thought of as a benefit of the Blockcerts initiative, as learners can now access their own certificate data and demonstrate their qualifications to employers. Although it is not particularly similar to accessibility in higher education. In conclusion, the second scenario of a national consortium that guides blockchain certificates does not lead to significant changes in terms of the organization of public values. The accreditation and validation process remains within the domain of the national government, and besides efficiency, the two public values of accessibility and quality of education are not significantly influenced.

6.1.4 Scenario 3: Non-governmental Consortium

In the third scenario, blockchain certificates are embedded by other actors than national governments or the European Union. It starts as a niche technology, but gradually moves out of the niche when universities decide to join the consensus-based consortium. This scenario is exemplified through the EUSL, EUBBC, and Concordia H2020 initiatives, the EduCTX case study, and BadgeCollect. In these case studies, universities can join the consortium if they qualify according to set rules, whereas neither the European Union nor the national government is involved in the consortium. This scenario is arguably the most disruptive one considering the role of the national government in higher education, as the consortium of universities wants to validate degrees from members of the consortium. Such is the case with the EUSL initiative where a joint Master degree is created, and

EduCTX, where transactions are confirmed by the delegate university that is voted by the other members of the consortium. Digitalization and Europeanization create windows of opportunity that are used by other actors in the socio-technical regime, such as universities and technology companies. Consequently, blockchain certificates are embedded in the socio-technical regime without governmental involvement. Co-evolution is present as universities adopt the digital credential infrastructure, partially for their own interests, while blockchain certificates simultaneously change the infrastructure of the universities. Although the initiatives that account for this scenario are not initially meant to replace the current certificate infrastructure, the question is how these two systems will co-exist when creating a consensus-based consortium presumes that part of the quality assurance should be delegated to that very consortium. As the government does not step in, other actors are bringing blockchain certificates from the niche into the regime.

In this scenario, the student-employer relationship changes because students are able to verify their credentials to the employer by themselves. Higher education institutions become the issuer of certificates, while students use blockchain certificates to register their credentials. The higher education institutions form a consensus-based consortium that is independent from both national and European governments. When the consortium takes up quality assurance by validating the degrees from universities within the consortium, then the governments have two problems at hand. Firstly, if the consortium is international, then the quality assurance will be organized through an international quality standard, which is not necessarily provided through a European framework. Secondly, it assumes that the role of the national government is to accredit institutions. However, since national governments are not involved in the consortium, it is unknown how the consortium would arrange quality assurance with national governments.

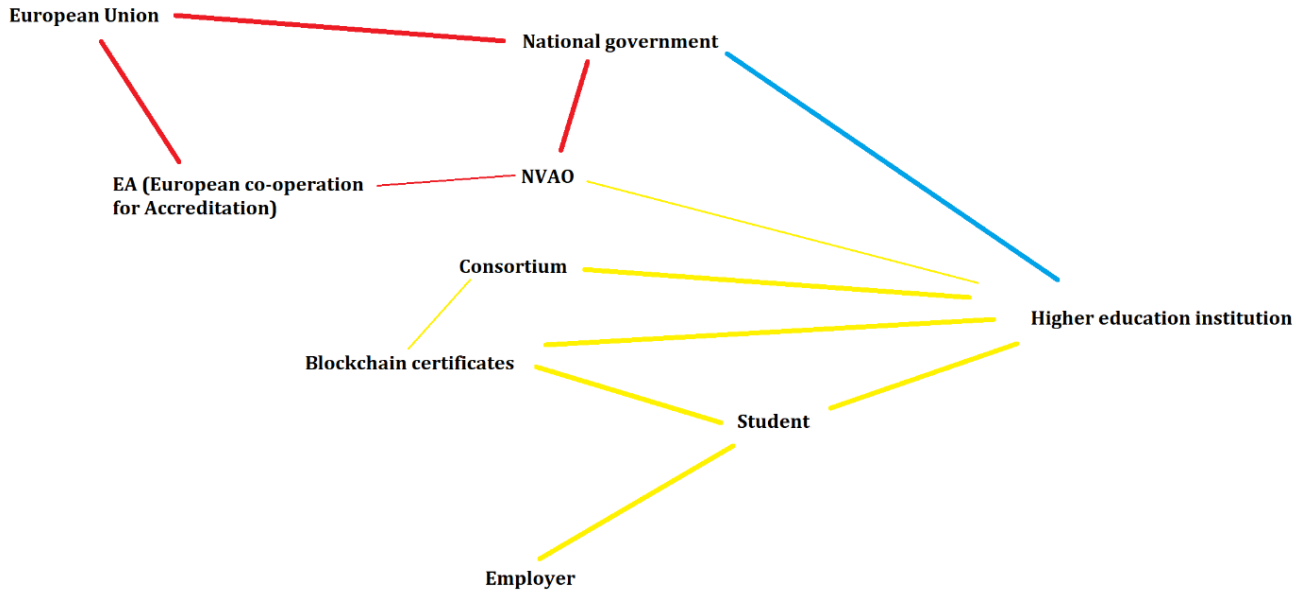

Figure 5. The Actor-Network in the third scenario: non-governmental Consortium

A consortium that involves higher education institutions, but neither national governments nor the European Union, results in a different organization of public values. The effect that blockchain certificates organized through a non-governmental consortium has on the organization of public values would be similar to a consortium in a European framework, because part of the national governments task for quality assurance is delegated to the consortium. The main difference however is that there is no governmental authority involved to with specific tasks are assigned. Instead, it is

assumed that the universities in the consortium take up the role of quality assurance through validation of certificates. In the BadgeCollect initiative, this role remained with the national government, albeit that there is no consortium of universities in that case study. Blockchain certificates are arguable a disruptive innovation of which visions on the future delegation of roles for quality assurance are uncertain. While it is unlikely that national governments would never intervene or participate, the exception being the technological niche ceasing to exist, there is at least a complementary system existing in the socio-technical regime. The three public values were mentioned in the relevant initiatives. For example, EduCTX is continuously referred to as a system that is more efficient than the current system of certificate validation and management, therefore explicitly mentioning efficiency. Accessibility is also mentioned, referring to the student's or graduate's access to his or her own certificates, something which is improved through this initiative (Turkanović et al, 2018; p. 5113). In the EUSL initiative, efficiency and accessibility were also explicitly named on the programs objectives (EUSLEnergy.com). Again, blockchain certificates do not seem to promise higher quality of education, or better access to higher education. Only the efficiency of higher education is somewhat improved through a system that simplifies the administrative process. Quality of education is said to be improved in the BadgeCollect initiative, since students would be better prepared for a professional life, hence fitting the definition of quality that is used in higher education. In conclusion, the non-governmental consortium scenario is similar to the European framework scenario in the accreditation task of the national government being partially delegated to the consortium of higher education institutions. However, the lack of governmental involvement raises uncertainty about the future of organizing public values.

7. Conclusion

7.1 Conclusion

In this research, the question was: *"How will blockchain certificates change the socio-technical regime, and thereby affect the governmental organization of public values?".* In order to answer this question, this research started by investigating public values. In the first chapter, the three main public values in higher education were identified, namely quality of education, efficiency, and accessibility. These values were defined according to the way in which it is expressed in higher education. After the main public values were discussed, the way in which these are currently organized in Dutch higher education was analyzed. The main finding is that the national government has a significant role in organizing public values, and that accreditation is an important tool that is used for this '*kwaliteitszorg'*. In the second chapter, blockchain technology was investigated. The chapter started with a discussion of digitalization of public services, as blockchain certificates arguably is an example of digitalization of public services. It then proceeded by analyzing the rise of digital platforms, blockchain in general, various scenarios of blockchain in higher education and its main promises and expectations. In the third chapter, five case studies were conducted.

In each of these case studies, an initiative of blockchain certificates was selected and its characteristics, driving forces, promises, expectations, were analyzed and consequently compared to each other. For this purpose, documents and reports about the initiatives and individuals working on those initiatives were consulted. In the fourth chapter, the current socio-technical regime and actor-network were established with the findings from previous chapters. In the findings from the case studies, the most important element was the type of consortium that the initiatives would create. As these could vary from being created in a European, national or non-governmental framework, the governmental involvement changes depending on the scenario. In two of these scenarios that were drawn, a part of the '*kwaliteitszorg'* of accreditation is delegated to the consortium, leaving national governments with a diminished role in the organization of public values.

The principal-agent relationship would become more asymmetrical, with the agents gaining more authority and consequently more knowledge about validating degrees than national governments. This is one part of the answer to the research question. The other part comes from the findings of the case studies as well. Whereas one can think of a mere technological replacement, in most of the cases this was not the case. Instead, blockchain certificates were introduced as part of a broader educational innovation. For example, the main objectives of the EUSL is to create a joint master's degree in engineering, with a supportive role for blockchain in this initiative. In the BadgeCollect initiative, the main purpose of open badges it to solve the mismatch between business and education. Other initiatives were focused at the idea of lifelong learning, or open education, in which blockchain has a supportive role.

Hence, a one-on-one technological replacement is not likely to happen, while embedding blockchain certificates together with a wider innovation in education in the socio-technical regime is more likely to happen. This is demonstrated when regarding the effects of blockchain certificates and educational innovations on the three identified public values. In the fourth chapter, the various blockchain initiatives were not found to have a great impact on public values themselves. Even in the cases where they were said to influence, for example, accessibility, it was a different kind of accessibility, namely access to certificates. Previously it was established that accessibility refers to both secondary school and university of applied science students moving to universities. Therefore, there are different definitions of particular public values in higher education and the blockchain certificates initiatives. However, when considering the educational innovation that is surrounding the blockchain systems, there seems to be promises of strengthening the public values. Ranging from the

benefits of open education for accessibility, solving the mismatch between business and education which improves quality of education, the creation of a high quality joint degree, or generally the idea of lifelong learning.

In conclusion of this research, blockchain certificates will change the socio-technical regime, and consequently the organization of public values, if it fulfills two conditions. The first condition is that the type of consortium is the major element determining actor roles in organizing public values. Since the '*kwaliteitszorg'* is delegated to higher education institutions, the socio-technical regime and the actor-network are changed, leading to a new configuration of roles. The second condition is that blockchain certificates are part of a broader educational innovation. If this is the case, then that broader innovation, of which blockchain is one part, is likely to have a direct influence on public values itself. Blockchain certificates are attached to this broader innovation, that makes use of the windows of opportunity created. Furthermore, the suggestion is that, in order to keep a stable socio-technical configuration, a particular extent of governmental involvement would be beneficial.

7.2 Limitations

The difficulty of this research was to integrate both the empirical methodology that is performed in usual Public Administration research, while also integrating two Science and Technology Studies methods, namely the Actor-Network Theory (ANT) and the Multi-Level Perspective (MLP). This was the main challenge of this paper. Namely, the challenge of combining these two types of research is that it can lead astray from both of them. On the one hand, structuring the research by placing real-life phenomena into the Actor-Network Theory and Multi-Level Perspective frameworks might do disservice to empirical findings that do not correspond with the structures that construe the basis of these respective frameworks. On the other hand, making an ethical reflection by using these frameworks can become difficult when real-life phenomena do not correspond with the frameworks. To name one example, the transition pathways that are discussed in Geels et al (2007) might be very interesting to apply to the case studies. However, the moment it became clear from the empirical findings that governmental regulation and the type of consortium were the factors that have the most impact on governmental organization of public values in higher education, using the example of transition pathways would have led to more challenges. This is probably the greatest challenge of doing this research.

Another challenge is the way in which blockchain certificates were initially defined. When construing the theoretical framework, the general idea was that blockchain is going to be embedded in the socio-technical regime of accreditation, and, although accreditation plays a significant role in the actual findings, the initiatives that were selected for research were focused on blockchain for certification or certificate management, including issuing, validation, and verification. It was not about creating a blockchain system that, for example, the NVAO will use to accredit institutions, but instead, a blockchain system that higher education institutions and students will use for certificates. This caused quite some confusion while conducting the research and this confusion could have been avoided by more sufficient preliminary research.

7.3 Recommendations

There are a couple of recommendations for future research. Since the scope of this research was limited to one specific application of blockchain in higher education, namely blockchain certificates, the other scenarios were not analyzed. In the Grech and Camilleri report (2017), blockchain certificates was one among eight scenarios of blockchain in higher education. Other applications might not require a consortium of universities, which makes the implications of this research less applicable to those. Future research can focus on these other scenarios and explore the

consequences of those initiatives for the organization of public values. Moreover, the focus in this research was on the three most important public values, namely quality, efficiency, and accessibility. This made the analysis more detailed on the one hand, but led to overlooking other public values on the other hand. Therefore, another topic for future research is the impact of blockchain certificates on alternative public values. In terms of the findings of this study, there is still much uncertainty about the willingness of the Dutch national government to get itself involved in blockchain certificates, and to what extent they want to become the main actor in the embedding of this new technology. From the case studies it seems that this interest is present, but the exact discourse remains in the shadows. Future research can be done to better uncover the actor interests of the national government, and perhaps other actors as well. Overall, this research provides an understanding of organizing public values with blockchain certificates through set frameworks. Perhaps the use of a different framework, for example, one that does not give agency to non-human actants, might lead to different results. Although the results of this research are indicative of the future of blockchain certificates in higher education, future research can further solidify and nuance the findings of this research.

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9. Appendix

9.1 Interview topics

1. Who are behind the initiative?
2. For whom is this initiative designed?
3. How does this initiative operate?
4. Who is the owner of the platform?
5. What is expected from different organizations?
6. Which actor roles are involved in the initiative?
7. What is the current business model?
8. What is the current stage of development?