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▶ **To cite this version:**

Jiaman Chen, Wenchi Ying, Yonggui Chen, Zupeng Wang. Design Principles for Blockchain-Enabled Point Exchange Systems: An Action Design Research on a Polycentric Collaborative Network for Loyalty Programs. 21th Working Conference on Virtual Enterprises (PRO-VE), Nov 2020, Valencia, Spain. pp.155-166, 10.1007/978-3-030-62412-5_13 . hal-03745803

HAL Id: hal-03745803

https://inria.hal.science/hal-03745803v1

Submitted on 4 Aug 2022

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Design Principles for Blockchain-enabled Point Exchange Systems: An Action Design Research on a Polycentric Collaborative Network for Loyalty Programs

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Abstract. In order to improve the customer experiences and explore value of loyalty programs, the operators are extending the scope of point redemption through creating a strategic polycentric collaborative network (CN) across multiple LPs. The point exchange is considered as a selectable approach. Because of the complexity, multicurrency and security risk of the CN, the existing process for exchanging points is cumbersome. However, the challenge of corresponding information system (IS) design received few attentions, which is critical for the success of the CN. We fill the gap by introducing blockchain technology and conducting an action design research (ADR). We partnered with a consulting corporate to design blockchain-enabled point exchange systems for the polycentric CN of loyalty programs. Our ADR study is in progress and the preliminary findings of new design principles may contribute to design theory in the blockchain and IS literature, and enrich both research and practice on LP.

Keywords: loyalty programs, blockchain, polycentric collaborative network, point exchange, SALP.

1 Introduction

Loyalty programs (LP) as marketing strategies of corporates are leveraged to encourage customers to continue to shop at or use the services of corporates associated with each program [1] and most of LP offer rewards in the form of points that can be redeemed for goods and services [2]. There are two types of traditional LP including stand-alone loyalty programs (SALP) and multi-vendor loyalty program (MVLP) [3], both of which contain the role of LP operator who issues the points awarded for customers' purchase (see Figure 1). Thereinto, SALP refers to that the operator is the vendor who provides customers with its own core products at the same time [4], such as airlines or telecom operators. By contrast, MVLP refers to that the operator has no its own products but accumulates other vendors who provide diverse products [5], such as shopping malls or OTA (online travel agency). Traditionally, customers purchase the goods from vendors and collect points rewarded by the

operators, as well as can redeem points for new goods or services from operators or vendors.

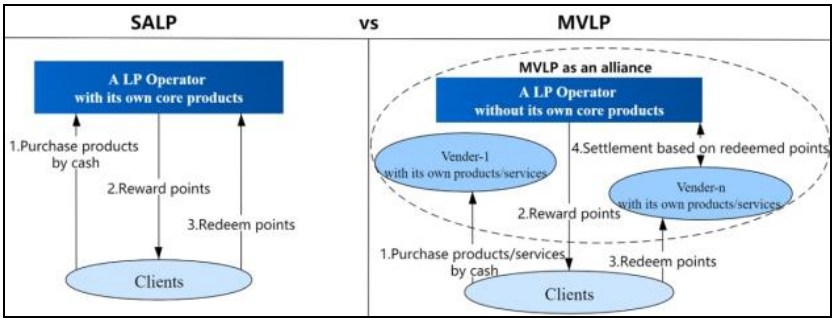

Fig. 1. The Structures of SALP and MVLP

In order to improve the customer experiences and further explore value of loyalty programs, the operators of SALP are expanding the scope of the points redemption, not only introduce more merchants as redeemers instead of vendors [4] (see Figure 2) but also cooperate to create a strategic collaborative network (CN) of multiple SALPs [6] (see Figure 3). Thus, the point exchange between SALPs is considered as a selectable approach to strategic CN of multiple SALPs. This is a typical polycentric CN anchored by a consortium of all the participant operators [4,7].

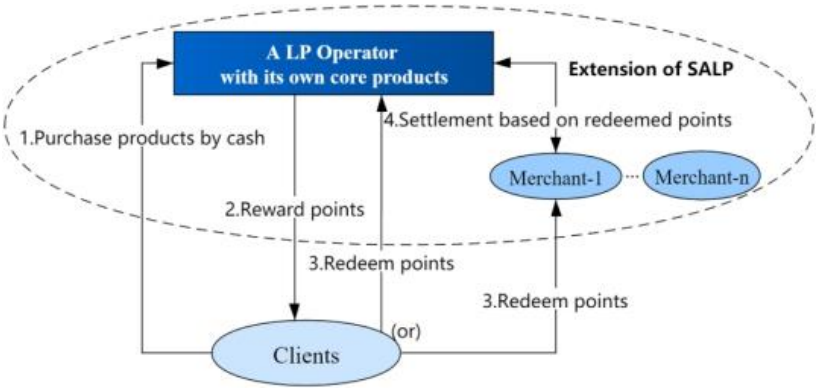

Fig. 2. The Extension of SALP

Because of the complexity, multicurrency and security risk of the collaboration, the existing process for exchanging points among SALPs is cumbersome [4]. However, the challenge of LP system design involving strategic CN received few attentions, which is critical for the success of the CN. Furthermore, the importance of blockchain enabling LP innovation received more attentions [8]. Thus, according to essentials and features of the polycentric CN of multiple SALPs, we introduce blockchain technology to address the challenge and research gap.

We partnered with a consulting corporate and conducted an action design research (ADR) as the method [9] to design a blockchain-enabled system for LP operators.

Thus, we derive our research question: *what are design principles of developing the blockchain-enabled point exchange system for a polycentric CN of multiple SALPs.*

We have completed preliminary findings and are proceeding in summarizing results of the first BIE cycle. In next steps, we will improve and refine the design principles and the system architecture design, and then intervene in development of a prototype of the system based on Oracle blockchain cloud. According to the preliminary findings, our ADR study may contribute to design theory in the blockchain and IS literature, and enrich both research and practice on loyalty programs.

2 Research Background

2.1 Loyalty Programs and a Polycentric CN based on Point Exchange

Although LP are popularly adopted by the corporates, the customers have become disenchanted with accruing or using loyalty points [10]. The key reasons include a lack of diversity in the range of goods and services that can be redeemed and restrictions on where and when customers can use the points [5], especially in the context of SALP. Thus, the operators of SALP extend the scope of point redemption (see Figure 2). Specifically, the operators introduce a range of merchants into the LP and consider the points as enterprise currency that can be redeemed across the merchants [4]. The merchants act as redeemers instead of original vendors, the points can be redeemed into vouchers or discount coupon, even into merchants' goods or services directly. Eventually, the settlement, based on the redeemed points, can be reached between the merchants and the operators. Therefore, much of the existing research has focused on LP design elements, including the financial value of points, reward options, and the rules of redemption [11].

Recently, the strategic CN of multiple SALPs consisting of a operators' consortium and corresponding LP alliance become a hot topic (see Figure 3), which is viewed as a new opportunity for partnership portfolio [6]. Simultaneously, several studies further examine the point exchange between operators/SLAPs [4] or between customers [5]. Thereinto, the point exchange between operators is considered as an alternative method to strategic CN of multiple SALPs. On the one hand, the collaboration, to a larger extent, can expand sources of customers for each operator rapidly. On the other hand, the corresponding alliance can improve the customer experience through a more diverse range of redeemed goods and services [4,5]. This is a typical polycentric CN anchored by all operators participating in the alliance [4,7].

However, due to the complexity and multicurrency, the current process of the point exchanged among SALPs results in that customers are reluctant to use the service of exchange [4]. More importantly, the point exchange system and the consortium model lead to the updating or upgrading of legacy information systems of all the operators, as well as the introduction of an intermediary to operate the exchange business. All

above further increase the complexity and security risk of the consortium, which received few attentions in the research fields.

Simultaneously, Breugelmans et al [6] proposed the research agenda to advance LP research and practice, including the challenge of LP designs involving strategic alliance and consortium. Sun et al [8] emphasized the importance of blockchain enabling the LP innovation. According to the features of SALPs alliance as the polycentric CN and the potentials of blockchain in LPs, we introduced blockchain technology to meet the challenge and address the research gap.

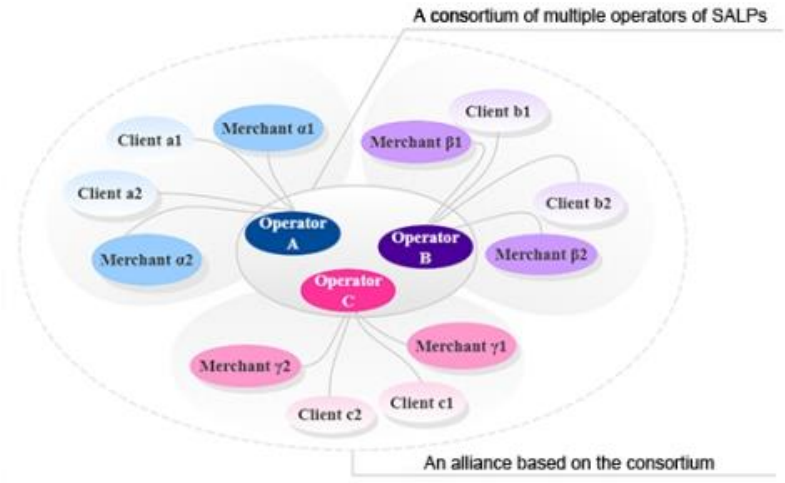

Fig. 3. The Polycentric Collaborative Network of multiple SALPs

2.2 Blockchain's Potentials on a Polycentric CN

Blockchain originates from bitcoin [12], and its applications are already contributing to the remodeling of traditional industries and business models in other areas [13]. Blockchain can be used as an electronic log and smart contracts for transactions and other relevant messages along the commercial activities by enabling secure transfer, reducing fraud, improving proof of tracking, enhancing transparency, reducing cost and increasing efficiency [14].

Wang et al [5] leveraged BubiChain to examine the point exchange activities among customers in the context of MVLP, and further mentioned that future research needed to explore the complicated relationships between blockchain-based LP design and LP engagement. Obviously, the blockchain-based design for the polycentric CN of multiple SALPs and corresponding alliance should be further explored, and the model of consortium (federated) blockchain architecture [13] are suitable for SALPs alliance. Moreover, the point exchange system is leveraged to connect each operator's legacy information systems. Kowalewski et al [4] emphasized that transferability rules, customer information security and unbiasedness of the system were essential. These demonstrate blockchain's potentials on realization of the point exchange system for polycentric CN of multiple SALPs, e.g. customer privacy preservation,

unified rules of exchange rate and transferability, transparency and traceability of exchange transactions, as well as settlement based on the consistent ledgers [4,8]. However, the development of the blockchain-enabled point exchange system for polycentric collaborative network of multiple SALPs has remained at the conceptual level and received few attentions, which is critical for the success of the CN.

2.3 A Socio-Technical Perspective Guiding the System Design

Information systems are the typical socio-technical systems [15]. Socio-technical perspective distinguishes the social entities structures and actors as well as the technical entities tasks and technologies [16,21]. We adopted the socio-technical perspective as a theoretical lens [17] to guide the ADR. Specifically, structures are characterized by project organizations and institutional arrangements and embodied as the polycentric CN anchored by a consortium of all the participant operators. Actors are characterized by a shared culture and business context and embodied as core operators, complement merchants and all the clients in corresponding LP alliance. Technologies are characterized by technological tools or platforms and embodied as the architecture of blockchain-enabled point exchange systems. Tasks are characterized by the processes which are required to fulfill work or the delivery of functionalities.

Obviously, the system design is reflected in the organizational context related to shaping entities at the structure, actor, and technology levels, while actions at the three levels then lead to design principles at the task level.

3 Research Methodology

3.1 Action Design Research

This study is intended to develop a blockchain-enabled point exchange system for a polycentric CN of multiple SALPs. The design principles will constitute an IS design theory [18], which can reduce developers' uncertainty in implementation of relevant information systems (IS) and increase the chances of IS success [19]. ADR is a form of design research, which combines design science research with action research, and integrates the building and evaluation phases of the design process through organizational intervention [9]. ADR also differs from action research in which the design of an IS-related artifact is not necessarily required [20]. Sein et al [9] establish four phases for ADR: (1) problem formulation; (2) building, intervention and evaluation (the BIE cycles); (3) reflection and learning; (4) formalization of learning.

We chose ADR as the research method for two reasons. First, ADR treats an IS-related artifact as an ensemble artifact, which refers to a bundle of tools or systems (software and/or hardware) and treats the design process as a socio-technical construction that involves both technical and organizational factors [22]. Prior ADR studies have also shown that ADR method allows scholars to gain richer insights about the interactions of technology and organization [23]. Second, thanks to the

incorporation of action research and organizational intervention, ADR is a dynamic process between building and evaluation rather than a stage-gate process, like that in other forms of design research. Therefore, ADR allows researchers to respond to unexpected consequences. For example, design research often assumes that problems identified at the beginning of the process will not change, but ADR allows the problems to be modified as the project goes.

3.2 Project Setting

The CU Group (a pseudonym) is the only Chinese telecom operator listed on the stock exchanges of New York, Hong Kong, and Shanghai. It has been a Fortune 500 company for many years and was ranked at No. 262 in Fortune 500 in 2019. The CU Group owns nearly 200m customers and the business value underlying its LP system has reached the scale of billions of yuan (CNY).

However, the CU Group also encountered the challenges of traditional SALP, such as the lack of diversity of goods and services that can be redeemed. Despite the large scale of financial value in LP, the points for each customer are frequently regarded as 'sunk assets' and eventually expire, and the usage of corresponding funds toward points failed to get the expected effectiveness. Thus, the CU Group, on the one hand, introduced more merchants as point redeemers, on the other hand, sought for cooperation with other operators. Given the risk of peer competition, the CU Group decided to initiate a horizontal alliance with the operators from different business fields, such as airlines and banks. Thereinto, developing a blockchain-based point exchange system was top priority.

The HuaQi Corporate (HuaQi), headquartered in Beijing, had been rooted in consulting business of telecom field and extended its business scope into other fields in recent years. Based on the rich experiences on IT/IS planning and design, the HuaQi has been one of the CU Group certificated partners and undertaken many important consulting projects of the CU Group. However, the HuaQi, in the face of the challenges of emerging technologies, accepted the assignment and recognized difficulties of the tasks. Thus, the HuaQi invited our research team to participate in the design process, perceive the problems and provide the knowledge of theory and technological advances. The process of development includes several IT-dominant BIE cycles, a new set of design principles emerged during the BIE cycles.

4 Research in Progress and Preliminary Findings

Our ADR study is in progress and we have completed the tasks of the problem formulation phase and the first building-intervention-evaluation phase (the first BIE cycle). We are proceeding in the second BIE cycle.

4.1 ADR Problem Formulation

Our research in this phase formulates the problem, which should be an instance of a class of problems. The objectives, challenges and actions during problem formulation phase are depicted in Table 1.

Table 1. Objectives, Challenges and Actions during Problem Formulation Phase

Objectives	Challenges or Actions
Conceptualize the research opportunity	How to develop a point exchange system for a loyalty-program alliance?
Formulate initial research questions	What are design principles of developing the blockchain-enabled point exchange system for a polycentric CN of multiple SALPs?
Cast the problem as an instance of a class of problems	(1) Unified process and security of exchange transferability (2) Transaction traceability and privacy preservation without intermediary (3) Settlement based on consistent rules
Identify contributing theoretical bases and prior technology advances	(1) Originally expected contributions: We focused on leveraging blockchain to manage the whole process of point exchange among operators' systems. (2) Unexpected Challenges: Leveraging blockchain to manage the whole process caused that the legacy systems must be upgraded a lot and cost a lot. (3) Shifted expected contributions: we derived two basic principles – minimum modification for legacy systems and technology hybridization of blockchain and conventional technologies – to guide new design actions.

4.2 First BIE Cycle: Preliminary Design Principles and System Architecture

We originally leveraged blockchain to manage the whole process of point exchange among operators' systems. However, the solution was not accepted by the operators, as an expert of the HuaQi mentioned, "The original solution showed that the legacy systems must be upgraded a lot and cost a lot".

Thus, we analyzed the business process among multiple SALPs again (see Figure 4) and summarized three core tasks for the system design: 1) Unified process and security of exchange transferability, 2) Transaction traceability and privacy preservation without intermediary, 3) Settlement based on consistent rules.

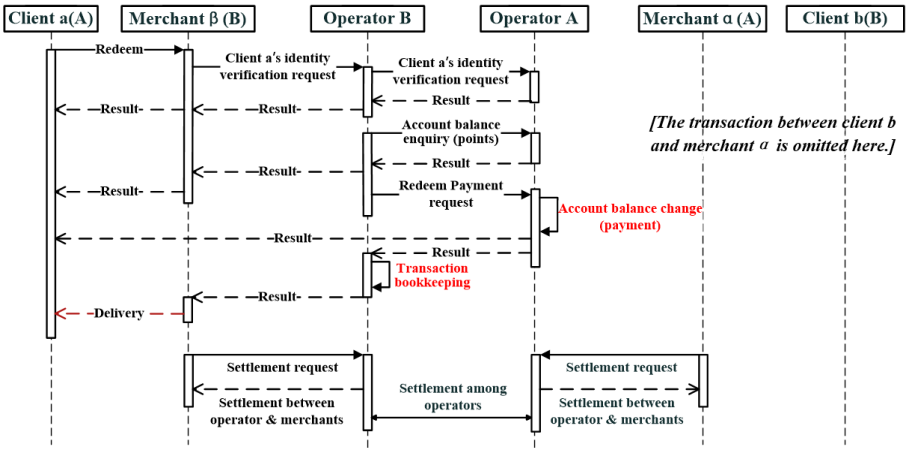

Fig. 4. Business Process Analysis on point exchange among multiple SALPs

Simultaneously, we adopted a socio-technical perspective on structure, actors and technologies to identify the design context of polycentric CN of multiple SALPs, and derived two basic principles – minimum modification for legacy systems and technology hybridization of blockchain and conventional technologies, which received recognition of both the HuaQi and the CU Group. Thus, we combined the core tasks and the two basic principles to contribute to the six concrete design principles (see Table 2).

Table 2. Preliminary Design Principles (DPs) for a BC-enabled Point Exchange System of Polycentric CN

Core Tasks / Basic Principles	Unified process and security of exchange transferability	Transaction traceability and privacy preservation without intermediary	Settlement based on consistent rules
Minimum modification for legacy systems	DP-1: Given technological heterogeneity of different operators' (LP) legacy systems, the operators should provide standard interfaces of legacy systems and the practitioners provide standard interfaces of blockchain, so that all the systems can easily use their functionalities by calling the interfaces.	DP-3: Given limited boundaries of each legacy system, each operator only creates a special exchange account in the (LP) system, so that they can record how many points each client exchanges, accumulate exchanged points and avoid double payment.	DP-5: Given multicurrency of cross-boundary transactions, operators set a consistent exchange rate according to financial cost of points in their own loyalty programs, so that not only each (LP) legacy system can be stable to keep original settlement rules to merchants and clients, but also the exchange rate can be stable for transactions.

Technology hybridization of blockchain and conventional technologies	DP-2: Given complexity of point exchange process, the practitioners manage all the interfaces, integrate them into a set of unified processes and manage permission of process-interface calling through installing smart contracts based on blockchain, so that interactions among operators' legacy systems and blockchain can be well-organized, flexible and secure.	DP-4: Given the complexity of cross-system transactions, the practitioners provide distributed ledgers to record cross-system transaction details in the blocks and to bridge the (special) exchange accounts of operators' legacy systems, so that the whole process of transactions is seamless and traceable. Simultaneously, blockchain can be used to ensure feasibility of transactions without sharing of customers' critical information.	DP-6: Given the complexity of settlement based on multi-account and multicurrency, the practitioners provide each (LP) legacy system with transparent and reliable ledgers that are ensured by blockchain's consensus mechanism, and provide smart contracts for cross-system settlement, so that settlement between operators and merchants, or among operators, can be executed based on consistent rules.

According to the design principles, we further designed the system architecture consisting of application layer, service (interface) layer and blockchain layer (see Figure 5). The application layer included (LP) legacy systems. We created the service (interface) layer through service-oriented architecture, in order to manage interactions among legacy systems and blockchain. Distributed ledgers and smart contracts were deployed the blockchain layer in order to work with other layers and to ensure reliability of the whole systems.

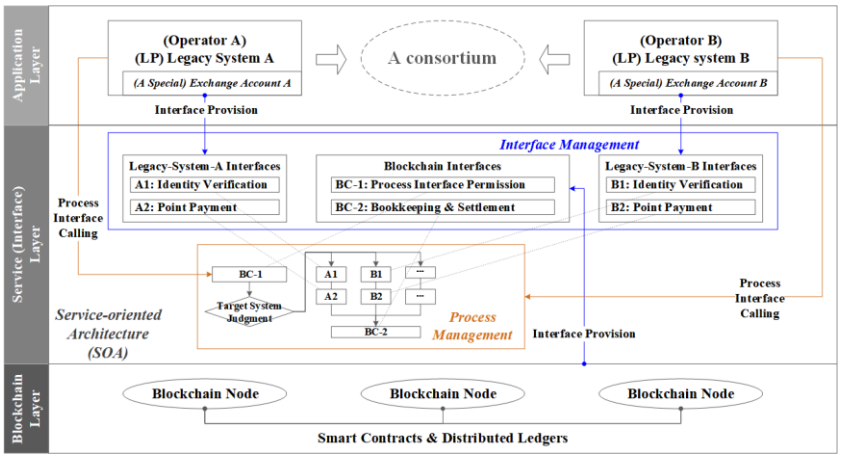

Fig. 5. Architecture for a Blockchain-enabled Point Exchange System of Polycentric CN

We have evaluated the preliminary findings through proof of concept (POC). Here we provided an example to show the details of transactions and process (see Figure 6).

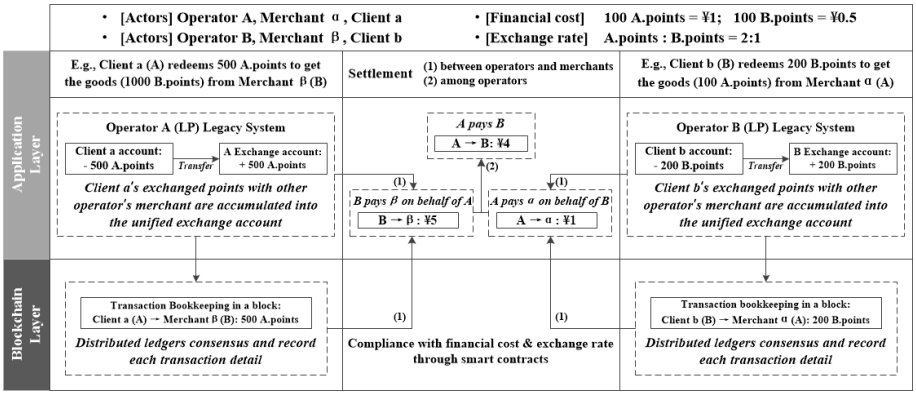

Fig. 6. An example for a Blockchain-enabled Point Exchange System of Polycentric CN

According to the horizontal alliance expected by the CU (as description in the project setting) and the system architecture designed in our research; we simulated the process of exchanging points in real scenarios. In order to simplify the explanation, a simplified example is as follow:

(1) Context setting: Operator ***A*** has merchant α & client ***a***, while Operator ***B*** has merchant β & client ***b***. A strategic alliance is created by Operator ***A*** and Operator ***B*** and consists of operators and their own merchants and clients. Operator ***A*** sets up a unified exchange account (*A-exchange-account*) in its own (LP) legacy system, similarly, Operator ***B*** sets up *B-exchange-account*.

(2) Exchange rate setting: 100 *A.points* are worth $1, while 100 *B.points* are worth $0.5. Therefore, the exchange rate between A.points and B.points is 2:1.

(3) Transactions: When ***a*** redeems 500 *A.points* to get the goods (equivalent to 1000 *B.points*) from β, ***a***'s 500 *A.points* are transferred into *A-exchange-account*, and the corresponding "Transaction Bookkeeping in a block" occurs. Theoretically, β gets the 500 *A.points* in the blockchain. Practically, ***A*** collect the 500 *A.points* for β. Similar scenario toward the transaction between ***b*** and α.

(4) Settlement: According to distributed ledgers (blockchain), ***B*** pays β $5 on behalf of ***A***, while ***A*** pays α $1 on behalf of ***B***. Finally, ***A*** pays ***B*** $4. Eventually, the corresponding points are recalled from *A-exchange-account* by Operator ***A***'s (LP) legacy system. Similar scenario toward Operator ***B***.

5 Next Steps and Expected Contributions

We are proceeding in summarizing the feedbacks from the POC. Fortunately, the feedbacks do not seem to disrupt our design principles so far. In next steps, we will first improve and refine the design principles and the system architecture design, and then to intervene in development of a prototype of the system based on Oracle

blockchain cloud. Second, we will deeply evaluate the outcomes of the prototype in pilot run to examine the set of design principles. Third, we will summarize the findings in the Reflection and Learning phase, and derive the final design guidelines in the Formalization of Learning phase. Finally, we will summarize the ADR process in the form of table according to the four stages of ADR.

According to the preliminary findings, our ADR study may contribute to design theory in the blockchain and loyalty programs (LP) literature, and enrich both research and practice on loyalty programs. First, our study contributes to the blockchain literature by providing prescriptive design knowledge on how organizations design a blockchain-enabled system. Specifically, the knowledge is proposed in the form of design principles that combine abstract core tasks with basic principles, while the basic principles can contribute to the scalability of blockchain-enabled system design. Second, alliances of LPs are hot topics in IS. The frequent interactions among multiple actors and information systems as well as complicated transactions and settlements lead to technological constraints of the alliances. Our study adopts blockchain technology to mitigate the constraints of the SALP alliance. Obviously, a future research direction is to further explore blockchain applications in other types of LP alliances and more design principles for blockchain-enabled systems.

Acknowledgement. Funding for this research was provided by the Fundamental Research Funds for the Central Universities (2019RCW011) and Beijing Jiaotong University Education Foundation (03060083).

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