Decentralised Qualifications' Verification and Management for Learner Empowerment, Education Reengineering and Public Sector Transformation: The QualiChain Project

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Abstract—**In today's society, formal and non-formal education credentials play an important role not only for holders of such diplomas and degrees but also for human resource management processes in public and private organisations. However, the degree of digitization in the sector is lagging, as certificates are still paper based and verification processes are very time-consuming. While the first Information & Communication Technology (ICT) solutions in these domains have been developed, they are still dependant on issuing organisations and manual processes. Blockchain is one technology that can be considered for developing trustworthy solutions for digital certificates, given its native characteristics for decentralisation, visibility and verification of transactions. Additionally, the computational intelligence found in analytics and decision support can help develop added value services while gamification can help develop more personalised approaches for the stakeholders of such domains. Under this context, the present publication presents QualiChain, an European Union (EU)-funded project that aims to revolutionise the domain of public education, as well as its interfaces with the labour market, policy making and public sector administrative procedures by disrupting the way accredited educational titles and other qualifications are archived, managed, shared and verified.**

Keywords-higher education; public sector; certification; human resource management; blockchain.

I. INTRODUCTION

In an era that every single piece of information around us is digitised and being exploited via innovative technological solutions in a variety of value adding ways, education certificates are largely resisting the pull of technology, as they are still held in diverse formats in siloed databases, often involving time consuming manual processes for their verification [1]. In education, certificates confirm the achievement of certain learning outcomes and are until today mostly issued on paper or other physical formats [2]. Paper certificates have their advantages, such as being easy to store and difficult to forge due to built-in security features. However, they also create several issues, such as dependence from accrediting authorities for their issuing and verification as well as vulnerability to loss and damage [3]. Additionally, lying about education and employment credentials is a common problem, as it has become very easy to counterfeit academic diplomas and certificates, or even "buy" degrees from fake degree websites [4]. According to a survey by CareerBuilder [5], a staggering 58% of employers have caught a lie on a resume, whereas 33% of them have seen an increase in resume embellishments and fabrications. Similar findings arise from another survey by StatisticBrain [6], according to which over half of resumes and job applications contain falsifications and over three quarters are misleading. Under these circumstances, and although fraud is not limited to educational awards, trust in the educational certification system is receiving significant blows [7][8].

The aforementioned challenges create problems when education credentials are requested as a means of ratifying decisions regarding either personnel recruitment or individuals' further admission in other educational programmes. The recruitment of personnel by an

organisation is a lengthy process that comes along with combing through hundreds of candidates' résumés, weeding out the unqualified ones and narrowing down the rest into a group of potential recruits', whose qualifications and academic degrees have to be checked and validated on a case-by-case basis. These challenges do not limit to the actual task of recruiting but extend to a wider set of processes indicatively encompassing personnel allocation and re-allocation, staff mobility, and skills' development and evaluation, most of which fall under the notion of competency management.

Disruptive technologies, such as blockchain, algorithmic techniques, data analytics and semantics and innovative concepts like gamification may offer solutions to these challenges. Particularly, blockchain technology, as a decentralised, permanent, unalterable store of information can help with the archiving and trust issues, as well as provide a frictionless method for transacting with others [9] [10], whereas computational intelligence found in the technological domains of algorithmic techniques, data analytics and semantic analysis may facilitate decision making and optimise work practices and procedures. Moreover, gamification practices can help with user engagement and in developing a more user-centric solution. Under these circumstances, this publication presents QualiChain, a project targeting the creation, piloting and evaluation of a distributed platform for storing, sharing and verifying academic and employment qualifications that will focus on the assessment of the potential of the aforementioned combination of technologies for disrupting the domain of education.

Section I of this publication introduces the scope of the document and describes the challenges revolving around the verification of education certificates. Section II introduces the QualiChain concept and the high-level functionalities that it is projected to have. Section III describes the platform's architecture and introduces the pilot use cases, in which the platform will be applied. Finally, Section IV concludes the document.

II.   THE QUALICHAIN CONCEPT

QualiChain is a project that aspires to investigate and provide evidence on the transformative impact of disruptive technologies, such as blockchain, semantics, data analytics and gamification in the domain of public education, as well as the interfaces of the latter with the fields of private education, the labour market and public sector administrative procedures. The concept and focus of the project lie more specifically in the design, implementation, piloting and thorough evaluation in terms of benefits, risks and other potential implications of the QualiChain technological solution, a distributed platform targeting the storage, sharing and verification of academic and employment qualifications. At this point, attention has to be drawn to the fact that although originally inspired from the field of public education and the need to transform certificates' archiving and management, as well as to fight fraud around education awards, QualiChain concept has practically a much larger scope, as its services transcend the mere validation of

training certificates and bring forward solutions to major challenges of both public and private interest, such as those of lifelong learning, recruitment, mobility, better linking education with the labour market, etc., thereby accommodating the needs of several stakeholders (see Figure 1).
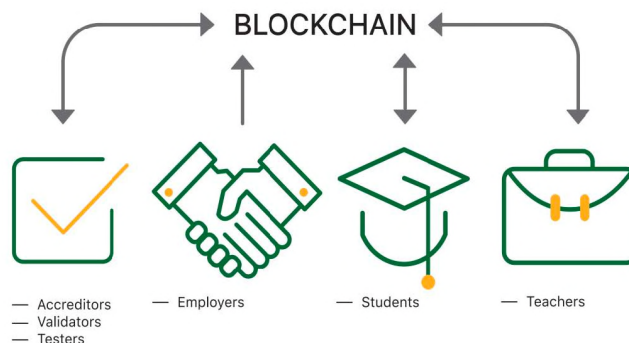

Figure 1. The value of blockchain to QualiChain stakeholders [3]

In fact, QualiChain services will be structured along two main pillars.

Figure 2. QualiChain Baseline Services

The first pillar (see Figure 2) will be grounded upon QualiChain main technological foundations, namely blockchain and semantics, enabling educational awards' and other qualifications' archiving and storing, awards' verification, the latter incorporating equivalence verification, as well as qualifications' portfolio management.

Figure 3. QualiChain Value Adding Services

The second pillar (see Figure 3) will build upon QualiChain baseline services to offer with the help of the computational intelligence, embodied in data analytics and decision support algorithms, as well as gamification techniques, a set of more advanced services, including career counselling, intelligent profiling, and competency management and within the context of the latter recruitment and evaluation support, and consulting.

III. ARCHITECTURE AND PILOT CASES

A. QualiChain High-Level Architecture

QualiChain will deliver an open source solution, comprising of stand-alone components and an integrated environment to facilitate its adoption by the different stakeholders according to their needs. To deliver the services and functionalities prescribed in the QualiChain concept in the previous section, the envisaged QualiChain platform logic layer consists of 3 main components, namely a *Validation and Verification Engine*, a *Profiling and Career Management Engine* and a *Recruitment and Competency Management Engine*, composed in turn by 11 modules (see Figure 4).

The *Validation and Verification Engine* will be responsible for registering from scratch newly awarded certificates and achievements as well as for ratifying claims around the possession of certain awards and qualifications.

Thus, it will feature an *Awards' Registration Interface* that will enable issuing and accrediting organisations to register new verified qualifications' records in blockchain's distributed ledger, as well as a *Validation Query Builder*, through which all issuing institutions, public and private organisations, as well as individual users can set up appropriate validation queries. In greater detail, the Validation and Verification Engine is made up of the following sub-components: i. an *Equivalence Verification Module* that supports the identification and verification of equivalent degrees (or even skills, achievements and training courses), issued by different institutions, ii. a *Translation Module*, capable of translating certificates from one language to another, in case a both validated and translated version of a certificate is required, and iii. a *Credentials' Auditing and Verification Module*, responsible for accommodating new awards' registrations and thus adding new blocks to the blockchain database, as well as for receiving users' queries on the validation of awards and other qualifications.

The *Profiling and Career Management Engine* will be responsible for the functionalities required for the management of individual users' digital portfolio, aka digital learning ledger where the latter can archive and access their achievements, qualifications and work experience with the purpose of showcasing them to third parties. The specific component's functionalities are made accessible through a *Portfolio Manager Interface* and are brought to life with the help of the following modules: i. a *Verification Request Module*, enabling individuals to submit to accrediting organisations requests for the confirmation and formal verification of their achievements, ii. a *Career Advisor Module*, capable of crawling world wide web resources and applying data mining techniques with the goal of identifying and bringing into the individuals' attention job vacancies that match their profile, and iii. an *Intelligent Profiling Module*, that leverages job vacancies' elicited requirements and synthesises accordingly individuals' base profile information to deliver multiple, customised versions of their curriculum vitae.

Finally, the *Recruitment and Competency Management Engine* will include functionalities for competency management at both strategic and tactical level addressed to corporate users, the latter including not only education providing institutions, but also public authorities, private companies and policy makers. The Recruitment and Competency Management Engine exposes its functionality through the *Competency Management Advisor Interface* which makes up the entry point to the following sub-components: i. a *Recruits' Profile Designer Module*, enabling recruiters to designate the criteria that candidates should meet, and thereby specify the type and level education, work experience and the rest of qualifications that they should possess as well as any other conditions and requirements they ought to fulfil, ii. a *Qualifications' Screening and Matching Module*, capable of retrieving

applicants' credentials and juxtaposing these with recruiters' criteria to sort out a subset of appropriate candidates, iii. a *Selection and Recruiting Module*, applying advanced decision support algorithms on the subset of qualified candidates, to optimise candidate selection and allocation in corporate positions, iv. a *Competency Development, Evaluation and Gap Identification Module*, responsible for keeping track of employees' qualifications records and identifying competency deficit in relation to organisations' mid and long-term horizon goals and v. an *Advanced Decision Support Module*, featuring a variety of sophisticated data analytics, i.e., data mining, statistics' calculation, pattern/ trend recognition, data visualisation and other functionalities of both descriptive and prescriptive character, to support insights acquisition and informed decision making.
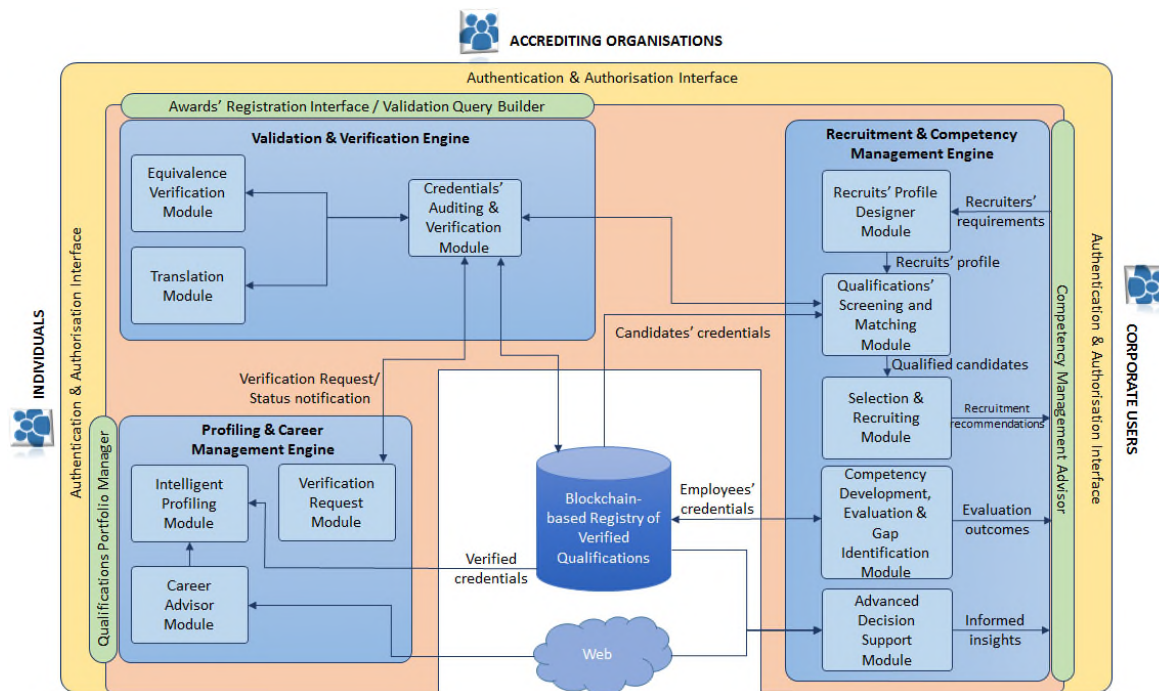

Figure 4. QualiChain Value Adding Services

From an end-user perspective and regarding the QualiChain platform presentation layer, the solution lays emphasis on intuitiveness and features beside the aforementioned management interfaces, appropriate authentication and authorisation interfaces for all targeted stakeholder groups, namely accrediting institutions, individuals and corporate users. Finally, the QualiChain data access layer envisages storage and retrieval of data from blockchain records regarding awards and qualifications, as well as from the web to the extent related statistics, job postings and other learning and career development opportunities are concerned.

B. QualiChain Pilot Use Cases

To test and validate the projected platform in its respective domains, it will be implemented in four distinct pilot use cases split between academia, private and public organisations. Specifically, the QualiChain pilots are the following:

1) Cross University Degree Equivalence Verification

Within this pilot use case, QualiChain will develop a methodology for representing the semantics of educational credentials, to support cross-institution and cross-context mapping between different forms of certifications. Existing vocabularies that describe learning goals and topics will be reused and extended to build a detailed knowledge model describing the entities relevant to educational accreditation and their relationships to each other, in the form of an ontology. This pilot will engage lifelong learners, students, job seekers and educational institutions.

2) Smart Curriculum Design and University Process Optimisation

This use case will be implemented in the School of Electrical and Computer Engineering of the NTUA. It will take advantage of QualiChain's analytics and decision support capabilities to analyse the current skill level of students, the school's curriculum and the labour market's requirements for the school's graduates to provide decision support for optimising the school's curriculum. Additionally, this pilot will leverage the blockchain ledger to verify student skills and qualifications with smart badges. This pilot will engage undergraduate and Ph.D. students of the school as well as professors and administrative bodies.

3) Staffing the Public Sector

This pilot use case lies in using the QualiChain platform and services for supporting and simplifying public sector recruitment and competency management procedures. Given that recruitment in public administration must be based on the principles of impartiality, transparency and fairness, this pilot will leverage the platform's blockchain to manage and verify the applications and other supporting documents submitted by candidates. Additionally, the recruitment and competency management services of QualiChain will be used to automate applications' checking and candidates' assessment and selection procedures, and respectively for supporting decisions related to the allocation of human resources within the public sector or employee mobility issues. This pilot will engage public administrations, recruitment firms, employees, job seekers and issuing organisations.

4) Provision of HR Consulting and Competency Management Services

This pilot will explore blockchain for easily checking and ensuring the availability of certain competencies in an individual curriculum. Also, data analytics methodologies and algorithms will be applied for the effective matching of skills, qualifications and competencies with job description requirements, not only for external selection, but also for internal mobility. Semantic technologies will be used to support corporate training and carrier management, throughout the entire individuals' job evolution. This pilot will engage public entities looking for new applicants, candidates and public workers.

IV. CONCLUSIONS

This publication presented QualiChain, a project aiming to develop a decentralised platform for storing, sharing and verifying academic and employment qualifications. Despite the fact that the project is still at an early stage, it has gathered the interest of the research community due to the innovative combination of technologies that it will leverage and the fact that it aims to create value to all stakeholders in the domains tackled. This is also reflected in the complexity of QualiChain's technical solution and the number of distinct pilot cases in which it will be implemented. The innovation potential of QualiChain is very strong, as it focuses on a domain, that of education credentials, that has largely resisted the pool of technology and where the improvement potential in the processes of certificates' archiving, management and verification, the information flow amongst stakeholders and the opportunity for offering value adding services on top of the aforementioned processes and developing new business and education models is literally huge. Disrupting any (or even more than one) of the aforementioned aspects can lead to substantial efficiency, productivity and transparency impacts, which should in turn have noticeable positive societal, economic, political and cultural effects.

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