

Loyalty system development based on blockchain technology

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Abstract - *The subject of this paper is a development of a loyalty system based on blockchain technology. The theoretical section of this paper will analyze different types of loyalty programs, their advantages and disadvantages as well as the current market situation. The concepts of blockchain technologies and the possibilities of applying blockchain in the implementation of loyalty programs will be explored in detail. Also, the possibilities of blockchain integration, mobile and IoT technologies for the realization of loyalty programs in smart environments will be analyzed. In the practical section of this paper, a system of partner loyalty program as a smart city service will be designed and implemented. The Hyperledger Fabric development environment will be used to implement the blockchain component of the system. The implementation will be carried out in microservice architecture. An Android mobile application will be developed for user interaction with the platform.*

Keywords - *loyalty systems, blockchain, Hyperledger Fabric, Android Studio, smart city*

I. INTRODUCTION

Loyalty systems have been one of the most common and diverse ways of marketing. Back in the 18th century merchants would give their customers copper tokens which could be exchanged for goods at a later purchase. In the modern days, they have been replaced with stickers, flyers, plastic cards and mobile applications while the principle remained the same. Research predicts that the global loyalty program market will grow from \$7.6 billion, in 2020 to \$15.5 billion in 2025, with a cumulative annual rate of 15.3%. Major growth drivers for the market include increasing adoption of omnichannel and multi-channel programs, technological advancements, and a growing need for competitive differentiation [1].

Internet of Things (IoT) is a network composed of physical objects that are able to collect and share digital data over the internet. The technology encompasses smart devices ranging from industrial machines to wearable computing sensors. According to the United Nations data from 2018, 55.3% of people worldwide live in cities and that number is expected to increase to 60% by the year 2030 [2]. Urbanization combined with constant population growth requires social, economic and environmental sustainability. Internet of things has started a technological revolution that represents the future of communication and the need for innovative technology [3].

A blockchain is a distributed database that contains all transactions made in the network. Each transaction is verified by consensus mechanism backed up by the majority of the participants and once the data is approved and stored in the distributed ledger, it cannot be tampered with. Bitcoin, the decentralized peer-to-peer digital currency, is the most

popular example of this technology [4]. Companies in various industries are considering the applicability of blockchain technology which would ensure data protection, simplify supply chain management, lower maintenance fees and increase customer retention [5].

This paper discusses the use and develops a partnered loyalty program based on blockchain technology while incorporating the principles of smart cities.

II. LITERATURE REVIEW

A. Loyalty systems

Science defines quality as satisfaction and possibly overcoming customer requirements, while loyalty is defined as the willingness of the customer to return to the company and cooperate with it, which is a consequence of a positive experience and perception of the value that the company offers. It costs a company 5 - 25 times more to gain a new customer than to keep an existing one, while existing customers spend on average 67% more than newcomers [6]. Through the years loyalty programs developed into a combination of a few core characteristics, in this paper they will be qualified into four types: point based program, tiered based, partnered based and premium based loyalty program, each bringing certain advantages and challenges.

Point based systems with each purchase give the customers a certain amount of points, usually associated with the stores' issued card. After a certain level of points have been collected users can exchange them for rewards. The coupon system is very similar, except that users are issued a coupon when making a purchase, with a guaranteed money back amount for the next store visit. Tiered system consists of several levels that a customer goes through by spending certain amount of money in a given period of time. The system focuses more on higher tiered customers without neglecting others, but makes a difference in providing better service to higher levels. Loyalty systems can be run by multiple companies which provides them with a larger base of customer habits, wider circle of users and a reduction in marketing and maintenance while enabling customers to collect diversified and unified points. Customers willing to participate in a premium based system maintain a subscription in exchange for immediately and always available benefits where companies are increasingly focused on fast product delivery.

B. Internet of Things

Internet of Things (IoT) is a paradigm that represents the connection of devices over the internet for the purpose of collecting and sharing information generated from the environment. Connecting different sensor equipped objects, digital intelligence created enables real-time communication

without the need for human intermediate. A smart device is considered to be any item that contains software and has the ability to connect to the internet. Such devices use internet protocols to store data collected through sensors in a database in real time.

By enabling easy access and interaction with a wide variety of devices, the IoT will foster the development of a number of applications that make use of the potentially enormous amount and variety of data generated by such objects to provide new services to citizens, companies and public administrations [7]. Some of the problems that come with IoT technology are data centralization, low levels of interoperability, security and privacy, device diversity and network complexity.

C. Blockchain technology

Blockchain technology provides an efficient way of recording transactions or any digital interaction in a way that makes it secure, transparent, highly resistant to outages and auditable [8].

In a narrow sense, blockchain is a chained data structure that combines blocks of data and information in a chronological order and records the blocks in encrypted form as a distributed ledger that cannot be tampered with or forged. Broadly speaking, blockchain technology uses block-type data structures to validate and store data, uses distributed node consensus algorithms to generate and update data, and encryption to ensure data transmission and to access security [6].

D. Blockchain as a solution to loyalty system problems

Even with the constant improvement of loyalty systems there are still persisting challenges in its implementation and usage. The table below shows those obstacles and how blockchain technology can be used to overcome them.

Table 1: Main problems and blockchain suggested solutions	
Problem with loyalty systems	Blockchain solution
High maintenance fees	Although blockchain requires initial investment, smart contracts and transparent transactions reduce the costs of management, intermediaries and human error. Companies that are part of a network of partner loyalty systems share this cost with each other.
Low flexibility rate, low redemption rate	By using a single electronic wallet, users can use the points of different companies in almost real time, through one platform and one cryptocurrency [9]. By doing so, blockchain centralizes customer loyalty programs, cancels time limits, and increases the flexibility and likelihood of customer returns.
Data security and privacy	One of the main advantages of blockchain technology is data security and validity. Each transaction created in the network has its own date and time, each block is approved by transparent consensus, encrypted and placed in a chain that cannot be changed as needed.
Distrust in a partnered system	Blockchain forms a distributed network of stakeholders who are familiar with the implemented smart contracts under which new blocks are added to the chain. Given that transactions and contracts are transparent, and that consensus needs to be reached, members are confident in the authenticity of gaining and using points.

Table 1: Main problems and blockchain suggested solutions

E. The benefit of blockchain incorporation in IoT

Blockchain is a complementary technology to IoT challenges as it can ensure decentralization, security and immutability amongst other. The next list shows a couple of main benefits to blockchain incorporation into IoT concepts:

1. Decentralization: depending on the chosen consensus mechanism, multiple participants of the network must deem every transaction as valid for it to be approved and put into a blockchain network. This is where the network's trust is built as there is no single centralized authority or a centralized database.
2. Data availability: each node in the network has a copy of a ledger with participant's encrypted information. The ledger gets automatically updated making the data always accessible and user's privacy protected.
3. Attack resistant: by changing information inside a block its hash also changes, unlinking it from its position in the chain. Even if the compromised block is accepted back into the blockchain on one of the nodes, every other node in the network still has an accurate ledger thus maintaining the network [8].

Blockchain solves the problem of a single point of failure that comes with a centralized system, it gives its users privacy and the whole network security and scalability.

It is important to stress that even with blockchain incorporation, this technology has other shortcomings. Blockchain in itself is still being developed to address its poor scalability performance. Decentralization brings a lot of stress on the storage needs and processing power. Given that IoT devices are usually small and numerous, both of these points represent a valid concern in technology's development and future usage.

This paper further discusses a solution of forming a partnered loyalty network based on blockchain technology. Such a platform increases flexibility, reduces maintenance

costs and ensures privacy and security, regardless of the existing structure of each individual company.

III. METHODOLOGY

A. B Loyal platform

Analyzing the current situation on the market and recognizing the shortcomings and possibilities in the current practice of loyalty systems and compatible choices of modern technology, the concept of the B Loyal platform was created. B Loyal is based on blockchain technology, serving as a loyalty program in which city municipalities, trade SMEs, individual customers and tourists interact. Customers and tourists can be eligible to collect and redeem points generated from purchases in any partnered SMEs while city municipalities have the responsibility of managing local sights, humanitarian activities and charities making them partners of the network as well.

The platform serves as an ecosystem consisted of a combination of loyalty programs: a partnered program connecting city municipalities, trade SMEs and a point system for customers and tourists. SMEs engaged in sales, regardless of the potential possession of an already built loyalty system, can access the platform and use the infrastructure to evaluate and award points to their customers. Each customer has the ability to download a mobile application that provides tracking and use of points earned at any point of sale of the network's partners. Tourists as a special group of users have the opportunity to collect points solely by visiting local sights, museums and galleries.

City municipalities are also part of the ecosystem, regulating the system and allowing users to collect points through socially useful and city significant activities.

B. B Loyal platform's business model

In the table below are stated benefits that B Loyal target groups acquire over the use of traditional loyalty systems:

Table 2: Benefits of a B Loyal platform	
<i>Parties involved</i>	<i>Benefits</i>
<i>Small and medium-sized enterprises</i>	<ul style="list-style-type: none"> no manufacturing and maintenances costs low marketing costs platform and data security high level of point utilization high flexibility high exposure to new users ease of use
<i>City municipalities</i>	<ul style="list-style-type: none"> greater coverage access to surveys tourism promotion promoting socially useful work promoting humanitarian activities accessibility to wide range of citizens
<i>Customers</i>	<ul style="list-style-type: none"> single account for all loyalty systems simple and unified collection of points high flexibility in multiple areas of trade data security and privacy digital wallets greater participation in communal work
<i>Tourists</i>	<ul style="list-style-type: none"> high flexibility in multiple areas of trade greater participation in touristic activities data security and privacy Points gain without any purchases

Table 2: Benefits of a B Loyal platform

C. B Loyal platform's business model

Figure 1 shows a summary of a canvas business model developed for B Loyal platform. Key partners, value propositions and customer segment have already been discussed in subsections above.

Key activities to attain value are to create and maintain a platform, develop interfaces for each target group, develop a two-role mobile application, a website, social media accounts, a desktop application and legal contracts binding platform's partners to their duties. Key resources can be

divided into two groups: human resources such as programmers, social media experts, lawyers and managers and other resources such as computers, licensed programs, servers and work space. The platform offers personalized assistance and automated services for the general population as a way of maintaining customer relationships. The website allows users of all target groups to find relevant information and contact local customer support agents. New partners join the network by signing legal cooperation agreements which define the rights and obligations concerning involved parties. Further channel expansion consists of applying both digital and traditional marketing tactics. The biggest cost is the development and maintenance of the platform followed by

salaries, equipment and workspace. Revenues are generated from annual subscriptions of SMEs and city municipalities. Downloading the mobile app is free as long as there is revenue-generating marketing material in it.

Figure 2 shows platform's SWOT analysts.

D. B Loyal platform's digital marketing

The main goals of digital marketing are to conduct research, bring the brand closer to the public and build long lasting relationships with the consumers. Digital marketing also aims to fill the gaps where traditional marketing tactics lag behind. This approach emphasizes the value of individualism and customer engagement in a targeted, accessible and easily sustainable manner. Digital marketing brings the ability to target a larger market, measure campaign results and target customers individually [10].

Nowadays, the presence of the company on the internet is necessary because users are increasingly turning to social networks and websites to get in touch or evaluate the brand. In order for the company to remain competitive in a modern turbulent market, it is imperative to monitor and accept

global trends.

Platform's online presence is introduced through a detailed website and main social media channels, the purpose of which being better market positioning and strengthening brand's visual identity. Some of the ways of introducing B Loyal platform to general public is through social media advertisement, referral marketing, affiliate marketing, SEO optimization as well as forms of traditional marketing that include billboards and posters in partnered SMEs and city municipalities.

Figure 1: B Loyal platform's canvas businesses model

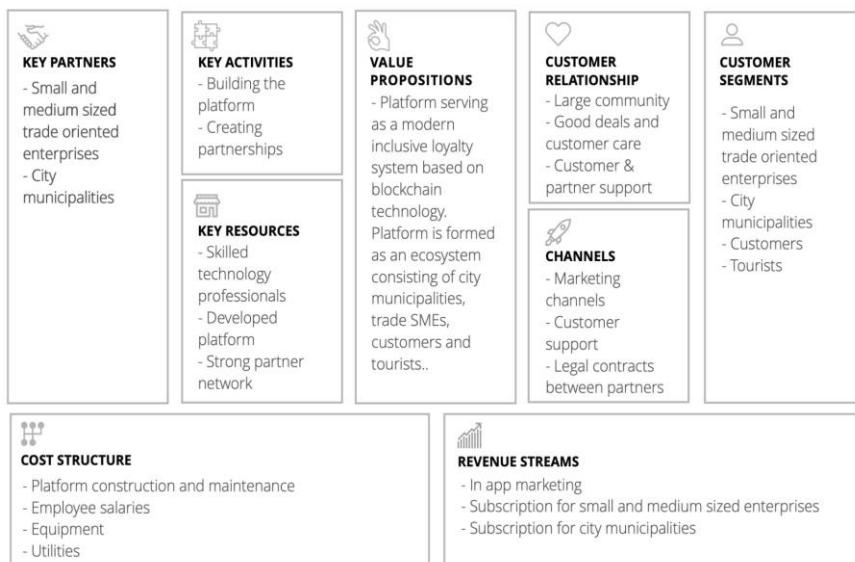


Figure 2: B Loyal platform's SWOT analysis

<p>STRENGTHS</p> <ul style="list-style-type: none"> - high level of innovation - high brand awareness - latest IT technology - high customer retention - product ready to go - exponential customer growth potential - low subscription fee - free for end users 	<p>WEAKNESSES</p> <ul style="list-style-type: none"> - possible programming delays - time needed for blockchain technology development - few initial merchants required - merchants already having a loyalty system - nonexisting pricing model - no additional personalisation for SMEs and city municipalities
<p>OPPORTUNITIES</p> <ul style="list-style-type: none"> - e-commerce business - SMEs without loyalty program more prone to participate - unsaturated market - easily expandable to other markets - expansion to services - wide market reach 	<p>THREATS</p> <ul style="list-style-type: none"> - purchasing power influenced by economy - low customer retention - legal obstacles - administrative obstacles - insufficient customer knowledge and commitment - partners not having infrastructure

E. B Loyal platform architecture

The implementation of this platform is carried out in a microservice architecture. It is built on blockchain technology using an open source Hyperledger project as application's building block, Docker for project's deployment, Android Studio for customers' mobile application and Hyperledger Fabric software development kit for connecting the mobile application with the blockchain network.

Hyperledger is an open source community founded to make available a multitude of frameworks, tools, and libraries for creating distributed blockchain applications. Out of all of the blockchain technologies that enable the development of private networks, Hyperledger is the most commonly used. It does not support cryptocurrencies, although they can be constructed, but focuses on providing infrastructure to companies for building modular blockchain

solutions in a way that suits their needs. Hyperledger Fabric is one of the Hyperledger frameworks which is used to build products, applications and solutions for business use. It is most widely used framework that forms the basis for the development of blockchain applications with a modular architecture. With its modular design, it reduces the complexity of large companies' requirements and contributes to resilience, reliability, scalability and flexibility. Fabric enables the construction of private, permitted and distributed blockchain solutions with modular components [11]. Chaincode is a business logic program in Fabric that is referred to as a smart contract in other blockchain platforms. This software runs outside the node and is called when the need to communicate with the general ledger arises.

Figure 3: Chaincode invocation on network

```
root@22733ed05c6:/opt/gopath/src/github.com/hyperledger/fabric/peer# peer chaincode invoke -o orderer.bloyal.com:7050 -C bloyal -n bloyal lcc --tls --cafile /opt/gopath/src/github.com/hyperledger/fabric/peer/crypto/ordererOrganizations/bloyal.com/orderers/orderer.bloyal.com/msp/tlscacerts/tlsca.bloyal.com-cert.pem -c '{"Args":["readPoints","sarap"]}'
2020-07-29 09:28:15.040 UTC [chaincodeCmd] chaincodeInvokeOrQuery -> INFO 001 Chaincode invoke successful. result: status:200 payload:{"docType":"points","username":"sarap","noofpoints":3}
```

Docker is an open source tool used for developing, running and shipping applications. It provides the ability to package and run the application in an isolated environment. Docker can be seen as a container engine that uses Linux Kernel features to create containers on top of an existing operating system.

B Loyal is built in Hyperledger Fabric and consists of organizations with one orderer node with the SOLO service

system as well as the business logic written in Golang. Docker is brought up to deploy the blockchain network and host containers. Figure 3 shows a successfully invoked chaincode execution on the running blockchain network.

F. Pedometer implementation

Android Studio is the official integrated development environment for Android applications. Android is a Linux-based operating system developed for smart devices with an interactive screen such as mobiles and tablets. The system is widely used and open to users, developers and designers. The Android platform provides several sensors that let you monitor the motion of a device such as: gravity, rotation vector, acceleration, step counting and step detection. Motion sensors are useful for monitoring device movement, such as tilt, shake, rotation or swing [12].

Hyperledger Fabric intends to offer a number of SDKs for a wide variety of programming languages [11]. They enable users to create solutions that facilitate the interaction of other applications with the blockchain platform.

Figure 4: B Loyal applications' sign up activity

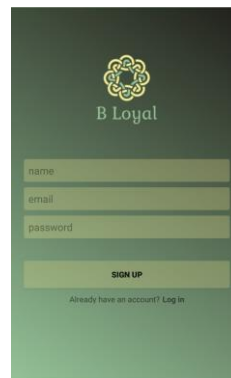
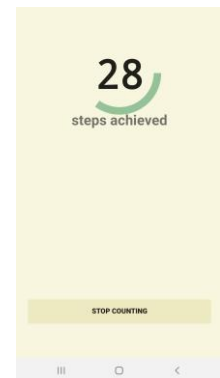


Figure 5: B Loyal applications' pedometer activity



B Loyal platform has an Android application developed for its customers' and tourists' interaction with the network. Figure 4 shows the design of the application and the landing sign up activity. A web service is created within the application for communicating with the blockchain network. On the other hand the blockchain network is made possible to communicate with users through fabric-sdk.

To demonstrate a smart city principle integrated in this platform, a pedometer is implemented through the Android application as shown in figure 5.

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