CVerify: Construct the right match in the labour market

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Abstract**—**Economically, employment is a core constitution of the world economy as it stimulates overall growth. Therefore, questions related to employer-employee resource allocation and efficiency during recruiting can be challenging for any business. Very little is known regarding the accuracy and verifiability of employee background information. We propose a solution to increase the efficiency and accuracy during recruiting using an enterprise-based permissioned blockchain information system under the Hyperledger fabric framework. The use of permissioned blockchain enables efficient, secure data collection. The use of Chaincode allows employers to update and query the data of the distributed ledger. The use of channels allows stakeholders to have a private subnet of communication between specified stakeholders under their own strategy, regulation, and chaincode as a different channel is totally independent, which increases privacy. The use of the multi-verify configuration method could prevent fraud when maliciously inputting incorrect data. The use of Multi-Channel can increase the scalability and classify companies with different levels of requirements.

Keywords**—**Permission blockchain, labour market, Hyperledger fabric, Verification

1. Opportunity

"Population is a strong driver of the economy as well as the quality of the labour force." [1]. Ali Babacan introduced the importance of population and labour force in an economy. "Labor is prior to and independent of the capital. Capital is only the fruit of labour and could never have existed if labour had not first existed. Labour is the superior of capital and deserves much the higher consideration." [2]. Abraham Lincoln emphasized the significance of prioritizing labour. According to the data from International Labor Organization, the amount of total labour force in the world has reached 3.388 billion in 2020 [3]. The enormous number is because of the key roles that labourers act in an economy: buying and consuming goods and services and owning and selling production factors.

Digital employment platforms can contribute significantly to reducing the large information gap. Such technology can increase overall productivity by improving the allocation of labour and skills to the most suitable opportunities in the market [4]. Therefore, digital employment platforms solve the problem of data sharing between employers and employees. However, there is still an existed problem: the authenticity and credibility of the resume or experience of employees. The authenticity and credibility of employees are important as the credibility and authenticity of the experience of an employee affect his work. Assuming the number of job vacancies is fixed and employees' experience has a high level of authenticity and credibility, the problem of underemployment in an economy can be solved, reflecting a right match in the demand and supply for skilled and unskilled workers.

The following sections shall discuss the problem of the traditional way to check the credibility of an applicant, as well as offer a solution by using permission blockchain to increase the credibility and authenticity of a certain employee. Additionally, market, architecture, governance (etc.) will be discussed.

1. 1 Problem

1. 1. 1 Low efficiency of the traditional background investigation

For the companies and employers who want to hire new employees, It's difficult for them to verify applicants' historical internship experiences.

Currently, there are three ways to do a background investigation currently.

1. Self-investigation: human resources will verify the applicant's experience by directly contacting the human resource of the applicant's previous company. Most of the time, the medium of communication is phone calls and email.
2. Human resources will ask for a headhunter to investigate
3. Human resources will cooperate with a professional third-party pre-employment investigation agency and hire a professional investigation team to carry out background tracking.

Most companies depend on third-party background check companies and self-investigation. However, this approach is time-consuming and money-consuming and can't avoid humanity's weakness. So, employers need comprehensive and systematic work experience verification software for employees.

1. 1. 2 Inaccessibility for small and medium-sized enterprises (SME)

For SMEs, The number of staff headcounts is low compared with big companies, which means they do not have a human resource department. Additionally, they may lack

the fund to hire a professional third-party pre-employment investigation agency. Our flexible and modular solution can be tailored for both SMEs and big companies.

1. 1. 3 Inconvenience of applicants

Employees also want to have widely accepted and compatible supporting documents to prove that they indeed have the internship. During their work application period, they also have to submit their application multiple times by filling out different forms with the same contents, which is tedious and time-consuming.

1. 1. 4 Lack of data accuracy

out of the 30 percent of people who exaggerate on their resumes, most never get caught, according to a study conducted by Zippia, which surveyed 1,000 U.S. adults. 79 percent of respondents said they were never found out for lying. More, the 14 percent of people who were exposed said nothing happened. Only 7 percent of workers who lied said they faced negative consequences [5].

Employment platforms, which work as a bridge between companies and employees, not only aim to improve the efficiency but also the credibility of information on the platform.

1. 1. 5 Inconsistency of regional degree system

Another problem is the difference between the education degree system in mainland China and Hong Kong. For example, an associate degree is a degree in Hong Kong that is suitable for students who want to enter a career field after two years but want the option to transfer to a four-year college in a related field. However, there is no equivalent degree in mainland China, which will lead to numerous problems for the associate degree holders to pursue their career dream in the Great Bay Area.

2. Solution and Architecture

To solve the mentioned problem, CVerify cooperates with different stakeholders to use permission blockchain technology to serve as a bridge between employers, employees, and educational institutions. CVerify aims to increase the efficiency of application and construct the right match in the demand and supply of skilled and unskilled workers. The detailed solution and architecture will be discussed following.

2. 1 Data flow

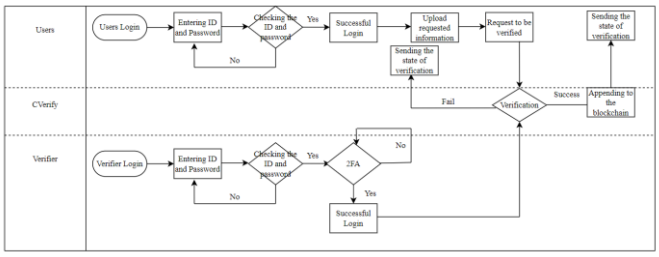

Figure 1: The data flow of CVerify

The above diagram can be mainly divided into three parts. These three rows between dashed lines indicate the user side, our CVerify system and the verifier side, respectively. For users and verifiers, logging in or registration is the first action they should take when using our system. Authentication of entering ID and password is required. If it's inconsistent with the identity that we store on the cloud, the authentication is failed, and they have to re-enter their identity. If authentication succeeds, verifiers need to proceed to the next step of 2FA (two-factor authentication). We will choose either "something they have" or "something they are", besides the password that "they know", to add one more layer of protection. If both password authentication and 2FA are passed, verifiers can access the "Verification" function, which is the core function of our system. Users can 1) request to be verified, and verifiers can verify the request. First, users request verification of their experience with providing information required by a certain company. This request will be submitted to our CVerify system and forwarded to that company. Then, the company will check the supporting documents and information and make the decision if this experience is valid or not. After the company conclude and submit the verification result to our system, we will show it to users when users query. And if the verification result is positive, we will append the experience as a new node to our blockchain and announce all members without showing the details.

2. 2 System design

We propose a solution using permission blockchain. We need to use permission blockchain because the system only allows a certain group to join in but is not open to the public. There are several mainstream modular blockchains that act as a foundation for developing blockchain-based products.

1. Private Ethereum for enterprise
2. Hyperledger
3. R3 Corda

The solution needs permission to access the blockchain system. We chose Hyperledger Fabric from the Linux Foundation. We choose Hyperledger fabric because Hyperledger Fabric allows components, such as consensus and membership services, to be plug-and-play. Its modular architecture maximizes the confidentiality, resilience, and flexibility of blockchain solutions. Additionally, Hyperledger fabric was truly open source and transparent. Another benefit of using Hyperledger fabric is that the Chaincode can be coded with the most popular programing language, such as Java node.js. Hyperledger Fabric contains the following core components: Membership Service Provider(MSP), Chaincode, Peers, Channel. We proposed the network architecture following.

2. 2. 1 Ledger

In Hyperledger Fabric, a ledger consists of a world state and a blockchain. A world state is a database that holds the current values of a set of ledger states. The world state makes it easy for a program to access the current value directly. A blockchain is a log that records all the changes that have resulted in the current world state [6].

2. 2. 2 Channel

Channel is an important concept in Hyperledger fabric as the concept of channel isn't exist in other blockchains such as Ethereum. Channel is a private "subnet" of communication between two or more specific network members [7]. Different channels could have different Chaincode and peers as they are totally independent. The use of channels could ensure the privacy of stakeholders. In CVerify's system, we will have two channels to differentiate two different main verifiers: Educational institution and employer of a company. In the future development part, Multi-Channel may be used to increase scalability and better trust between different companies.

2. 2. 3 Chaincode

A smart contract is defined within a Chaincode. Multiple smart contracts can be defined within the same Chaincode. Chaincode can be coded by several programming languages, such as Java [8]. The Chaincode is the business logic. Our system's business logic includes appending data to the ledger and querying the data in the ledger. Therefore, the function of the Chaincode in our system is to append data and query the data. Only authorized peers can execute Chaincode. Chaincode is important because it is the only way to append or read data. Chaincode belongs to a certain channel, but a channel can define multiple Chaincode. Therefore, A Chaincode also belongs to all the peers within a certain channel. Chaincode could be invoked after installation and initiation. Every Chaincode is executed in an independent docker container, increasing the peers' security. The Chaincode has its endorsement policies. For example, an endorsement policy could be defined by one peer in the channel agreeing to reach a consensus or all of the peers agreeing to reach a consensus. In Cverify's system, our business logic only needs one peer to agree to reach a consensus. To be more specific, only one company acknowledges the work experience of its historical workers, and then the network reaches a consensus. In the governance part, we introduced how we build better trust between different companies.

2. 2. 4 Membership Service Providers

Membership Service Providers defined the channel and the peers [9]. Its certificate is issued by Certificate Authority (CA). Every peers and orderer have their own MSP certificate. Only peers with the same MSP can communicate and find each other.

2. 2. 5 Peers and Ordering Service

Peers are the place or position of the ledger or blockchain. In other words, the ledger or blockchain is stored in Peers [10]. Peers can be on a different channel. In CVerify's system, some peers may be in a different channel. For example, The Chinese University of Hong Kong, one of the educational institutions in Hong Kong, not only educates university students but also recruits summer researchers. Therefore, some peers can also be in both channels due to the business logic. The concept of peers and channels could enhance the flexibility and scalability of the system. Ordering Service function to order the service and create the block [11].

2. 2. 6 Certificate Authority

The Certificate Authority provides a number of certificate services to users of blockchain. Fabric CA can produce different certificates for different users. Users can define their own attributes, such as account number or ID. CA can define the authority of different users. For example, the administrator can install Chaincode. Normal users can only invoke the Chaincode. By using the certificate authority, every operation corresponds to a participator, which means that we can know the participator behind the operation. Notably, we can define a certification system to manage users as Fabric CA is pluggable.

2. 2. 7 Network Architecture

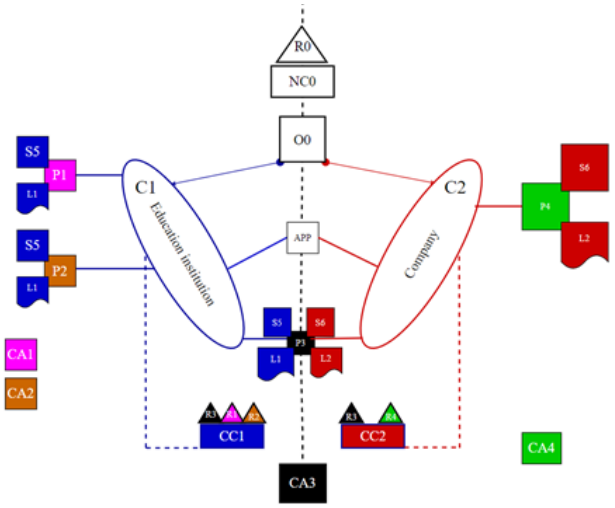

Figure 2: The Network Architecture of CVerify

In Figure 2, the R0, CVerify, owns the network configuration NC0, which gives the administrative rights to CVerisy. The Ordering service, O0, is configured according to a network configuration NC0. In reality, there will be more than one orderer. The figure was shown only **for description.** In our business logic, we have two channels. The first channel is created for educational institutions, and the second one is created for the employer of a certain company. These two separate channels are independent, which means that the channel's information can not be read by another channel. The users of the channel can not write data into the channel as the channel configuration contains its own users. Channel configuration CC1 contains R3, R4, and R2, three educational institutions. C1 and C2 store the information of students and employees separately. Channel configuration CC2 contains R3 and R4, which is the company. The organization could be in a different channel. R3 is a university that manages not only the information of students but also manages the workers or professors in the university. In other words, R3 both work as the verifier of students and employees. Each organization has its own peers and ledger. S5 and S6 are Chaincode. In our business logic, S5 and S6 could be appending information or reading information into the blockchain. The CA defines the right of each peer or organization.

3. Market

3. 1 Potential User: The potential users of the system included:

1. Employees: Employees who want to apply for jobs would like to show their evidence that they were verified, as being verified could increase their competitiveness when finding jobs.

2. University Students: University students who want to apply for a university degree would like to show their verified evidence, as being verified could help them apply for university more easily.

3. Employer: Employers act as the verifier of the system and will verify a period of internship, part-time, or full-time of an employee. Employers could see that the applicant was already verified if the applicant would like to provide the unique identifier of a period of work experience.

4. Educational institution:
Educational institutions, which act as the verifier of the system, will verify the period of studying of a student. The educational institutions could also see that the applicant was already verified if the applicant would like to provide the unique identifier of a period of the learning experience.

3. 2 Potential Revenue:

l. Government oriented: We will work as a bridge for some national organizations, such as the Hong Kong Council for Accreditation of Academic and Vocational Qualifications. These national organizations need to pay for verification after their applicant provides a unique identifier. We will also charge a certain amount of money monthly or quarterly.

2. Users and platform-oriented: We want to cooperate with the employment platform and charge the users of the employment platform. For example, JobsDB users want to show the evidence of verification on their "profile" page. They need to pay money for the employment platform, and the employment platform will export their job experience to our system, and our system will guide users to request to be verified by historical employers. Our system will not ask users to pay because users have already paid in the interface of the employment platform. The revenue of the employment platform would also be part of our's revenue. The alternative included a charge employment platform by subscriptions method. We will charge a certain amount of money monthly or quarterly.

3. Headhunter-oriented: A headhunter is a company or individual that provides employment recruiting services on behalf of the employer. Headhunters verify and contact potential and adequate individuals who meet their specific job requirements. If headhunters want to verify a potential employee, headhunters also need to pay for verification after the employees provide the unique identifier. We will also charge a certain amount of money monthly or quarterly.

4. Advertisement: Advertisement could be one of our potential revenue as companies may promote jobs vacancy on our platform.

5. Talent mapping: We may extend our business to provide CV commendation in the future. (please refer to 9. 5. 1 CV recommendation service)

3. 3 Potential Cost

The potential cost includes the set-up fee of the blockchain system and the cost of cooperating with the company and educational institutions.

3. 4 Market Data

This section shows the statics information about employment in Hong Kong and the Greater Bay Area. We also list the number of users of several famous employment platforms.

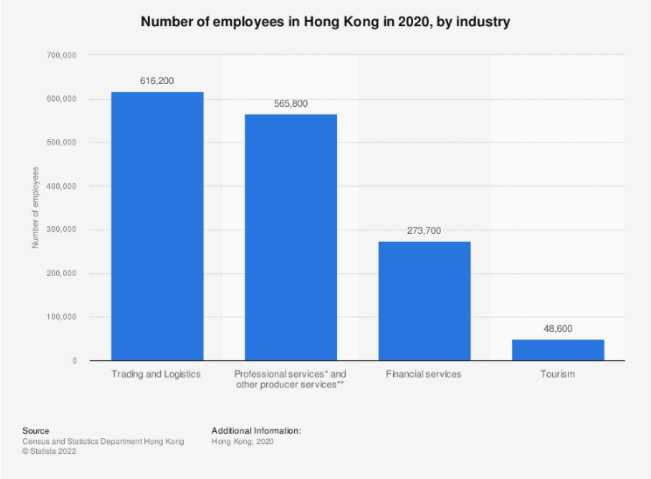

Figure 3: Number of employees in Hong Kong in 2020, by industry [12].

According to the data from The Government of the Hong Kong Special Administrative Region, four key industries in Hong Kong, trading and logistics, professional services, financial services, and Tourism, the number of employees respectively, 616200, 565800, 273700, 48600. A total of 1504200 people contribute 55.1 percent of GDP in Hong Kong.

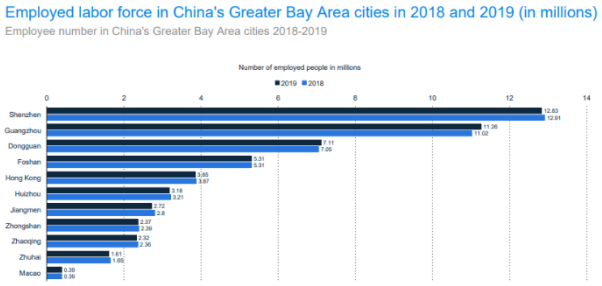

Figure 4: Employed labour force in China's Greater Bay Area cities in 2018 and 2019 [13].

In the Greater Bay area, there are millions of employed people. The highest number of employed people is in Shenzhen. Employees contribute to the economy as they are not the producers of the given resource. They are also the consumers of a certain region. By using our system, solving the trust problem between employers and employees could bring an appropriate resources allocation in the labour market, which could increase the output in Greater Bay Area.

Therefore, attracting more potential employees working in Greater Bay Area.

JobsDB, one of the most famous employment platforms in Hong Kong, owned over 14.6 million job seekers in the jobsDB database. More than 10 million page views per day [14]. LinkedIn, an American business and employment-oriented online service platform owned 740 million members statistics in February 2021 [15]. We believed that cooperating with an employment platform could accumulate a huge amount of users and bring profit for both of us.

4. Partners

There are several partners whom we will corporate with. Their roles, responsibilities, and incentives to cooperate will be discussed separately in this part.

1. Company

Roles: We would like to cooperate with the company. To be more specific, we want to cooperate with the human resource department in the company closely.

Responsibilities: There are in charge of reviewing and acknowledging employees' work experience by clicking the button on our website after employees request to be acknowledged. After these parties agree, the work experience information will be added to the blockchain. A unique identifier will be given to employees or users of our system, which means that the employee's work experience was already verified. If employees falsify the work experience, the unique identifier will not be sent.

Incentive: The company would like to cooperate because after digitizing employees' work experience, they will not need to verify the work experience of an applicant when employees apply for jobs in their company, which increases the efficiency of recruiting employees and decreases the workload of employers. The company would like to cooperate with other companies is because of the company not only the supplier of human resources but also the demander of human resources. The company always wants excellent employees to maximize their output.

2. Educational institution

Roles: We would like to cooperate with the educational institution. To be more specific, we want to cooperate closely with the Registration Department and the University Information Technology Service Centre.

Responsibilities: They are in charge of acknowledging that the requesting students used to be studied in their school by clicking the button on our website after students request to be acknowledged. An educational institution can also append students' grades into our system if students request so. After these parties agree, student information will be added to the blockchain. A unique identifier will be given to students or users of our system, which means that students' educational experience was already verified. If students falsify the educational experience, the unique identifier will not be sent.

Incentive: The reason that educational institutions would like to cooperate is that after digitizing the student information of students, they will not need to verify the student information by contacting the former university of the applicant when students apply to their university. Therefore, by cooperating with us, the efficiency of verifying a certain applicant increases.

3. Employment platform

Roles: We would like to cooperate with the employment application or website. Such as Jobs DB and indeed.

Responsibilities: The purpose of the employment platform is to scrab the jobs information from the employer's website and list the information on the employment platform. Generally, the jobs information included the job's responsibility and preferred qualification. Employment platforms like JobsDB will list jobs information on the employment platform. Users or employees of their application will search for jobs based on their abilities. After users find the appropriate jobs they prefer, they will submit their resumes through the platform. After the submission, the employer will receive their resume. The mentioned process is how the information is transmitted between employers and potential employees. Employment platforms digitalize the process of job posting and resume submission, which helps employees match with their preferred employer. However, it is hard to verify the accuracy of the information on the resume. Therefore, we will cooperate with the employment platform to solve these issues. On the profile page of the employment platform, users can write experiences and corresponding Unique identifiers that are issued by our system. Employers could see that the experiences were already verified after the users of the employment platform submitted the application. Another way is that the users of employment platforms could pay money for the employment platform, and the employment platform will export the work experiences of the users to our system, and our systems will guide the users of the employment platform to request to be verified by historical employers.

Incentive: Cooperating with employment platforms could help employment platforms attract more users, As employees will be more competitive if their profile is verified. Therefore, the method could bring more users and profit to the employment platform.

4. Users

Roles: Users are one of our partners. Users could be potential employees or students.

Responsibilities: Our system allows users to request to be acknowledged by the university or company. Users can gain a unique identifier when employers or universities verify their experiences.

Incentive: Students and employees would like us to help them become more competitive when applying for jobs or a degree. In addition, we simplify some procedures when students apply for jobs or a degree, for example, handing in the education information to the school that students are applying for.

5. Competition

5. 1 Porter's 5 Forces model [16]

5. 1. 1 Vendor of substitutes- Medium

In the human resources market, the substitute for "CVerify" would be the companies that provide background investigation, such as iBeiDiao and YiNuoBeiDiao. Through the form of "big data + AI + professional offline services," these companies provide users with online cloud background investigation services in the Internet era. These companies provide similar service to "CVerify" while their specific areas focus on Mainland China, "CVerify" are concentrated in CV verification in the Greater Bay Area, which tightly connects Hong Kong and Macau to different cities of Guangdong Province, which may be a niche market to conduct the verification business. Therefore, considering both the disadvantages and advantages, the competitive force of "CVerify" is medium from the substitutes' perspective.

5. 1. 2 New competitors- Strong

With the fast development of blockchain technology, blockchain-based solution is becoming easier to implement in different cases. The companies in the market which have the ability to achieve blockchain implementation in CV verification can enter the market with few entry barriers. Regarding this situation, "CVerify" represents a relatively weak competitive advantage.

5. 1. 3 Existing rivals- Weak

The blockchain-based application of Curriculum Vitae is a newly established concept in the Human Resource market. There are only a few existing rivals in the market. For example, one of the rivals is called "CV Chain", which established its company in Shanghai. Our service "CVerify" will focus more on the Greater Bay Area, which means we own a certain number of the market share compared with the existing rivals. This niche market will help "CVerify" step into the market without large barriers, establishing a relatively strong competitive force.

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5. 1. 4 Supplier power- Weak

Roughly speaking, suppliers of CVerify could be companies that provide a blockchain-based solution. Since the popularity and improvement of blockchain technology lately, more and more blockchain companies have come along with strong technical support. It means that there are different choices for CVerify to choose a company as a supplier to provide the base implementation on the CV verification project. Hence, it indicates the supplier power is weak while CVerify gains a relatively high competitive force.

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5. 1. 5 Buyer power- Weak

The most important factor is the pain point. It is difficult for the employee to prove whether their education certification is official. Additionally, the employer is suffered from the accuracy of employees' CVs. Both of the factors increase employees' time cost in finding a job and increase the human resource cost in finding the right person. Therefore, employees and employers, as the buyer or the customer of CVerify, have low buyer power, so CVerify has a relatively strong competitive advantage.

6. Risks

6. 1 Stolen files (upload process)

If the customer uploads the historical working experience and information proof files to the server, in this process, it is very likely that hackers can intrude into a certain server to steal the original file or even tamper with the original file. To prevent this, it may be a good idea to adopt the multi-level hash digital identification coded generation application to encode the original work.

6. 2 Inherently Insecure Services

These types of risks are the most common security threats. For instance, DDoS attacks, SQL injection attacks, and the most common brute force attacks are included. In fact, the existing mature firewall technology and server operating system security technology have been able to provide better protection against the above-mentioned attacks. Thus, a mature server firewall will be implemented as we must support our users and protect their initial artworks and our hash value database.

In our system framework, except the Client-Server firewall should be implemented, the chain is the most important part of the data, which should be strictly restricted and protected. Once it is under attack, the platform will break down at once. As a result, we proposed two Stateful Packet Inspection Firewall (SPI) between the file database/user and the chain in order to keep safe of it.

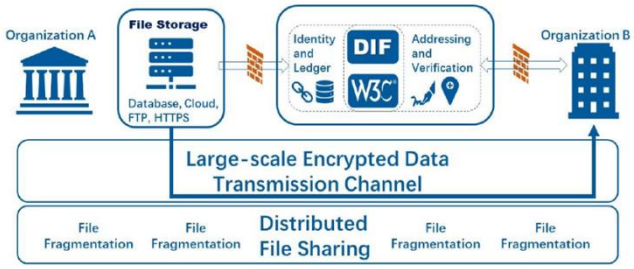

Figure 5: Two stateful packet Inspection Firewall

As the figure shows above, The information is stored in distributed file-sharing database with the implementation of encrypted data transmission channel for file-sharing operation. In the process of file data transmission to the organization, the SPI is implemented. Both the organization and user's identity will be verified and confirmed before the data transmission. Hence, as a commercial company, all we have to do is to continuously pay attention to and emphasize the issue of network security and provide sufficient manpower and financial support on this issue.

6. 3 Business continuity risk

The business processes built by blockchain technology may be vulnerable due to technology vulnerabilities such as chaincode vulnerabilities. A misconstructed chaincode can be used by hackers to perform destructive operations. Therefore, security code scanning on chaincode is necessary to remove code susceptible to hacker attacks. Thorough testing is also important to avoid misuse of the chaincode. The following process will be used to prevent the vulnerabilities of chaincode.

1. Independent code reviews

2. Penetration testing

3. Smart contract audits

4. Redundant security measures

6. 4 Incorporation with partner system

Failure to integrate with partner systems may result in a poor user experience. We hope our partners, and companies, can verify the requested work experience by invoking their employees' recording system.

6. 5 Strategic risks

Very weak existing rivals in the market right now. Most background investigation companies still do not embrace the use of blockchain technology. We can lead the adoption of the permission blockchain technology or wait to adopt unit blockchain technology to become mature. Leading the adoption of the permission blockchain technology may bring unpredictable risks.

6. 6 Operation risks

Existing policies and procedures of corporate companies will need to be updated to reflect new business processes. The new business processes may change the procedures of the employers or human resources department as they work as the verify.

6. 7 Supplier risks

It is possible that we may be exposed to third-party risks if the technology is sourced from external vendors [17].

7. Governance

7. 1 Proof in a service:

7. 1. 1 Multi-manager verification

CVerify suggests companies or educational institutions increase the number of verifiers. Its functions are to acknowledge the information of employees or students by the agreement of several verifiers.

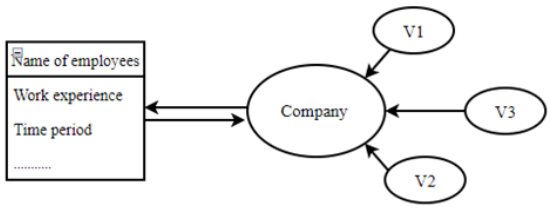

Figure 6: Multi-manager verification method

In figure 6, a company receives a request from users of CVerify. The configuration of verification of the company needs several people to verify, respectively V1, V2, and V3. Both of the three verifiers need to verify the information of employees. If only V1 acknowledges the work experience, the experience of a certain employee will not be successfully verified. The Multi-manager verification method aims to increase security if the identity of the verifier is stolen. Therefore, the method could decrease the probability of the "Garbage in Garbage out" problem.

7. 1. 2 Multi-Channel

Multi-Channel is one of the solutions of CVerify that ensure the agreement between different employers and companies. Multi-Channel is one of the future development and a new way of system design in the future. The architecture of CVerify already helps employers trust each other and reach a consensus. However, it is still vulnerable. Imagining the following assumption, Suppose person A and person B forge a company. Person B is the verifier, and person A is the requester, as the requested information of a corporation depends on the corporation's employers. Person B can help person A to falsify the insistent internship. It is important to build trust between different employers because sometimes big corporations such as HSBC may not trust the start-up or SME because different companies may have different document requirements. For example, HSBC may want employees to upload information about the internship certificate or any relation to the worked company. Start-ups may only want the information about their personal identity. To solve this problem, Multi-Channel may be used as one of the solutions. Those with a low level of requirements will be grouped in a channel. Enterprises with a high level of requirements will be assigned to another channel. Companies contained in a channel can be known to companies in another channel. In other words, companies in different channels know the requirements of different channels. The ledger of different channels is different. Additionally, nodes/companies can exist in different channels. Because of the flexibility of Hyperledger fabric, multi-channel can be easily realized. Therefore, companies can choose whether to trust other companies based on the level of requirements. The use of Multi-Channel can increase the scalability and classify companies with different requirements. Multi-Channel will be one of the future development.

7. 2 Proof as a service

7. 2. 1 Identity

Centralized identity will be used by CVerify. To increase security, Two-Factor Authentication (2FA) is necessary. Verifier's operation requires two factors of authentication, such as Duo MFA. The use of 2FA aims to prevent the stealing of identity. By using 2FA and Multi-manager verification, we believe the inputted information is accurate when the system interacts with the verifier. It's possible that biometrics authentication will be used as a form of identification in the future.

7. 2. 2 Fabric CA

The use of Fabric CA can increase the security of identity as CA supports inheritance. If one of the certificates was stolen, the superior CA could abandon the subordinate certificate. Additionally, root CA can be offshore, which means that the hackers can not steal the root level CA. Every operation corresponds with stakeholders, which was guaranteed by encryption.

7. 3 Proof in a consensus

7. 3. 1 Raft consensus

Raft is one of the consensus algorithms in Hyperledger Fabric Network, and we will use Raft as our consensus. Raft consensus can be used to organize multiple service information nodes. Although Raft is quite similar to the existing Kafka ordering service, Raft is easier to set up and less likely to go wrong compared with Kafka, as there are many components to manage with Kafka [18]. Raft can be run across large networks, which conform to our business logic. Additionally, Raft can also provide high-throughput, low latency processing capabilities.

7. 4 Technology ethics

General Data Protection Regulation (GDPR) recognizes individuals have the right to request the deletion or removal of personal data where there is no compelling reason for its continued processing [19]. However, this is at odds with blockchain architecture as the data can not be deleted. A unique identifier was used in order to increase the privacy of users. CVerify only helps connect employees with employers by recording the employees' work experience using blockchain. Individuals have the right to reveal their personal work experience to potential employers if individuals would like to provide the UID to other parties.

7. 4. 1 Ethical responsibility of the technical subject

1. CVerify respect privacy and will not invade the privacy of users.

2. Cverify guarantees fairness and impartiality in the acquisition, dissemination, and use of information.

3. CVerify abides by the principle of harmlessness. A social individual's own information behaviour does not constitute harm to others.

4. CVerify respect the principle of autonomy. Data storage, use, the right to know, and other rights should be fully granted to data producers.

(For the **use** of information, please refer to 9. 5. 2 Multi-Channel and data acquisition).

7. 5 Self-governance industry

We believe the proposal is possible as the employment industry is mature and the recruiting process is complete. Most companies will offer an interview after verifying the information of the employees. Employees will receive the offer if they pass the interview. We believe the maturity of the employment industry and the completed recruiting process govern the process of recruiting. If very unlucky employees falsify the information by colluding with the manager and benefit from the "Garbage" in the chain, a face-to-face interview is another process to testify to the ability of the applicant. Therefore, we believe a strongly regulated or self-governance industry and CVerify complement each other.

8. Value Proposition

Our mission is to develop a trustworthy verification and recruitment platform that helps companies find qualified candidates and successfully fill openings. By providing a blockchain-based talent pool, where job seekers' working experience is acknowledged and stored with fidelity and security, our platform will foster the openness, fairness, and impartiality of the talent market.

Specifically, the following three parties would benefit from our platform:

Job seekers: We expect to provide an efficient and fair job hunting environment for talents. On the one hand, we would recommend opening to job seekers according to his/her past working experience and expectation. On the other hand, with verified and blockchain stored CVs, job seekers' competitiveness in the job market would be strengthened.

Companies: We provide advertisement service to companies which would like to improve their corporate image. Advertisements would attract more talents to apply for related positions.

Education Institutions: We expect to form long-term cooperation with educational institutions. With the trustworthy talent pool as well as first-hand hiring information from companies, we would see the gap between current personnel supply and company demands and therefore help education institutions to better prepare their students for the job market.

9. Distribution

9. 1 Niche market

As a trustworthy talent pool would be the core competitiveness of our platform over other platforms, and it would be easier to establish such a database for students and fresh graduates, we would focus on distributing our platforms to students and fresh graduates in the short term. The following steps are mainly targeted at students but also for general job seekers.

9. 2 Cooperation

We would connect closely with education institutions and companies which act as the supply and demand of talents. By clearly understanding the gaps between supply and demand, we aim to establish win-win cooperation.

9. 3 Promotion Events

We would cooperate with multiple companies to hold virtual job fairs. Job seekers will be required to use our platform to upload work experience.

9. 4 Free service

We would provide free CV verification service and resume polish service to attract more customers within a certain amount of time.

9. 5 Future development

9. 5. 1 CV recommendation service

To further increase users' experience, we may come up with a CV recommendation service in the future. We may recommend CV to the company. Tell them this candidate might be a good fit. In this process, we may use the data. This service obeys the Ethical responsibility of technical subjects.

9. 5. 2 Multi-Channel and data acquisition

To further increase scalabilities and to build better trusting relationships, Multi-Channel will be one of the future development (Please refer to 7. 1. 2 Multi-Channel for more details). In this process, there will be more data acquisition based on the level of requirement of the employer's company. This solution obeys the Ethical responsibility of technical subjects.

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