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From ambivalence to trust: Using blockchain in customer loyalty programs

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ABSTRACT

Global initiatives on climate protection and national sustainability policies are accelerating the replacement of fossil fuels with renewable energy sources. Many electricity suppliers are engaged in efforts to monetize this transition with 'green' services and products, such as Green Electricity Tariffs. These promise customers that their supply includes a specific share of green electricity, yet since electricity suppliers often fail to deliver on those promises, many customers have lost trust in their suppliers. Further information asymmetries may not only exacerbate this loss of trust, but also spark distrust and lead to an overall feeling of ambivalence. Eventually, ambivalent customers may feel inclined to switch suppliers. To prevent this domino effect, electricity suppliers must eliminate ambivalence by increasing customer trust and reducing customer distrust. Here, we discuss how these challenges can be met with a customer loyalty program built on blockchain technology. We developed the program following a Design Science Research approach that facilitated refinement in four iteration and evaluation cycles. Our results indicate that the developed customer loyalty program restores trust, reduces distrust, and resolves customer ambivalence by providing four features: improved customer agency, sufficient and verifiable information, appropriate levels of usability, and unobstructed data access.

1. Introduction

Heightened environmental awareness and a growing need for sustainability have led to various 'green' transformations across multiple sectors, and perhaps nowhere more so than in in the energy industry (Dwivedi et al., 2022; Ågerfalk et al., 2022). These transformations have started to shift power generation from fossil fuels like coal and gas toward Renewable Energy Sources (RES) (Dong, Luo, & Liang, 2018; Hua, Jiang, Sun, & Wu, 2020). Moreover, they change the dynamic of energy consumption by balancing it against the intermittency of many RES (Andoni et al., 2019; Dorfleitner, Muck, & Scheckenbach, 2021). Meanwhile, green electricity has achieved the status of a lifestyle product for many customers; a trend that many electricity suppliers are trying to commercialize with various 'green' services and products (Bogensperger, Zeiselmair, Hinterstocker, & Dufter, 2018; Kley, Lerch, & Dallinger, 2011). Green Electricity Tariffs (GETs) are a case in point (Diaz-Rainey & Ashton, 2011; MacPherson & Lange, 2013; Ozaki, 2011). GETs promise that "some or all of the units of electricity [a] customer buys are 'matched' by units of energy that have been generated from a verified renewable energy source" (Energy, 2013). Although the overall share of RES in the electricity market is steadily increasing (Andoni et al., 2019; Hua et al., 2020), electricity suppliers are not always able to meet these green supply commitments with their own RES. In such cases, they typically purchase 'guarantee of origin' certificates from other RES suppliers (Abad & Dodds, 2020).

The problem with these certificates is that many customers understand neither their nature nor their purpose, which can lead to distrust and fears of 'greenwashing' (Ambrose, 2021; Guo et al., 2014; Mezger, Cabanelas, López-Miguens, Cabiddu, & Rüdiger, 2020). These fears can easily grow into a general feeling of ambivalence (Moody, Galletta, & Lowry, 2014; Moody, Lowry, & Galletta, 2017) that leads customers to question their formerly trusted relationship with their electricity supplier (Arkesteijn & Oerlemans, 2005; Bang, Ellinger, Hadjimarcou, & Traichal, 2000; Hansla, Gamble, Juliusson, & Gärling, 2008). In some cases, customers may even consider switching to a competitor. Many suppliers try to mitigate this risk with preemptive measures that rebuild institution-based trust and safeguard against the development of distrust (Cheng, Fu, & de Vreede, 2021; Moody et al., 2017). Often, customer

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loyalty programs (Dolšak, Hrovatin, & Zorić, 2019; Peng & Wang, 2006) are conceived to foster a trusting relationship in which information is shared between supplier and customer (Bansal, Taylor, & James, 2005). When successful, these programs strengthen the three dimensions of institution-based trust (Bélanger & Carter, 2008; Cheng et al., 2021; McKnight, Cummings, & Chervany, 1998; McKnight, Lankton, Nicolaou, & Price, 2017) at the same time as they reduce the three dimensions of institution-based distrust (Moody et al., 2014, 2017).

Digital technologies that facilitate such trustful sharing of information are an essential prerequisite for most of these programs. Blockchain technology, in particular, appears to be a suitable technological option (Andoni et al., 2019; Ante, Steinmetz, & Fiedler, 2021). Although a 'trustless' technology by design, given that it does not require trust in a central operator (Werbach, 2018), blockchain's properties, such as secure and distributed data storage, can generate trust (Amend & Kaiser, 2021; Roth, Stohr, Amend, Fridgen, & Rieger, 2022). By virtue of these properties, blockchain can mediate trust concerns in many environments where trust is either nonexistent or severely compromised (Amend & Kaiser, 2021). To assess its further usefulness in resolving trust issues concerning energy supply and consumption, we have set out to answer the following two research questions:

RQ1: How can blockchain technology enhance institution-based trust and reduce distrust in electricity suppliers?

RQ2: How can a trust-based customer loyalty program be designed with blockchain technology?

To answer these questions, we followed a Design Science Research (DSR) approach (Gregor & Hevner, 2013). The use of DSR helped us identify design requirements for the enhancement of institution-based trust and the reduction of institution-based distrust. It also benefitted our investigations into how a customer loyalty program can be designed with blockchain technology. We began with a comprehensive literature review (Webster & Watson, 2002), followed by a workshop with an electricity supplier as well ex-ante interviews with experts to derive design objectives and requirements. Based on these, we then designed Nexo Energy, a conceptual architecture for a customer loyalty program based on blockchain. Using an iterative approach, we continuously refined our artifact through a series of workshops with employees of the electricity supplier, a comprehensive test with customers, and interviews with both groups (see Table A1). Upon completing the refinement and evaluation process, we deduced a nascent design theory that is based on four design principles (Gregor & Hevner, 2013). This design theory makes an important contribution to blockchain research as it illustrates a specific way in which blockchain can help manage ambivalence by facilitating institution-based trust and reducing institution-based distrust. In a broader context, it advances the current investigation into how innovative technologies can be used to build consumer trust (Abbas, Martinetti, Moerman, Hamberg, & van Dongen, 2020; Cheng et al., 2021; Jeon, Kim, Lee, & Lee, 2021).

2. Theoretical background

2.1. Green electricity tariffs and customer satisfaction

At present, global initiatives for climate protection and various national sustainability policies are driving the replacement of finite resources with RES (Ante et al., 2021; Dorfleitner et al., 2021). While RES play a significant role in reaching sustainability goals, their intermittency and volatility introduce not just multiple organizational and technical challenges but also a long list of regulatory issues (Andoni et al., 2019; Baumgarte, Glenk, & Rieger, 2020). What is more, the prominence of RES poses a specific challenge to the traditional business models of electricity suppliers (Ahl et al., 2020; Hua et al., 2020) as they are now expected to meet their customers' surging demand for green electricity (Bogensperger et al., 2018; Luke, Lee, Pekarek, & Dimitrova, 2018).

To this end, electricity suppliers typically employ Green Electricity Tariffs (MacPherson & Lange, 2013). The use of such GETs, however, poses two further challenges. One, GETs are subject to complex electricity market regulation (Andoni et al., 2019; MacDonald & Eyre, 2018), and their implementation is both cumbersome and costly (Bergaentzlé et al., 2019), which is why GETs are often more expensive than conventional electricity tariffs (Fang, Cui, Du, Li, & Kang, 2021; MacDonald & Eyre, 2018). Two, GETs typically involve the use of so-called 'guarantee of origin' certificates (Abad & Dodds, 2020) because many electricity suppliers do not have direct access to the full amount of RES required to satisfy their customers' contractually agreed units of green electricity. To reach the quota, they buy these certificates from other RES suppliers (Hamburger, 2019; Raadal, Dotzauer, Hanssen, & Kildal, 2012). Although guarantee of origin certificates are a legitimate measure to support the distribution of RES, customers often feel deceived by them – be it because they suspect disproportionate charges for green energy or because they do not receive the expected 'kind' of green electricity (Ambrose, 2021; Guo et al., 2014; Mezger et al., 2020). The resentment this causes is often reinforced by negative publicity resulting from double-spending affairs (Castellanos, Coll-Mayor, & Notholt, 2017; Hamburger, 2019).

Such resentment can lower customer satisfaction and ultimately lead to a drop in customer loyalty. Customer satisfaction is typically defined as an important antecedent of customer loyalty, and it is rooted in certain (perceived) service qualities (Berry, Parasuraman, & Zeithaml, 1988; Culiberg, 2010). One important such quality is reliability, which is to say the "ability to perform the promised service dependably and accurately" (Muzahid & Noorjahan, 2009, p.26). This definition of reliability is rather close to the standard definition of customer satisfaction, which can be described as "a feeling [resulting] from a process of evaluation of what has been received against what was expected […]" (Muzahid & Noorjahan, 2009, p.27). It is worth noting that some expectations concerning GETs may have been unrealistic from the get-go and may be attributed to the general public's limited understanding of the complex workings of electricity generation, transmission, and distribution work. It is a separate issue, however, that electricity suppliers have not always been able to provide the desired and promised services (Bang et al., 2000; MacPherson & Lange, 2013; Wüstenhagen, Wolsink, & Bürer, 2007). This incompetence (Moody et al., 2017) to deliver green electricity has led to widespread skepticism (Kramer, 1999) concerning the electricity supplier's ability to improve its services in the future, and this in turn has had two unfortunate consequences. One, customer satisfaction has dropped (Martínez & Rodríguez del Bosque, 2013). Two, customer trust has been reduced and customer distrust has become a considerable problem (Kramer, 1999; McKnight et al., 2017; Moody et al., 2017).

2.2. The loyalty trilemma: Institution-based trust, institution-based distrust, and ambivalence

An important second antecedent of customer loyalty is customer trust (Chu, Lee, & Chao, 2012; Stathopoulou & Balabanis, 2016). Such trust is generally based on the belief that a service provider acts in the long-term interest of its customers (Martínez & Rodríguez del Bosque, 2013). Accordingly, trust is contingent on "the willingness of a party to be vulnerable to another party's actions based on the expectation that the other party will perform a particular action important to the trusting party, irrespective of the ability to monitor or control that other party" (Cheng et al., 2021, p. 3). While this definition of trust (Lewicki & Brinsfield, 2011; Mayer, Davis, & Schoorman, 1995; Tams, Thatcher, & Craig, 2018; van der Werff, Legood, Buckley, Weibel, & de Cremer, 2019) implies a lack of control and monitoring capabilities, it is important to note that the willingness to be vulnerable is not the result of naivety but rather a consequence of the trusting party's rational judgment (Dietz & Gillespie, 2011; van der Werff et al., 2019).

In the energy sector, customers and their electricity suppliers have typically developed a long-standing relationship of trust (Ambrose, 2021). When customers make the switch to GETs, they expect their suppliers to deliver green units of electricity at reasonable prices and with the same reliability with which they previously delivered the 'gray' units (Hartmann & Apaolaza Ibáñez, 2007; Rosell & Ibáñez, 2006). In most cases, electricity suppliers have managed to meet these expectations to such an extent that customers developed a feeling of security concerning the surrounding structure and the inherent legal guarantees (McKnight et al., 1998). This so-called *institution-based trust* (Cheng et al., 2021; McKnight et al., 2017) has three dimensions: *calculation-based*, *cognition-based*, and *knowledge-based trust* (Cheng et al., 2021).

Calculation-based trust is the most basic dimension of trust and builds on the *integrity* of a trusted party (Bilgic, Hoogensen Gjørv, & Wilcock, 2019; Moody et al., 2017). *Calculation-based trust* can be described as taking a "calculated risk" and building a positive affection (Bilgic et al., 2019 p.4). Both elements depend on information about the *integrity* of the trusted party. This information may range from observations of the trusted party's *competence* (Moody et al., 2017) to the keeping of contractual agreements and general demonstrations of openness and reliability (Ibrahim & Ribbers, 2009; Muzahid & Noorjahan, 2009). When such information affirms the trustworthiness of the trusted party, the trusting party may become willing to be vulnerable. This so-called trust motivation can initiate trust development processes (van der Werff et al., 2019) which are just as relevant when it comes to the promotion of the second dimension of trust, *cognition-based trust*. This type of trust depends on a favorable assessment of the trusted party's know-how, goodwill, and reliability. The more information the trusted party provides (*competence*) in a transparent and verifiable manner (*integrity*), the easier it will be for the trusting party to establish trust (Ibrahim & Ribbers, 2009). As for the third dimension of trust, *knowledge-based trust*, this depends on a positive evaluation of experiences in dealing with the trusted party. Of particular concern here is its *benevolence,* and evidence of this can only emerge when there is an interaction history in the course of which the information required to develop such trust could be accumulated (Moody et al., 2017). For this third type of trust to develop, then, trust at the *calculation-* and *cognition-based* level has to be sufficiently advanced to allow for the requisite interaction (McKnight et al., 1998).

It is a matter of some concern, therefore, that guarantee of origin certificates introduce ambiguity into the generation processes of these three trust dimensions. While electricity suppliers interpret both the direct provision of RES and the indirect procurement of guarantee of origin certificates as 'delivering green electricity' (Ambrose, 2021; Guo et al., 2014; Mezger et al., 2020), many customers would disagree with this wider definition. Instead they would contend that only electricity drawn directly from RES deserves to be called 'green' (Andoni et al., 2019; Bogensperger et al., 2018; Perrons & Cosby, 2020). When the supplied electricity diverges notably from the customers' interpretation of green electricity, this constitutes a violation of *cognition-based trust*. Customers are then likely to doubt or even dismiss the supplier's reliability and *competence* to provide the expected service. At this point, the supplier's *integrity* as measured in terms of costs and benefits (*calculation-based trust*) is no longer evident (Bilgic et al., 2019). On the contrary, customers may suspect that they have become victims of 'greenwashing' by paying premiums for green electricity even though they have been receiving gray electricity misleadingly labelled with guarantee of origin certificates to make it appear like green electricity (Ambrose, 2021; Mezger et al., 2020). Where such suspicions lead to resentment, they extend customers' doubts about the *benevolence* of their supplier, at which point some may feel cheated or even taunted (*knowledge-based trust*).

At a more general level, such drastic setbacks in all three trust dimensions undermine *institution-based trust* in electricity suppliers. Furthermore, they also leave room for the growth of *institution-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001; McKnight & Choudhury, 2006). Distrust has many definitions, depending on its context (McKnight & Chervany Norman, 2001), but generally speaking it can be described as a "strong negative feeling regarding the conduct of another [party]" (Lee, Lee, & Tan, 2015, p. 162), or a "lack of confidence in the other, a concern that the other may act as to harm one, […] not [caring] about one's welfare […]" (Govier, 1994, p. 240). Distrust is often accompanied by feelings of fear, frustration, and rejection (Govier, 1994; McKnight & Choudhury, 2006). Analogous with the three-part structure of *institution-based trust*, distrust may also have three dimensions, which we describe as *vigilance-based distrust*, *skepticism-based distrust*, and *control-based distrust*. Their respective root causes are perceived *deceit*, *incompetence*, and *malevolence* (McKnight & Choudhury, 2006; McKnight et al., 2017; Moody, Galletta, & Lowry, 2010). While distrust is often overlooked as the 'little brother of trust', it warrants explicit attention for being a key element of risk assessment and risk avoidance (McKnight & Chervany Norman, 2001).

In our GET context, customers are keen to mitigate the risk of falling victim to 'greenwashing' when their suppliers use guarantee of origin certificates (Ambrose, 2021; Andoni et al., 2019; Mezger et al., 2020). They suspect "that the [trusted party] is dishonest and potentially provides false information" (McKnight et al., 2017, p. 4). In due course, such *deceit* will lead to greater *vigilance-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001). Customers will pay more attention to the consumed units of electricity and their source, while also taking note of the respective green electricity prices (Bogensperger et al., 2018). However, many electricity suppliers are simply unable to provide green electricity to the required extent because they do not have direct access to RES, and even if they did, it would not change the fact that all electricity in the grid is gray (Luke, Anstey, Taylor, & Sirak, 2019; Peter, Paredes, Rivial, Sepúlveda, & Astorga, 2019). While electricity suppliers believe this to be common sense, customers often have different expectations and conclude that "the [trusted party] lacks the ability to accomplish [this] task" (McKnight et al., 2017 201, p. 4). In short, they perceive the supplier to be incompetent. When customers extend such *incompetence* beliefs to future tasks, they may develop far-reaching *skepticism-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001). In some cases, where customers are convinced that GETs help their electricity supplier to 'greenwash' gray electricity (Ambrose, 2021; Guo et al., 2014), this conviction can lead to the feeling "that the [trusted party] has the intention to harm the [trusting party]" (McKnight et al., 2017, p. 4) or to act in a *malevolent* way. This suspected *malevolence* can make a customer seek out more information and exercise greater caution when it comes to their own future actions, eliciting *control-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001).

When previously trusting relationships between electricity suppliers and their customers suffer a decrease in trust along with an increase in distrust, the result is a conflict that can best be described as *ambivalence* (Jarvenpaa & Majchrzak, 2010; Moody et al., 2014). *Ambivalence* is commonly defined as "holding simultaneously at least two contradictory attitudes toward the same attitude object" (Moody et al., 2014, p. 267). These attitudes have three dimensions: behaviors, feelings, and beliefs, and each can have different valences (Moody et al., 2017). In the case of GETs, the long-standing relationship with an electricity supplier can, for instance, have a higher valence than their customers' distrust-beliefs and trust-reducing behaviors or feelings. It will not, however, automatically nullify the customers' negative attitudes. Instead, it creates *ambivalence* (Moody et al., 2014; Ning, Feng, Feng, & Liu, 2019). Such *ambivalence* may influence a wide variety of buying decisions and, in the particular case of deciding whether to stay with one's electricity supplier, it can notably affect the customer's loyalty (Moody et al., 2017; Olsen, Wilcox, & Olsson, 2005). After all, ambivalent customers may feel inclined to compare offers and even switch to another supplier.

To safeguard against losing their customers, electricity suppliers must not only rebuild *institution-based trust* (Cheng et al., 2021; McKnight et al., 2017) but also reduce *institution-based distrust* (Moody et al., 2014; Olsen et al., 2005). Typically, their strategy for doing so

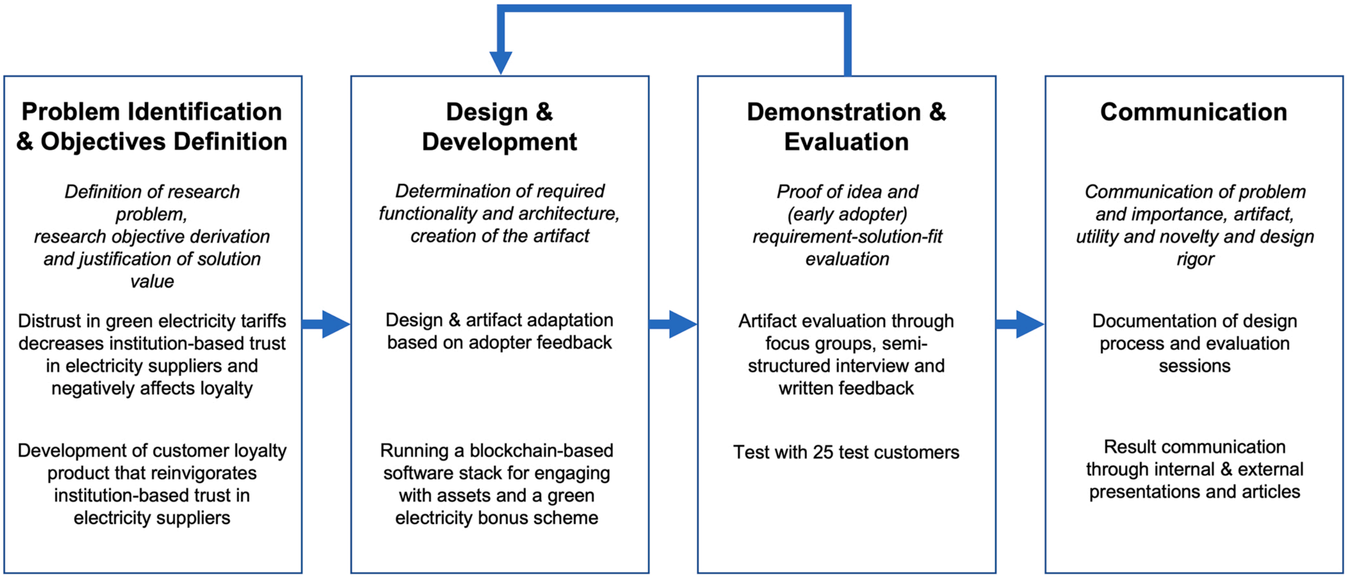

Fig. 1. Adapted Design Process Model based on Peffers et al. (2007).

involves the use of customer loyalty programs (Dowling & Uncles, 1997; Uncles, Dowling, & Hammond, 2003). These are often based on innovative technologies, such as blockchain, and aim to both strengthen *institution-based trust* dimensions and weaken *institution-based distrust* dimensions (Abbas et al., 2020; Warkentin & Orgeron, 2020). The expectation is that such customer loyalty programs will replace the feeling of *ambivalence* with trust attitudes, which may ultimately increase customer loyalty (Moody et al., 2017; Olsen et al., 2005).

2.3. *Trustless blockchain technology as trust mediator*

In recent years, blockchain has received wide attention across many industries for being a 'trustless' technology. Various projects have since been initiated to test the prospects and limitations of blockchain applications (Ante et al., 2021; Sedlmeir, Smethurst, Rieger, & Fridgen, 2021; Upadhyay, 2020). Success stories in logistics (Jensen, Hedman, & Henningsson, 2019; Sarker, Henningsson, Jensen, & Hedman, 2021), retail (Bumblauskas, Mann, Dugan, & Rittmer, 2020; Cho, Lee, Cheong, No, & Vasarhelyi, 2021), insurance (Zhang, Wei, Jiang, Peng, & Zhao, 2021) and even public administration (Rieger, Lockl, Urbach, Guggenmos, & Fridgen, 2019) have raised hopes that blockchain may offer similar benefits when used in electric power systems. The aim is to create decentralized electric power systems with the help of a decentralized technology that obviates intermediaries (Diestelmeier, 2019; Mengelkamp, Schlund, & Weinhardt, 2019).

Technically speaking, blockchains are a particular type of distributed ledgers that build on a peer-to-peer network. All data can be replicated, shared, and distributed across multiple servers – so-called nodes (Beck, Müller-Bloch, & King, 2018; Butijn, Tamburri, & Heuvel, 2020; Chanson, Bogner, Bilgeri, Fleisch, & Wortmann, 2019). Such physical decentralization makes secure and distributed data storage possible (Amend, Fridgen et al., 2021; Chanson et al., 2019; Cho et al., 2021). Selected nodes within the network will group transactions into blocks that reference the previous block through a hash-value (Zhang, Wang, & Ding, 2019). These hashes typically make retrospective changes to the blockchain easy to detect. Private blockchains further allow for the distribution of the right to write and the right to access data in accordance with the role and attributed competencies of each involved party (Sedlmeir, Buhl, Fridgen, & Keller, 2020; Ziolkowski, Miscione, & Schwabe, 2020). This reduces complexity by maintaining the commonly shared truth as well as the necessary transparency, without disclosing information that either should not or must not be accessed (Hawlitschek, Notheisen, & Teubner, 2018; Mattke, Hund, Maier, & Weitzel, 2019; Rieger et al., 2019). Beyond storing data, blockchains can process payments and may even execute programming logic with the help of so-called smart contracts (Andersen & Bogusz, 2019; Chong, Lim, Hua, Zheng, & Tan, 2019; Lacity, 2018). These are redundantly executed scripts that enable participants to control the validity of transactions, which can significantly reduce dependencies on third parties as well as the trust that these dependencies require (Chong et al., 2019; Gorkhali, Li, & Shrestha, 2020; Rossi, Mueller-Bloch, Thatcher, & Beck, 2019). This, in turn, mitigates lock-in effects and goes a long way towards preventing the aggregation of market power (Hoess, Roth, Sedlmeir, Fridgen, & Rieger, 2022; Thomas, Zhou, Long, Wu, & Jenkins, 2019). Moreover, distributed data storage and execution of transactions obviate a single point of failure while also enabling reliable information sharing and process automation (Du, Pan, Leidner, & Ying, 2019; Watanabe et al., 2016). This makes blockchain particularly attractive for building and running critical infrastructures (Amend & Kaiser, 2021; Rieger et al., 2019).

On account of its technical characteristics, blockchain is commonly described as an inherently trustless technology (Da Xu & Viriyasitavat, 2019; Gorkhali et al., 2020). Instead of requiring users to trust one another or engaging a trusted third party, blockchain "shift[s] from trusting people to trusting math" (De Filippi, Mannan, & Reijers, 2020 p.6). Specifically, blockchain can be used as a means to collaborate even when the parties do not know or trust each other, which is why many believe blockchain technology to be a direct substitute of trust or a technical manifestation of so-called trustless trust (De Filippi et al., 2020; Risius & Spohrer, 2017; Werbach, 2018). Hawlitschek et al. (2018) have examined this notion of blockchain's trustlessness in an extensive literature review and found that the key to successful collaboration is not the algorithm-based trust of blockchain technology (Al Khalil, Butler, O'Brien, & Ceci, 2017; Maurer, Nelms, & Swartz, 2013). Rather, it is *institution-based trust* (Abbas et al., 2020; Lustig & Nardi, 2015). Blockchain only mediates this trust by virtue of its underlying technical properties, such as immutability and selective transparency (Amend & Kaiser, 2021; Rieger et al., 2019; Roth et al., 2022). With this in mind, we aimed to design a customer loyalty program for electricity suppliers that is based on blockchain. Such loyalty programs may already be known from the works of Bulbul and İnce (2018) and Choi (2018), who focus on the development and analysis of technical components of blockchain-based customer loyalty programs. Moreover, Agrawal et al. (2018) address related implementation and stakeholder challenges. Extending these works, this paper focuses on ethical design, incorporating the latent dimensions of *institution-based trust* and *institution-based distrust*, which is ideally suited to inspire customer trust and to reduce distrust as essential albeit often neglected factors to customer loyalty.

3. Research method

3.1. Design Science Research approach

We followed a DSR approach to analyze the role that blockchain technology can play in the creation of a customer loyalty program which reinvigorates *institution-based trust*, reduces *institution-based distrust*, and resolves customer *ambivalence*. DSR is a well-established research method, widely used in the design and development of various IT-based artifacts, such as constructs, frameworks, architectures, models, methods, and instantiations or algorithms (Hevner, March, Park & Ram, 2004; Peffers et al., 2012). DSR also covers more abstract artifacts like social innovations and design propositions (van Aken, 2004), technical and social properties (Järvinen, 2007) or related design principles and theories (Costa, Soares, & de Sousa, 2020; Vaishnavi & Uechler, 2008).

Our artifact, Nexo Energy, constitutes a conceptual architecture for a blockchain-based customer loyalty program. Throughout the iterative process of its design and construction (Hevner & Chatterjee, 2012; Hevner et al., 2004), we followed the DSR steps proposed by (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007) (Fig. 1). We began with a comprehensive literature review to identify the problems and define a preliminary set of design requirements (DR) and objectives (DO) (Webster & Watson, 2002). We then refined these DRs and DOs as represented in our architecture, first in a workshop with an electricity supplier, then in ex-ante interviews with domain experts (DSR process steps 1–3) (Table A1).

To demonstrate and evaluate our conceptual architecture, we conducted a series of workshops with employees of the electricity supplier. We also implemented it in a prototype and tested it with the electricity supplier's customers. Lastly, we addressed its various features in a series of interviews (Table A1) with both groups (DSR process steps 4–6) (Hevner et al., 2004; Peffers et al., 2007).

When working on our final architecture, we developed four design principles (DP) that not only offer contributions to the theories of *institution-based trust* (Cheng et al., 2021; McKnight et al., 2017), *institution-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001), and *ambivalence* (Moody et al., 2014, 2017). Our four design principles also form a nascent design theory (Gregor & Hevner, 2013). This theory can be framed as a Design Relevant Explanatory or Predictive Theory (DREPT) that examines why the artifact can have the proposed effects (Kuechler & Vaishnavi, 2012). In contrast to an Information Systems Design Theory (ISDT), a DREPT better explains the relations between the kernel theory and the artifact (Walls, Widmeyer, & Sawy, 2004), thus bridging the gap between abstract theories and "achievable effects" (Kuechler & Vaishnavi, 2012, p. 399). In doing so, our theorizing is in line with demands for relevance of both the theoretical contributions and practical implications of the developed artifact (Gregor & Hevner, 2013; Hevner & Chatterjee, 2012; Hevner, 2007).

Our proposed DREPT makes a knowledge contribution of the exaptation type. Exaptation requires the extension of a known solution to new problems (Gregor & Hevner, 2013). Customer loyalty programs have a long tradition in business literature (Dowling & Uncles, 1997; Nunes & Drze, 2006; Uncles et al., 2003; Yi, Youjae & Hoseong, 2003), ever since American Airlines debuted their 'Frequent Flyer Program' three decades ago. In the intervening years, such programs have gained traction in multiple other areas, such as hospitality, retail, financial services (Hofman-Kohlmeyer, 2016), and the energy industry (Dolšak et al., 2019; Gamma, 2016), where the introduction of RES and GETs is currently a matter of notable contention (Ambrose, 2021; Andoni et al., 2019; Mezger et al., 2020). To mediate these contentions, technological innovations like blockchains are examined. They aim to extend and evolve current customer loyalty programs, while at the same time, their development may be instrumental in delivering generalizable design knowledge for future artifacts (Gregor & Hevner, 2013).

3.2. Identifying the problem and defining the objectives

In line with Webster and Watson (2002), we conducted a preliminary literature search on various databases, including Google Scholar, Scopus, Web of Science, etc. For each search, we used using multiple keywords and combinations, such as "trust distrust", "customer loyalty trust", or "blockchain trust". When reading the literature on blockchain technology in electric power systems and beyond, we focused on publications dating back nor further than 2018, at which time applications reached a level of maturity beyond conceptualization. After our initial keyword search, we eliminated lower-quality publications by considering the journal impact factors and scientific merit criteria applied by Scopus. Upon reviewing the titles and abstracts of this high-quality subset, we identified 95 publications of immediate relevance to our analysis. Having analyzed each of these publications, we extrapolated a preliminary problem statement and derived an initial set of design requirements and design objectives.

In the next step, we refined these requirements and objectives by organizing a workshop with an electricity supplier in Leipzig, Germany. In addition, we also conducted 18 ex-ante interviews with domain experts. Three of the workshop participants were managers of the electricity supplier, two of them employers of its IT service provider. We asked each of our 18 interviewees how their customers had reacted to green electricity, to GETs, and to any associated challenges. As recommended by Myers and Newman (2007), we used a semi-structured interview format. The interviews lasted between 45 and 60 min. They were audio-recorded as well as transcribed for further examination. When moving on to our data analysis, we followed the recommendations of Miles et al. (2018) by performing a two-step coding process based on inductive and deductive coding.

3.3. Demonstration and evaluation

We demonstrated and evaluated our blockchain-based customer loyalty program by means of a series of workshops with employees of the electricity supplier, extensive testing with 25 customers, and a total of 12 semi-structured interviews with members of both groups. This allowed us to continuously review and refine our conceptual architecture in iterative build-and-evaluate loops (Hevner et al., 2004; Peffers et al., 2007). We visited the test customers at regular intervals and noted their experiences and requests for adaption. In our interviews with the electricity supplier and its customers, we initially discussed the status quo, the challenges related to current GETs, and the possible applications of blockchain technology that might validate the identified design requirements and objectives. Subsequently, we presented a draft of our conceptual architecture for a blockchain-based customer loyalty program and gathered feedback. Like the ex-ante interviews, our evaluation interviews were between 45 and 60 min in length, audio-recorded, transcribed, and analyzed in a two-step coding process.

4. A blockchain-based customer loyalty program

4.1. Objectives of the artifact

By way of our literature analysis, ex-ante workshop, and ex-ante expert interviews, we arrived at 14 design requirements and 6 design objectives (Table A2) which together provide the framework for the architecture of our blockchain-based customer loyalty program.

4.1.1. DO1 – Accountability

Typically, customers have to rely on their electricity supplier when it

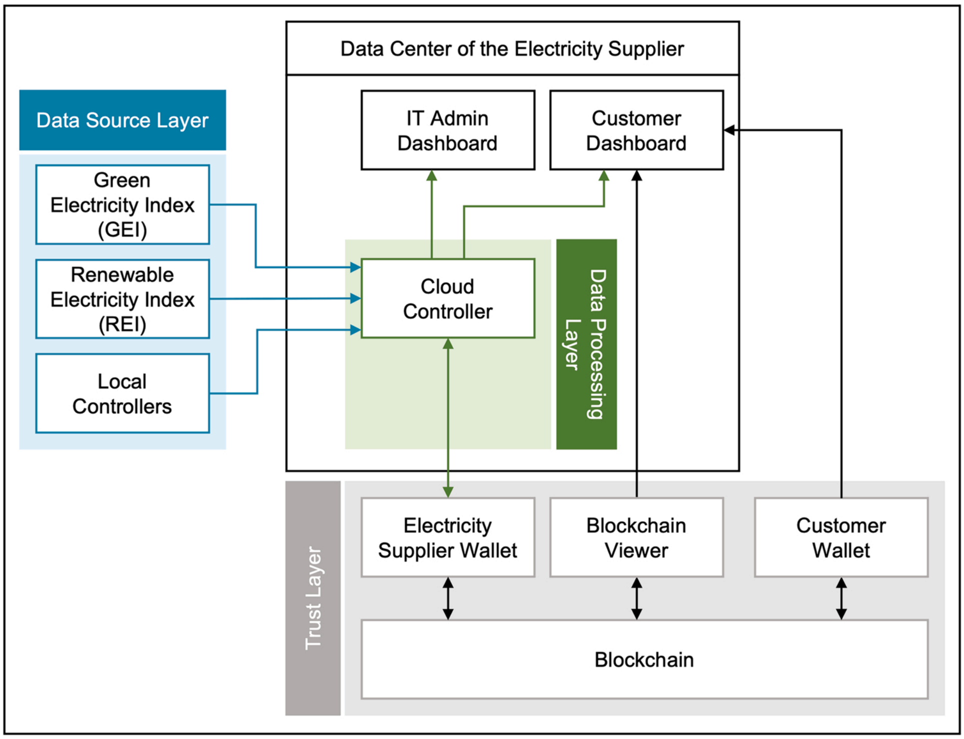

Fig. 2. Nexo Energy's architecture.

comes to their consumption data, the origin of consumed electricity, and electricity pricing (Ahl et al., 2020; Perrons & Cosby, 2020). To give customers more control over their data, and to prevent any subsequent manipulation by the electricity supplier (Andoni et al., 2019; Risius & Spohrer, 2017), one has to provide *tamper-proof and easily accessible storage of data in the blockchain network (DR1)*. Ease of access is of critical importance because many customers are not digitally literate enough to interpret data that is directly extracted from the blockchain (Jang, Han, & Kim, 2020). Instead, data has to be displayed in a readily accessible and verifiable way (Lockl, Schlatt, Schweizer, Urbach, & Harth, 2020; Paymans, Lindenberg, & Neerincx, 2004). This is also true of consumption and generation data which has been transferred to the blockchain. To avoid the storage of erroneous data or its manipulation during the information transfer (Rieger et al., 2019), *tamper-proof and automated data processing (DR2)* is required, for instance via smart contracts.

4.1.2. DO2 – Customizability

In the context of GETs, data on the generation of electricity has for quite some time now been the largest bone of contention between customers and suppliers (Ambrose, 2021; Andoni et al., 2019; Mezger et al., 2020). Collecting and storing such data in the back-end systems of energy suppliers is no longer deemed sufficient by many customers. This has led to requests for additional, secure *storage of generation and consumption data (DR3 and DR4)* in the blockchain network. Access to such securely and immutably stored data (Perrons & Cosby, 2020) enables customers not only to automatically adjust their electricity consumption but also to do so flexibly, depending on the share of renewable or green electricity in the grid. This *intuitive and comprehensive adjustment of electricity consumption (DR5)* is particularly relevant to GET customers who are concerned about the sustainability of their electricity consumption. With this growing demographic in mind, the architecture should also help customers monitor their consumption data. While the direct storage of consumption data in the blockchain network violates privacy regulations, such as the General Data Protection Regulation (GDPR), it is worth noting that pseudonymized transaction values are less critical. Albeit verifiable, they would prevent the inadvertent attribution to customers (Rieger, Roth, Sedlmeir, & Fridgen, 2021).

4.1.3. DO3 – Simplicity

Customers vary in their degree of digital literacy (Paymans et al., 2004; Portes, Cases, & N'Goala, 2020), which is why the architecture requires an *intuitive user interface (DR8)*. Users should not have to deal with the technical details of blockchain technology (Lockl et al., 2020), be it when monitoring generation and consumption data, or when managing their GET and sustainability bonuses. This requirement also applies to system setup and access. Should it be deemed necessary or desirable that the setup can be done without the support of a technician, the electricity supplier is advised to *deliver all information for the setup process (DR6)*. Moreover, the architecture should enable *automatic smart device detection (DR7)* to ease the setup process for customers.

4.1.4. DO4 – Efficiency

A key component of a reliable customer loyalty program is the seamless information exchange between electricity supplier and customer (Andoni et al., 2019; Gorski, Bednarski, & Chaczko, 2019). The specific requirement for this exchange is *fast data synchronization between software components (DR9)*. Since blockchain does not scale as easily as other technologies (Di Silvestre et al., 2020; Khorasany, Dorri, Razzaghi, & Jurdak, 2021; Saha et al., 2021; Sousa et al., 2019) data processing via blockchain should be reduced to a minimum to retain *high software uptime and availability (DR10)*.

4.1.5. DO5 – Maintainability

If the architecture is to work well for all customers, it is important that it can connect to different legacy systems (Ahl et al., 2020; Hasankhani, Mehdi Hakimi, Shafie-khah, & Asadolahi, 2021). Specifically, this means that the uptime of the connection should be *easy to monitor by IT administrator staff (DR11)* to ensure that they can make helpful interventions, should any be required. While customers do not have monitoring and maintenance responsibilities, they should be given responsibility for the design of their service agreement. What this means

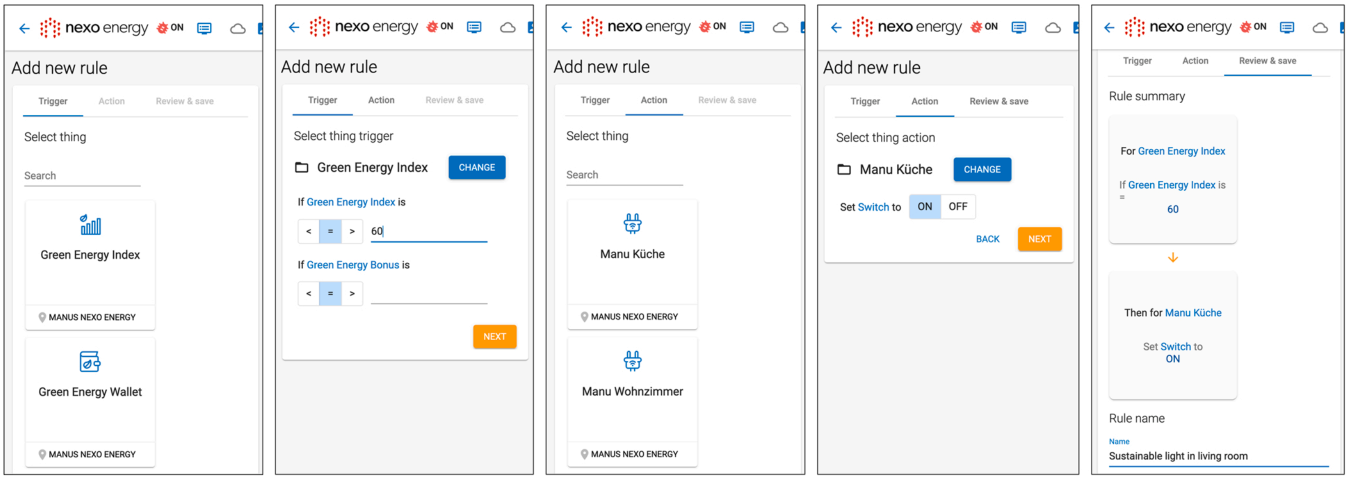

Fig. 3. Connecting smart devices with services via rules (app view).

in practical terms is that Nexo Energy should integrate existing GETs and make it *easy to order for customers (DR12)* who wish to use it in addition to existing or new GETs.

4.1.6. DO6 – Affordability

Participation in a blockchain-based customer loyalty program should remain *affordable for customers (DR13)*. While the architecture should accommodate GETs that are tailored to the needs of individual customers, electricity suppliers should keep the costs for this additional service at bay (Gomes, Melicio, & Mendes, 2021; MacDonald & Eyre, 2018). Customers are already charged a higher price for GETs and would probably become skeptical to the point of cancelling the tariff were they to receive the same electricity mix as before but at an even higher price and with only a slightly improved service offering (Ambrose, 2021; Guo et al., 2014; Mezger et al., 2020). It is, therefore, important for electricity suppliers to ensure *reasonable costs for operation (DR14)* before they implement a blockchain-based customer loyalty program. Related considerations include the choice of consensus mechanism and energy consumption as well as affordable hardware options, such as a Raspberry Pi (Raspberry Pi Foundation, 2016).

4.2. Description of the artifact

The overarching goals of our artifact, Nexo Energy, are the restoration of *institution-based trust*, the reduction of *institution-based distrust*, and the resolution of *ambivalence*. Offering customers transparency and affording them the opportunity to actively participate in their electricity supplier's sustainability efforts can improve the trust between supplier and customer. More specifically, our blockchain-based artifact enables customers to trace electricity generation data and monitor their own electricity consumption. What is more, Nexo Energy allows customers to optimize their consumption patterns according to their sustainability and cost reduction preferences. Customers can set their own rules for their smart appliances, for instance, "consume electricity primarily at times when the share of regional green electricity is particularly high or when electricity prices are exceptionally low". By setting such sustainable rules and consumption patterns, customers qualify for additional loyalty tokens. These tokens are awarded for an increased consumption of green electricity and can be used in a variety of ways: to reduce the price of a customer's GET, to make donations to charity, to use services of other utility companies like electric scooters or car sharing, or to reinvest in shares of RES, which contributes directly to the greater adoption and availability of green electricity. Overall, Nexo Energy comprises three layers: the data source layer, the operation layer, and the trust layer (Fig. 2).

The **data source layer** provides consumption and generation data from authentic sources (DO1). The sustainability of generation can be assessed with the Green Electricity Index (GEI) or another Renewable Energy Index (REI) (Zoerner, 2020). Meanwhile, 'local controllers' provide authentic consumption data for all connected appliances (DO1, DO2). Local controllers are IoT devices that are installed in the households of customers and automatically connect to their smart appliances (Figure A1), whereupon they collect consumption data (DO2, DO4). To process data and to execute the underlying software, they require a reliable and scalable operating system (DO4), but the hardware for local controllers must not exceed a certain price limit. It must also not unduly increase the prices of existing GETs (DO6) and should remain affordable for customers. Based on an analysis of costs, network capabilities, and operating systems, we selected Raspberry Pis (DO6).

The **data processing layer** is at home in the data center of the electricity supplier, where it ensures a high degree of uptime and reliability (DO4). As the main element of data storage and display, it uses a cloud controller (DO5). To safeguard GDPR-compliance, such as the right to erasure (Rieger et al., 2019), the generation and consumption data collected by local controllers is not stored on the blockchain, but rather in the cloud controller's database (DO1, DO2). Individual web applications (see Figure A2) allow customers to display, monitor, and manage their current GET along with their electricity consumption levels (DO1, DO3). Moreover, customers can display their connected smart appliances alongside trustworthy data sources, such as the GEI or another REI (DO3). When using these data sources, customers can set rules for their smart appliances to ensure that their electricity consumption are in line with their sustainability preferences (DO5). For instance, a customer can set the rule that a WIFI-connected lamp shall be switched on or off depending on the availability of green electricity at the time of consumption (Fig. 3). Customers can freely determine the number and nature of such rules (DO3, DO5), while the local controllers synchronize with the cloud controller in short interval loops to transfer and store data (DO4).

The **trust layer** with its underlying blockchain network facilitates the issuance, storage, and verification of loyalty tokens (DO1). Supplier and customer have separate blockchain wallets and both can use their respective wallets to exchange loyalty tokens. These tokens are issued from the supplier's blockchain wallet, based on generation and consumption values transmitted by the cloud controller (DO1, DO2). Technically speaking, these values are the input for two smart contract functions that automatically (DO1, DO5) publish the bonus – a certain amount of loyalty tokens for the use of GETs – and transfer the determined amount of loyalty tokens from the supplier's blockchain address to that of the respective customer. The loyalty tokens can, for instance, be reinvested in RES, used to reduce the costs of current GETs, or transferred into fiat money. To prevent the electricity supplier from making retrospective changes without customers noticing that the original data has been tampered with, hashes of generation and consumption values are stored on the blockchain (DO1). To keep transaction costs at bay (DO6), we decided on the Ethereum blockchain and tested it in the Ethereum test network Ropsten (Github, 2020).

4.3. *Evaluation of the artifact*

4.3.1. *First design iteration*

The **first evaluation phase** of Nexo Energy consisted of two testing phases: an extensive technical testing phase and a customer testing phase. For the technical testing phase, we simulated more than 1000 transactions to ensure that data storage on the blockchain and data exchange via smart contracts was secure and resistant to abuse (DO1). Furthermore, we assessed the seamless transmission of data to the cloud component, i.e., the transmission of generation data from the GEI and that of consumption data from local controllers (DO2). This technical testing phase indicated no major flaws in the design and setup of Nexo Energy. Moving on to the user testing phase, we prepared starter kits containing the Raspberry Pi, two WIFI-lamps, and one WIFI-power-socket (Figure A1), as well as relevant installation and setup instructions for 25 test customers. Some of those customers, however, immediately requested more detailed information, especially concerning the function and value proposition of our architecture (DO3). Once installed, the local controller reliably and automatically connected to the two WIFI-lamps, the WIFI-power-socket, and other smart appliances in the test customer's household. Test customers were also able to set their own rules that adjusted the electricity consumption patterns of their connected devices to the availability of local green electricity generation (DO2, DO3).

However, adapting consumption in line with GEI generation was not intuitive and Nexo Energy failed to identify all smart appliances that could have been connected to the local controller (DO3). Another negative to be noted is that customers were unhappy with the original set-up since this required the use of a separate web application (blockchain viewer) to view their loyalty token transactions (Figure A3) (DO1, DO3). Feedback was positive, however, about the use of blockchain to manage loyalty tokens and publish bonuses for the use of GETs. To improve usability in this regard, customers were only provided with a simplified version of this data on the user dashboard. Feedback was also positive in relation to trust-enhancing elements of blockchain, i.e., its transparency and tamper-resistance (DO1). Meanwhile, the costs of hardware and services were deemed acceptable by electricity suppliers and customers alike (DO6). Since the first evaluation phase was primarily aimed at collecting customer feedback on the basic functions of Nexo Energy, questions about maintainability and efficiency were postponed to the second evaluation phase (DO4, DO5).

4.3.2. *Second design iteration*

In the **second evaluation phase**, we considered the feedback received during the first evaluation phase and adapted the setup and usability of Nexo Energy accordingly. To make the dashboard more accessible to customers, we integrated the blockchain viewer into the cloud dashboard (DO3, DO2). In addition, we engaged a design thinking coach to create illustrations that would explain the basic functions of Nexo Energy to customers and make the underlying value propositions more tangible and comprehensible. Some of these were retrospectively added to the starter kit (DO3). To make the connection of smart appliances less cumbersome, we added a green flower icon in the customer dashboard to all compatible appliances. One click on a smart appliance marked with this green flower icon would open a submenu in which customers could set a threshold for the minimum availability of green electricity in the grid, and this minimum measure could easily be brought in line with GEI. Accordingly, all appliances would turn off when the availability of green energy was below the selected threshold; above it, they would turn on (DO3).

Even though these improvements appealed to customers, we saw fewer interactions and received less feedback. When we asked the test customers about this change in behavior, they indicated that they had been engaging in fewer interactions due to the many down-times and long loading times of their customer dashboards (DO4). Those loading times had gone up from the acceptable maximum of 5–30 s, and customers dealing with more than one local controller were most affected by this negative development (DO2, DO4). We assumed the reason for these prolonged waiting times to be the data synchronization cycles between the local controllers and the cloud controller, but in order to be sure we scheduled a cause investigation for the third evaluation phase.

4.3.3. *Third design iteration*

In the **third evaluation phase,** we made improvements to downtimes and data synchronization rates (DO4), and added monitoring capabilities for IT administrators (DO5). As suspected, the interoperability and interconnectivity problems were caused by inefficient data synchronization between the cloud controller and local controllers (DO2, DO4). To resolve this issue, we introduced asynchronous queries that keep loading times within acceptable limits. We also managed to reduce downtimes after moving Nexo Energy to a stable development and production environment in which technical tests were simpler. Throughout these tests, we determined that certain flaws in the code were the cause of system instabilities which had led to the initial downtimes (DO4).

In the third evaluation phase, the loading times of local controllers were tracked by both customers and developers. Due to the limited monitoring capabilities of local controllers, however, we had to rely primarily on user feedback to determine exact loading latencies (DO4, DO5). This illustrated the need for an additional, automated monitoring capability (DO5). Customers also had achieved a deeper understanding of the underlying blockchain technology and criticized the management of their blockchain addresses (DO1). In the first and second design iteration, we had bundled the management of the supplier and customer addresses in one blockchain wallet, since doing so took account of usability and digital literacy (DO3), but now customers explicitly requested their own blockchain wallets and more control (DO1). Meanwhile, the general interest that customers showed in Nexo Energy had increased considerably, which is why a separate, simple ordering tool (DO5) was set up for the supplier's entire customer base.

4.3.4. *Final design*

When working on the **final design** in the fourth evaluation phase of Nexo Energy, we focused on making the monitoring capabilities of IT administrators more efficient, so we introduced an IT admin dashboard (Figure A4). This dashboard allowed IT administrators not just to view the on- or offline status of local controllers but also to assess the latency of loading times as it showed the electricity consumption of all smart appliances connected to local controllers (DO4, DO5). Should a connected appliance not respond, IT administrators were able to initiate a problem diagnosis (DO5). The decision to use only a single blockchain wallet was reversed, and customers were given their own wallets (DO1, DO3). They were further given the opportunity to connect any valid Ethereum blockchain address to their local controllers (DO1). Moreover, it was now possible to order Nexo Energy via the electricity supplier's website (DO5).

Feedback from IT administrators indicated that the IT admin dashboard was as user-friendly as it was functional in performing such essential tasks as monitoring local controllers (DO5). Customers appreciated the possibility to access their blockchain addresses directly, which increased the general feeling of technical emancipation and trust (DO1). Furthermore, the convenient method of ordering Nexo Energy via the electricity supplier's website had a positive impact on its perceived usability (DO3, DO5). The outcome of the four evaluation phases showed that all DRs and DOs had been considered and refined in the various design iterations (Table A3), which allows us to conclude

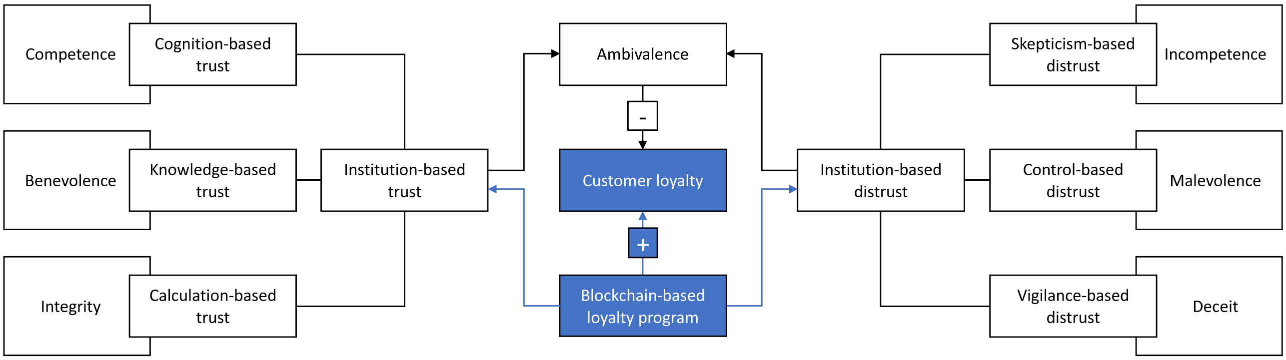

Fig. 4. Overview of the positive effects of our blockchain-based loyalty program on institution-based trust, institution-based distrust, and ambivalence.

that the presented architecture fulfills the required intention-design fit (Gregor & Hevner, 2013; Hevner et al., 2004).

5. Discussion

The evaluation of our conceptual architecture produced a number of insights of general validity concerning the design of blockchain-based customer loyalty programs. Following in the footsteps of Gregor and Hevner (2013) and Baskerville, Baiyere, Gregor, Hevner, and Rossi (2018), we have identified four design principles that promise to be of use to practitioners who wish to design and successfully implement such programs.

In using blockchain technology for our artifact and its multiple design iterations, we also contribute to theory. Specifically, we indicate how blockchain can help to restore *institution-based trust*, restrict *institution-based distrust*, and resolve *ambivalence* for customers dealing with electricity suppliers. In doing so, we connect theories about *institution-based trust* (McKnight et al., 2017; Moody et al., 2017), *ambivalence* (Moody et al., 2017), and *institution-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001; McKnight & Choudhury, 2006). In conjunction, these theories account for many of the intricacies of customer loyalty (Chu et al., 2012; Stathopoulou & Balabanis, 2016). Moreover, their successful integration into a DSR approach underlines the importance of bringing together theory and practice when it comes to the development of innovative solutions for complex problems (Gregor & Hevner, 2013; Kuechler & Vaishnavi, 2012).

5.1. Practical implications

The loss of customer loyalty is not a unique problem for electricity suppliers. Across multiple industries, such as hospitality (Kandampully, Zhang, Christina & Bilgihan, 2015; McCall & McMahon, 2016) and retail (Vesel & Zabkar, 2009; Yi, Youjae & Hoseong, 2003), service providers are struggling to retain their customers. One way to reverse this trend and increase customer loyalty is to implement loyalty programs that can help develop long-lasting relationships between service providers and their customers (Hofman-Kohlmeyer, 2016). Basing these programs on blockchain technology, rather than on regular databases, promises to be an important mediator on the customer's journey from *ambivalence* to *institution-based trust*; as we have shown, blockchain does this by virtue of its inherent properties (Amend & Kaiser, 2021; Rieger et al., 2019; Roth et al., 2022; Sedlmeir et al., 2020). Since the four design principles that emerged in the development and evaluation of our conceptual architecture can be abstracted and generalized, they may support a broad variety of practitioners.

5.1.1. DP1 – Give customers agency

When evaluating customer feedback in our design iteration phases, we learned that customers value choices (Interviews 1,3,5,6,7,8,9,12). Although they initially found it somewhat challenging to set their own rules for smart appliances and determine thresholds for electricity in line with GETs, they became increasingly appreciative of the level of personalization afforded to them by Nexo Energy (Interviews 2,3,4,5,10,11,12). Another positive impression shared by several test subjects was that, unlike many other customer loyalty programs (Bulbul & İnce, 2018; Uncles et al., 2003), Nexo Energy allowed customers to use their obtained loyalty tokens for a purpose of their own choosing (Interviews 1,2,3,6,7,8,9,10). Our test customers appreciated that they could exchange their tokens for fiat money or use them at participating public utility companies to pay for such services as the rental of electric scooters or cars. Other options were also welcomed, such as the opportunity to reinvest one's tokens into shares of RES. This general appreciation extended to the fact that the value of these tokens is high because they are not exclusive to the electricity supplier. Indeed, they have value beyond the loyalty program (Interviews 2,3,5,6,7,9,11) since there are multiple other reinvestment opportunities, which give the tokens a much broader appeal. One positive side-effect of this broadened loyalty token scheme is that customers feel their choices are taken seriously, so much so that these choices can have an impact beyond consumption (Interviews 1,2,3,4,6,7,8,10,11). Customers are most likely to enjoy this sense of choice and real agency when customer loyalty programs do not anticipate all services but instead leave room for customers to shape their own portfolio of desired services and functions.

5.1.2. DP2 – Provide customers with sufficient and verifiable information

In the first evaluation phase, customers criticized the customer kit that presented Nexo Energy's value propositions. According to this initial feedback, there was too much information and too little clarity (Interviews 2,3,5,6,8,9,10,11,12). Such poor communication and insufficient verifiability were the root cause of customer skepticism (Interviews 2,3,5,6,7,9,11). With this in mind, we consulted a design thinking coach in the second design iteration to help us provide accessible explanations and tangible value propositions for Nexo Energy. After all, customers require more information than superficial knowledge about the purpose of a service if they are to assess the trustworthiness of their electricity supplier (Interviews 3,5,7,8,9). Of particular interest in this context is the sustainability of electricity. Since all of the information on this key factor is transparently and immutably stored on the blockchain, customers can easily check whether their electricity is as sustainable as promised by their GETs (Interviews 2,3,5,7). Likewise, all other data posted on the user dashboard is verifiable by customers. If need be, customers can control the compliance with individually determined rules and set GET thresholds for every smart appliance and every single transaction. Since such simple consumption management and reliability control of GETs are enormously attractive, customer loyalty programs should proactively ensure that customers can access all required information in an easily verifiable manner.

5.1.3. DP3 – Consider appropriate levels of usability for customers

Customers have varying levels of digital literacy (Interviews

2,4,5,6,7,8,9). What they all have in common, however, is the desire for equal access to offered services (Interviews 1,4,5,6,8,12). Making everything equally accessible is particularly challenging, however, when it involves the use of innovative technologies like blockchain. As evaluations of Nexo Energy have indicated, the user interface should be as simple and intuitive as possible (Interviews 1,2,4,6,7,11,12). Irrespective of how complex the underlying processes turn out to be, the user interface ought to contain nothing more than the didactically minimum of information required to make use of the technology's functions. This also applies to the execution of services. It should be automized as far as possible, which is to say that customers should only have to take individual steps themselves in relevant situations, where either their choice or their consent is required. To improve usability accordingly, Nexo Energy bundled the blockchain addresses of all its customers in the energy provider's wallet. This decision, however, was met with significant backlash from digitally rather emancipated customers, so we reversed it in the fourth design iteration and gave customers their own blockchain wallets (Interviews 4,6,7,8,9). What this process showed us is that, although data stored directly on the blockchain is difficult to read and would exceed the digital literacy of most users, service providers should not decide on behalf of all customers which functions each of them is allowed to use. Instead, service providers would do well to offer a spectrum. As long as the key message is retained also at the didactically most simplified level, users are not disadvantaged, not even if they cannot understand the information at the most granular level (Interviews 1,2,4,5,8,11). In short, customer loyalty programs should not proactively reduce access to more granular information but instead provide different levels of didactical reduction while retaining the basic message.

5.1.4. DP4 – Give data access to customers

Information asymmetry between an electricity supplier and its customers puts the latter in the uncomfortable position of having to take the supplier's assurances on faith, without knowing whether this faith will be repaid (Ambrose, 2021; Guo et al., 2014; Mezger et al., 2020). With the introduction of blockchain technology, however, loyalty programs can provide customers with a tamper-resistant transaction record stored in a distributed fashion (Amend & Kaiser, 2021; Rieger et al., 2019; Sedlmeir et al., 2020). This record includes hashes of all consumption and generation values as well as the respective token transactions. To increase usability, an early version of Nexo Energy only provided customers with a simplified version of this data on the user dashboard. Customers had no way of verifying the displayed data. With advancing digital literacy, however, customers demanded access to their blockchain addresses in order to directly monitor electricity consumption and generation data as well as loyalty token transactions on the blockchain (Interviews 1,4,5,6,7,9). After this considerable reduction of 'data asymmetry', customers came to appreciate that blockchain technology enables the desired checks and balances required to create an equal footing for customers and suppliers (Interviews 1,4,5,7,8,11,12). While many service providers fear the effects of giving customers unlimited and transparent access to their data (Merlo, Eisingerich, Auh, & Levstek, 2018), our analysis of Nexo Energy indicates that such customer emancipation does not alienate customers from their supplier (Interviews 2,3,4,7,8,9). Far from it, the result was a feeling of empowerment that strengthens the bond between customer and service provider (Interviews 1,2,4,5,6,7,10,11). Consequently, customer loyalty programs promise the greatest success if they include an option for customers to be granted access to all relevant and verifiable data.

5.2. Theoretical implications

The four identified design principles provide more than actionable guidelines for the development of specific blockchain-based customer loyalty programs. They also offer insights into *trust*-restoring, *distrust*-reducing, and *ambivalence*-resolving processes, as described in the relevant literature (Kramer, 1999; McKnight & Chervany Norman, 2001; McKnight & Choudhury, 2006; McKnight et al., 2017; Moody et al., 2017). While the relationship between trust and loyalty has been researched and discussed at length (Chu et al., 2012; Martínez & Rodríguez del Bosque, 2013; Nguyen, Leclerc, & LeBlanc, 2013; Stathopoulou & Balabanis, 2016), actionable trust factors have yet to be clearly defined (Chaudhuri & Holbrook, 2001; Stathopoulou & Balabanis, 2016). Some have hypothesized that *institution-based distrust* and *ambivalence* have a negative impact on customer loyalty, but this supposed impact has yet to be observed in practice (Lee et al., 2015; Yen, 2010). In the following, we do exactly that by demonstrating how our blockchain-based architecture and its underlying design principles function as mediating factors (Fig. 4) to rebuild *institution-based trust* (McKnight et al., 2017; Moody et al., 2017), reduce *institution-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001; McKnight & Choudhury, 2006; Moody et al., 2017), and resolve *ambivalence* (Moody et al., 2014, 2017).

As illustrated in Fig. 4, our blockchain-based architecture counters *ambivalence* and mediates between the two latent constructs of *trust* and *distrust* as well as their respective latent factors (Kramer, 1999; McKnight & Chervany Norman, 2001; McKnight & Choudhury, 2006; McKnight et al., 1998, 2017).

5.2.1. Impact on institution-based trust

Although some prior studies have made attempts to base customer loyalty programs on blockchain technology (Agrawal et al., 2018; Bulbul & İnce, 2018; Choi, 2018), they have not elaborated on the intricate relationship between *institution-based trust* factors and blockchain properties, nor have they analyzed how their interplay fosters customer loyalty. To do so, we focused on increased customer agency when we defined our **first design principle (DP1)**. Customers are given the opportunity to tailor the services and functions of Nexo Energy in a self-responsible fashion, which is to say they can choose to adjust any and all of them to their needs and priorities. No longer are they passive consumers of electricity at the mercy of predefined GETs (Ambrose, 2021; Guo et al., 2014; Mezger et al., 2020). Instead, customers become actively involved in a bilateral process; directly setting goals for their electricity consumption and indirectly setting goals for their electricity supplier's sustainability agenda. As a result, the supplier and its customers have a common goal, which is an essential dimension in the creation of *cognition-based trust* (Cheng et al., 2021; McKnight et al., 1998). Furthermore, the possibility to reinvest blockchain loyalty tokens into shares of RES proves to customers that the supplier is *competently* supporting the distribution of green electricity, rather than attempting to deceive its customers (Ambrose, 2021; Mezger et al., 2020). Having an immutable and transparent transaction record of loyalty tokens on the blockchain further emancipates customers in the sense that the supplier invests them with verification capabilities (Ziolkowski et al., 2020). Moreover, since the use of Nexo Energy requires continuous interaction between the supplier and its customers, the latter gain the reassuring feeling that their choices are being taken seriously, so much so that they can have a real impact on the supplier's development of its business model. This is a contributing factor to *knowledge-based trust* (Cheng et al., 2021; Li, Pieńkowski, Van Moorsel, & Smith, 2012; McKnight et al., 1998) as it indicates the *benevolence* of electricity suppliers (Moody et al., 2017).

In defining our **second design principle (DP2)**, we took account of the high value that customers place on the possession of sufficient and verifiable information, especially the kind that they can personally access and verify. At present, the poor state of information provision and the insufficient verifiability of said information are the root causes of skepticism concerning GETs and related 'greenwashing' allegations

(Ambrose, 2021; Andoni et al., 2019; Mezger et al., 2020). During the multiple design iterations of Nexo Energy, we tried to eliminate the perceived information asymmetry by giving customers access to the blockchain component. The ensuing verifiability of information about hashes of consumption and generation data (Ahl et al., 2020; Perrons & Cosby, 2020) enabled customers to check whether the system complied with their individually determined rules as well as with the GEI thresholds of smart appliances. As we saw, this lets customers appreciate the supplier's *competency* to uphold contractually agreed services, which is seen as 'evidence of trustworthiness' or 'good reasons' to develop *cognition-based trust* (Cheng et al., 2021; McAllister, 1995). Furthermore, when given access to hashes of values concerning both consumption data and generation data as well as token transactions, customers are better able to assess the benefits of participating in Nexo Energy. Allowing customers to see and calculate all of the costs and benefits proved to be the foundation for *calculation-based trust* (Cheng et al., 2021; McKnight et al., 1998). It also provided obvious evidence of the electricity supplier's *integrity* (Moody et al., 2014, 2017).

In defining our **third design principle (DP3)**, we placed the emphasis on appropriate levels of usability for customers. While innovative technologies like blockchain entail many highly technical functions that would confuse average customers, we found that electricity suppliers do well not to preclude access to more detailed information. This was an important lesson learned during the design iterations of Nexo Energy, where the customers' blockchain wallets and control over their blockchain addresses were initially eliminated yet later reinstated due to notable customer disapproval. Having not only access to information as well as control over it because it is directly stored on the blockchain (Perrons & Cosby, 2020; Seebacher & Schüritz, 2017), customers can judge the reliability of their supplier along with its *competence* (Ibrahim & Ribbers, 2009) to deliver the agreed services (*cognition-based trust*) (Cheng et al., 2021; McAllister, 1995). Perhaps just as important is the fact that they can judge not only its *integrity* to deliver benefits for the customer (*calculation-based trust*) (Li et al., 2012; McKnight et al., 1998), but also its *benevolence* as this is instantly apparent when looking at the immutable transaction-history (*knowledge-based trust*) (Cheng et al., 2021; McKnight et al., 1998). To make such a comprehensive judgement possible, suppliers can provide this immutable and transparent data record on the blockchain (Hameed, Barika, Garg, Amin, & Kang, 2022; Sedlmeir et al., 2020; Zhang et al., 2019). Suppliers can also simplify auditability (Amend & Kaiser, 2021) on the user dashboard to cater to their less digitally-literate customers. As a result, all customers can rest assured that the supplier is trying to engage them equally in its endeavor to rebuild *institution-based trust*.

When defining our **fourth design principle (DP4)**, we concentrated on the importance of sufficient data access for customers. The current information asymmetry between electricity suppliers and customers makes it difficult for the latter to base their trust on rational decision-making (Bélanger & Carter, 2008; Dietz & Gillespie, 2011; van der Werff et al., 2019). It stands to reason, then, that customers are rather unwilling to be vulnerable to a supplier's policy changes (Ambrose, 2021; Cheng et al., 2021; Mezger et al., 2020; Tams et al., 2018). In the interest of more rational decision-making, we found that blockchain technology can be introduced into loyalty programs to ensure that customers have a tamper-resistant transaction record stored in a distributed leger (Amend & Kaiser, 2021; Rieger et al., 2019; Sedlmeir et al., 2020). However, letting customers assess consumption and generation data (Ahl et al., 2020; Perrons & Cosby, 2020) not only restores *cognition-based trust*. It also provides customers with their desired checks and balances (Abbas et al., 2020), which is to say it creates the necessary foundation on which customers can achieve an equal footing with their supplier. This empowerment of customers through the use of blockchain technology indicates a much-needed openness of the part of the electricity suppliers, which drives both *calculative-based* and *knowledge-based trust* (Ibrahim & Ribbers, 2009).

5.2.2. Impact on institution-based distrust

While there is already an extensive body of literature on the relationship between blockchain technology and trust (Abbas et al., 2020; Hawlitschek et al., 2018; Werbach, 2018), the research does not extend to the far-reaching ways in which the use of blockchain technology can reduce *institution-based distrust*. In developing our **first design principle (DP1)**, we discovered that an increase in customer agency leads to a decrease in their fear of *deceit* and thus a decrease in *vigilance-based distrust*. Customers can assume the responsibility of setting rules for their consumption patterns in line with GEIs, and they can use their blockchain-based loyalty tokens to invest in a purpose of their own choosing. They can even look at the blockchain to assess the system's compliance with their predefined choices (Kramer, 1999; McKnight & Chervany Norman, 2001). So far, countless customers are likely to have suspected that their electricity supplier is *incompetent* to deliver the agreed units of green electricity, as indicated by their GETs to date (Ambrose, 2021; Guo et al., 2014). This has encouraged a notable degree of *skepticism-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001). Going forward, however, they have the possibility to reinvest their tokens into shares of RES, which would automatically increase the distribution and availability of green electricity. What is more, when a supplier offers customers such reinvestment opportunities, it indicates that they share a common goal.

Both our **second design principle (DP2)** and our **fourth design principle (DP4)** had a moderating effect on *skepticism-based distrust* and *control-based distrust*. The ample provision of information and access to data immutably stored on the blockchain (Amend & Kaiser, 2021; Rieger et al., 2019; Sedlmeir et al., 2020) enabled customers to accumulate verifiable information. This prevented suspicions of *incompetence* and *malevolence* on the part of the electricity supplier (Kramer, 1999; McKnight & Choudhury, 2006; Moody et al., 2017). After all, since the information on the sustainability of electricity generated with GEI and hashes of consumption data are transparently stored on the blockchain, customers can easily detect retrospective changes to the data history (Sedlmeir et al., 2020).

Our **third design principle (DP3)** indirectly affects all three *institution-based distrust* dimensions: *skepticism-based distrust*, *control-based distrust*, and *vigilance-based distrust*. Without a tool like a blockchain viewer, customers are unable to monitor their data and accumulate the information required to assess the trustworthiness of their electricity suppliers (Kramer, 1999; McKnight & Choudhury, 2006; Moody et al., 2017). Moreover, they are unable to actively decide which individual services they would like to tailor to their specific needs. As our study has shown, however, usability is key to leveraging the potential of blockchain technology for customers, irrespective of how complex the underlying processes may be. Customers should, therefore, be able to access all essential information – even at the didactically most simplified level – to make their own rational choices and risk assessments (McKnight & Chervany Norman, 2001).

5.2.3. Creation of customer loyalty

As indicated in Fig. 4, an increase in *institution-based trust* and a decrease in *institution-based distrust* should notably reduce *ambivalence* (Moody et al., 2017). As we saw when deriving our design principles (DP1-DP4) from our blockchain-based customer loyalty program, it is possible to resolve the conflict between the competing latent constructs of *trust* and *distrust* (Jarvenpaa & Majchrzak, 2010; Moody et al., 2014). By providing unobstructed access to consumption and generation data (DP2, DP4) along with increased customer agency (DP1) and improved usability of technical monitoring tools (DP3), service providers can support the restoration of *institution-based trust* as well as the reduction of *institution-based distrust*.

As discussed in previous literature, reducing *ambivalence* may also have a positive impact on customer loyalty (Moody et al., 2017; Olsen et al., 2005). This would confirm assumptions that *ambivalence* is at the threshold of distrusting attitudes and that the behavior it motivates could negatively affect loyalty (Jonas, Broemer, & Diehl, 2000; Olsen et al., 2005). On the other hand, customers who felt empowered by Nexo Energy and saw themselves as active partners in this trust relationship indicated that they had little reason to distrust their electricity supplier. Since our proposed conceptual architecture facilitates this, it may indeed foster customer loyalty by virtue of resolving *ambivalence*, restoring *institution-based trust*, and reducing *institution-based distrust.*

5.3. Limitations of this study and potential for further research

Our study provides insights into how energy suppliers can design a customer loyalty program based on blockchain technology. The design principles derived from our artifact further indicate how blockchain technology can restore *institution-based trust* as well as reduce *institution-based distrust* and resolve *ambivalence* concerning electricity suppliers. These principles are predicated on theories about *institution-based trust* (McKnight et al., 2017; Moody et al., 2017) and *institution-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001; McKnight & Choudhury, 2006). Their multiple dimensions contribute significantly to whether or not customer loyalty is promoted (Chu et al., 2012; Stathopoulou & Balabanis, 2016). Despite our best efforts at rigorous analysis, however, this study is also subject to certain limitations.

Firstly, we did not quantify the electricity volumes that were affected by changes in consumption patterns due to the customers' predefined rules. Such quantification would have been necessary to evaluate effects beyond the customer-supplier relationship, such as the effects on distribution grid management. However, obtaining the necessary amount of quantitative data would have required a considerably larger test group as well as a far longer test period. Future research could, therefore, build on this study to evaluate such effects several months after broad implementation.

Secondly, our four design principles and our propositions concerning their effects on *institution-based trust* and *institution-based distrust* rely on a purely qualitative analysis supported by interviews and a comprehensive literature review. Additional quantitative analysis could determine the connection and interplay between both factors. Further research could particularly explore SEM-plots or hierarchical linear modeling based on quantitative data from questionnaires.

A final observation worth making here is that we only evaluated only one motivational factor, and we did so without considering its interplay with other motivational factors that may be driving how customers select and engage with their electricity suppliers. For instance, not all of them will be equally interested in sustainability, nor are all of them likely to respond with equal enthusiasm to increased customer agency and customer involvement. For many, cost factors may play a much more prominent role. With this in mind, future researchers may want to consider how customer intentions and preferences affect our proposed design principles and trust/distrust factors.

6. Conclusion

In this study, we discuss how blockchain technology can be used to design a customer loyalty program for electricity suppliers and how this blockchain-based customer loyalty program can restore *institution-based trust*, reduce *institution-based distrust*, and resolve *ambivalence* in order to retain or regain customer loyalty. We draw on various theories about the dimensions of *institution-based trust* (McKnight et al., 2017; Moody et al., 2017) and *institution-based distrust* (Kramer, 1999; McKnight & Chervany Norman, 2001; McKnight & Choudhury, 2006). Treating them as antecedents to customer loyalty (Chu et al., 2012; Stathopoulou & Balabanis, 2016), we argue that customer agency, sufficient and verifiable information, appropriate levels of usability, and unobstructed data access can increase customer loyalty. Particularly noteworthy is our finding that the immutable and transparent storage of data on the blockchain can have a significant positive impact on the three dimensions of *institution-based trust* and *institution-based distrust.* The same applies to specifically created customer dashboards for monitoring and blockchain wallets for token transfers. We have reason to believe, therefore, that our DSR approach to customer loyalty can help researchers and practitioners alike in efforts to understand the complex interplay of trust and distrust factors, especially when trying to generate or improve customer loyalty.

CRediT authorship contribution statement

Manuel Utz: Conceptualization, Data curation, Formal analysis, Writing – original draft. **Simon Johanning:** Conceptualization, Data curation, Formal analysis, Writing – original draft. **Tamara Roth:** Conceptualization, Writing – revised draft. **Thomas Bruckner:** Supervision, Writing – review & editing. **Jens Strüker:** Supervision, Writing – review & editing.

Declaration of Competing Interest

None. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

See appendix Figs A1–A4 and Tables A1–A3.

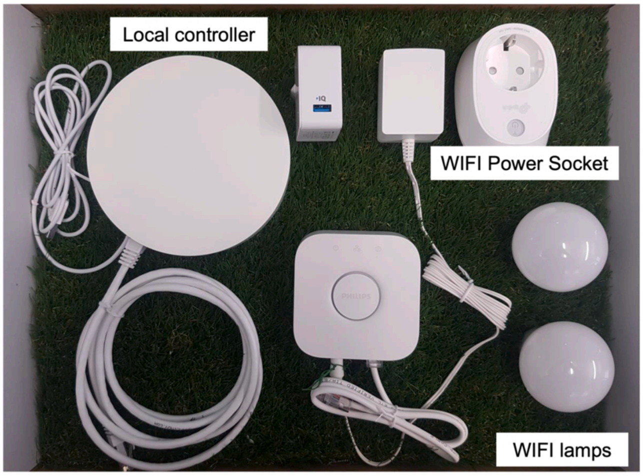
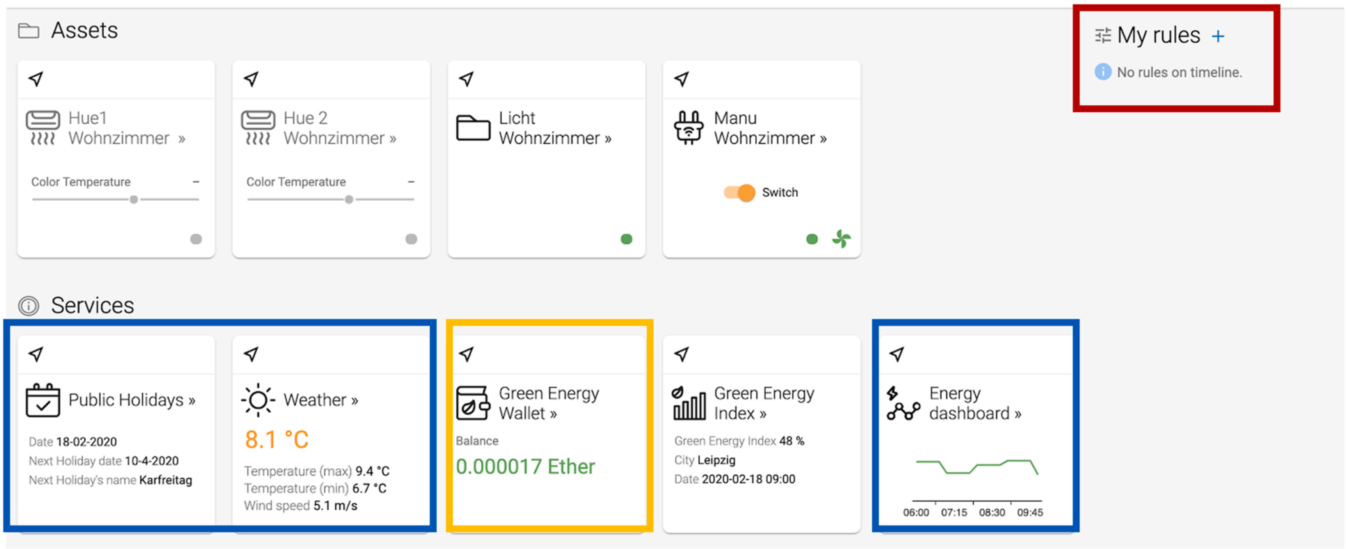


Fig. A1. Nexo Energy Starter Kit.



No rules on timeline.

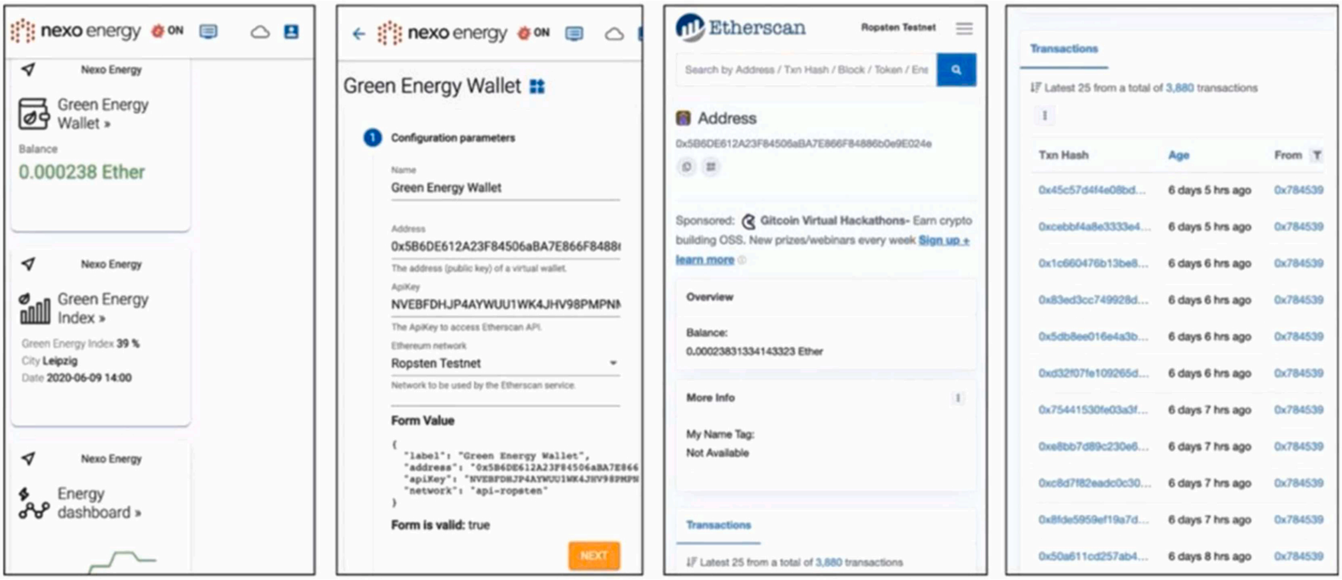
Date 18-02-2020
Next Holiday date 10-4-2020
Next Holiday's name Karfreitag

8.1 °C
Temperature (max) 9.4 °C
Temperature (min) 6.7 °C
Wind speed 5.1 m/s

Balance
0.000017 Ether

Green Energy Index 48 %
City Leipzig
Date 2020-02-18 09:00

Fig. A2. Customer Dashboard.



Balance
0.000238 Ether

Green Energy Index 39 %
City Leipzig
Date 2020-06-09 14:00

1 Configuration parameters

Name
Green Energy Wallet

Address
0x5B6DE612A23F84506aBA7E866F8488
The address (public key) of a virtual wallet.

ApiKey
NVEBFDHJP4AYWUU1WK4JHV98PMPN
The ApiKey to access Etherscan API.

Ethereum network
Ropsten Testnet
Network to be used by the Etherscan service.

Form Value

```
{
  "label": "Green Energy Wallet",
  "address": "0x5B6DE612A23F84506aBA7E866
  "apiKey": "NVEBFDHJP4AYWUU1WK4JHV98PMPN
  "network": "api-ropsten"
}
```

Form is valid: true

0x5B6DE612A23F84506aBA7E866F84886b0e9E024e

Sponsored: Gitcoin Virtual Hackathons- Earn crypto building OSS. New prizes/webinars every week Sign up + learn more

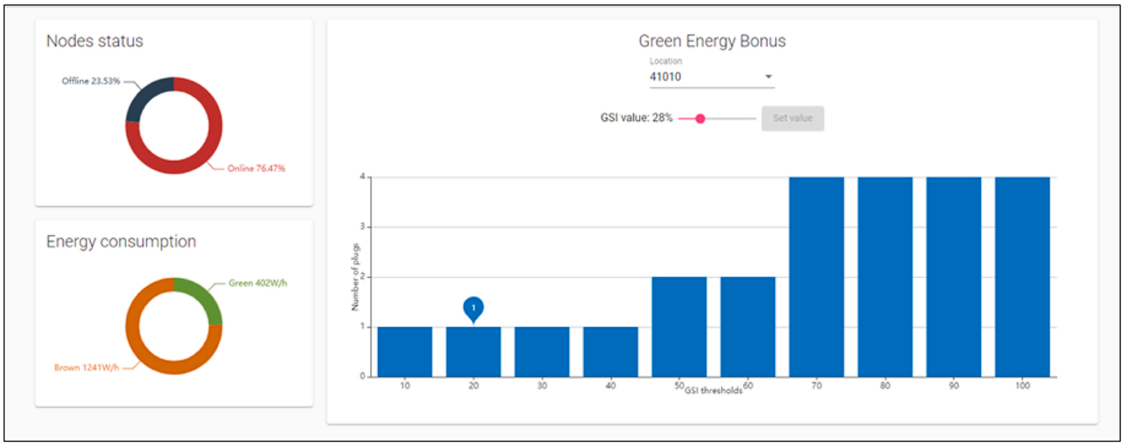
Balance:
0.00023831334143323 Ether

My Name Tag:
Not Available

Latest 25 from a total of 3,880 transactions

Txn Hash	Age	From
0x45c57d4f4e08bd...	6 days 5 hrs ago	0x784539
0xcebbf4a8e3333e4...	6 days 5 hrs ago	0x784539
0x1c660476b13be8...	6 days 6 hrs ago	0x784539
0x83ed3cc749928d...	6 days 6 hrs ago	0x784539
0x5db8ee016e4a3b...	6 days 6 hrs ago	0x784539
0xd32f07fe109265d...	6 days 6 hrs ago	0x784539
0x75441530fe03a3f...	6 days 7 hrs ago	0x784539
0xe8bb7d89c230e6...	6 days 7 hrs ago	0x784539
0xc8d7f82eadc0c30...	6 days 7 hrs ago	0x784539
0x8fde5959ef19a7d...	6 days 7 hrs ago	0x784539
0x50a611cd257ab4...	6 days 8 hrs ago	0x784539

Fig. A3. Blockchain Viewer Transaction History.



Location
41010

GSI value: 28%

Fig. A4. IT Admin Dashboard.

Table A1
Ex-Ante and Evaluation Interviews.

No.	Organisation	Role
Evaluation Interviews		
1	Energy utility	Head of Energy Asset Mgmt.
2	Energy utility	Teamlead Energy Products
3	Energy utility	Teamlead Energy Metering
4	Energy utility	IT Architect Digital Energy Solutions
5	Energy utility	Head of Data Security/ Data Center
6	Energy utility	Head of Dev. Ops
7	Energy utility	Head of Virtual Power Plants
8	Energy utility	Head of IT
9	Energy utility	IT Architect Digital Energy Solutions
10	Energy utility	Head of Virtual Power Plants
11	Energy utility	Fullstack Developer
12	Energy utility	Fullstack Developer
Ex-Ante Interviews		
13	Non-Profit Organization	Head of Electric Mobility
14	E-Mobility Start-Up	Product and Partner Manager
15	Energy Start-Up	Energy Sales and Business Development
16	Blockchain Start-Up	Business Development
17	Research Institute	Researcher
18	Software Company	Director Operations
19	Blockchain Start-Up	Chier Operations Officer
20	Consulting	Head of DLT
21	Energy utility	Head of Data Lab
22	Law office	Lawyer
23	Energy Service Provider	Digital Project Lead
24	Software Company	Head of Venture Creation
25	Non-Profit Organization	Head of Electric Mobility
26	E-Mobility Start-Up	Product and Partner Manager
27	Energy Start-Up	Energy Sales and Business Development
28	Blockchain Start-Up	Business Development
29	Research Institute	Researcher
30	Software Company	Director Operations

Table A2
Description of Design Requirements.

DO	DR	Description
DO1 (Accountability)	DR1	Tamper-proof and easily accessible storage of data in the blockchain network
	DR2	Tamper-proof and automated data processing
DO2 (Customizability)	DR3	Secure storage of electricity generation data
	DR4	Secure storage of electricity consumption data
	DR5	Intuitive and comprehensive adjustment of electricity consumption
DO3 (Simplicity)	DR6	Deliver all information for setup process
	DR7	Automatic smart device detection
	DR8	Intuitive user interface
DO4 (Efficiency)	DR9	Fast data synchronization between software components
	DR10	High software uptime and availability
DO5 (Maintainability)	DR11	Easy to monitor by IT administrator staff
	DR12	Easy to order for customers
DO6 (Affordability)	DR13	Affordable for customers
	DR14	Reasonable costs for operation

Table A3
Fulfilment of DOs and DRs during all Design Iterations.

DO	DR	Description	Initial Design	Second Design Iteration	Third Design Iteration	Final Design
DO1	DR1	Tamper-proof and easily accessible storage of data in the blockchain network	🟩	🟩	🟨	🟩
	DR2	Tamper-proof and automated data processing	🟩	🟩	🟩	🟩
DO2	DR3	Secure storage of electricity generation data	🟩	🟩	🟩	🟩
	DR4	Secure storage of electricity consumption data	🟩	🟩	🟩	🟩
	DR5	Intuitive and comprehensive adjustment of electricity consumption	🟨	🟩	🟩	🟩
DO3	DR6	Deliver all information for setup process	🟨	🟩	🟩	🟩
	DR7	Automatic smart device detection	🟩	🟩	🟩	🟩
	DR8	Intuitive user interface	🟨	🟩	🟩	🟩
DO4	DR9	Fast data synchronization between software components	🟧	🟧	🟩	🟩
	DR10	High software uptime and availability	🟧	🟧	🟩	🟩
DO5	DR11	Easy to monitor by IT administrator staff	🟧	🟧	🟧	🟩
	DR12	Easy to order for customers	🟧	🟧	🟧	🟩
DO6	DR13	Affordable for customers	🟩	🟩	🟩	🟩
	DR14	Reasonable costs for operation	🟩	🟩	🟩	🟩

References

Abad, A. V., & Dodds, P. E. (2020). Green hydrogen characterisation initiatives: definitions, standards, guarantees of origin, and challenges. *Energy Policy, 138*, Article 111300. https://doi.org/10.1016/j.enpol.2020.111300

Abbas, Y., Martinetti, A., Moerman, J. J., Hamberg, T., & van Dongen, L. A. M. (2020). Do you have confidence in how your rolling stock has been maintained? A blockchain-led knowledge-sharing platform for building trust between stakeholders. *International Journal of Information Management, 55*, Article 102228. https://doi.org/10.1016/j.ijinfomgt.2020.102228

Agrawal, D., Jureczek, N., Gopalakrishnan, G., Guzman, M., McDonald, M., & Kim, H. (2018). Loyalty Points on the Blockchain. *Business and Management Studies, 4*. https://doi.org/10.11114/bms.v4i3.3523

Ågerfalka, P. J., Axelsson, K., & Bergquist, M. (2022). Addressing climate change through stakeholder-centric information systems research: A Scandinavian approach for the masses. *International Journal of Information Management, 63*, Article 102447. https://doi.org/10.1016/j.ijinfomgt.2021.102447.

Ahl, A., Yarime, M., Goto, M., Chopra, S. S., Kumar, N. M., Tanaka, K., & Sagawa, D. (2020). Exploring blockchain for the energy transition: Opportunities and challenges based on a case study in Japan. *Renewable and Sustainable Energy Reviews, 117*, Article 109488. https://doi.org/10.1016/j.rser.2019.109488

Al Khalil, F., Butler, T., O'Brien, L., & Ceci, M. (2017). Trust in Smart Contracts is a Process. *As Well*. https://doi.org/10.1007/978-3-319-70278-0_32

Ambrose, J. (2021). How green is your 'green' energy tariff? The Guardian. https://www.theguardian.com/business/2021/apr/02/green-energy-tariff-renewable-deals.

Amend, J., Fridgen, G., Rieger, A., Roth, T., & Stohr, A. (2021). The evolution of an architectural paradigm-using blockchain to build a cross-organizational enterprise service bus. 54th Hawaii International Conference on System Sciences (HICSS), Maui, Hawaii (Virtual).

Amend, J., Kaiser, J., Uhlig, L., Urbach, N., & Völter, F. (2021). What do we really need? A systematic literature review of the requirements for blockchain-based e-government services. *Wirtschaftsinformatik 2021 Proceedings. Wirtschaftsinformatik 2021 Proceedings, 4*.

Andersen, J. V., & Bogusz, C. I. (2019). Self-organizing in blockchain infrastructures: generativity through shifting objectives and forking. *Journal of the Association for Information Systems, 20*(9), 1242–1273. https://doi.org/10.17705/1jais.00566

Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., … Peacock, A. (2019). Blockchain technology in the energy sector: a systematic review of challenges and opportunities. *Renewable and Sustainable Energy Reviews, 100*, 143–174. https://doi.org/10.1016/j.rser.2018.10.014

Ante, L., Steinmetz, F., & Fiedler, I. (2021). Blockchain and energy: a bibliometric analysis and review. *Renewable and Sustainable Energy Reviews, 137*, Article 110597. https://doi.org/10.1016/j.rser.2020.110597

Arkesteijn, K., & Oerlemans, L. (2005). The early adoption of green power by Dutch households an empirical exploration of factors influencing the early adoption of green electricity for domestic purposes. *Energy Policy, 33*(2), 183–196. https://doi.org/10.1016/S0301-4215(03)00209-X

Bang, H. K., Ellinger, A. E., Hadjimarcou, J., & Traichal, P. A. (2000). Consumer concern, knowledge, belief, and attitude toward renewable energy: an application of the reasoned action theory. *Psychology and Marketing, 17*(6), 449–468. https://doi.org/10.1002/(SICI)1520-6793(200006)17:6<449::AID-MAR2>3.0.CO;2-8

Bansal, H. S., Taylor, S. F., & James, Y. S. (2005). "Migrating" to new service providers: toward a unifying framework of consumers' switching behaviors. *Journal of the Academy of Marketing Science, 33*(1), 96–115. https://doi.org/10.1177/0092070304267928

Baskerville, R., Baiyere, A., Gregor, S., Hevner, A., & Rossi, M. (2018). Design science research contributions: finding a balance between artifact and theory. *Journal of the Association for Information Systems, 19*, 358–376. https://doi.org/10.17705/1jais.00495

Baumgarte, F., Glenk, G., & Rieger, A. (2020). Business models and profitability of energy storage. *IScience, 23*(10), Article 101554. https://doi.org/10.1016/j.isci.2020.101554

Beck, R., Müller-Bloch, C., & King, J. L. (2018). Governance in the blockchain economy: a framework and research agenda. *Journal of the Association for Information Systems, 19* (10), 1.

Bélanger, F., & Carter, L. (2008). Trust and risk in e-government adoption. *Journal of Strategic Information Systems, 17*(2), 165–176. https://doi.org/10.1016/j.jsis.2007.12.002

Berry, L. L., Parasuraman, A., & Zeithaml, V. A. (1988). SERVQUAL: a multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing, 64*(1), 12–40.

Bilgic, A., Hoogensen Gjørv, G., & Wilcock, C. (2019). Trust, distrust, and security: an untrustworthy immigrant in a trusting community. *Political Psychology, 40*(6), 1283–1296. https://doi.org/10.1111/pops.12613

Bogensperger, A., Zeiselmair, A., Hinterstocker, M., & Dufter, C. (2018). Blockchain technology - opportunity to transform the energy industry? Use cases. Forschungsstelle Für Energiewirtschaft e.V.

Bulbul, S., & İnce, G. (2018). Blockchain-based framework for customer loyalty program. *UBMK 2018 - 3rd International Conference on Computer Science and Engineering*, 342–346. https://doi.org/10.1109/UBMK.2018.8566642

Bumblauskas, D., Mann, A., Dugan, B., & Rittmer, J. (2020). A blockchain use case in food distribution: Do you know where your food has been? *International Journal of*

Information Management, 52, Article 102008. https://doi.org/10.1016/j.ijinfomgt.2019.09.004

Butijn, B. J., Tamburri, D. A., & Heuvel, W. J. V. D. (2020). Blockchains: a systematic multivocal literature review. *ACM Computing Surveys, 53*(3). https://doi.org/10.1145/3369052

Castellanos, J. A. F., Coll-Mayor, D., & Notholt, J. A. (2017). Cryptocurrency as guarantees of origin: simulating a green certificate market with the ethereum blockchain. *2017 5th IEEE International Conference on Smart Energy Grid Engineering, SEGE, 2017*, 367–372. https://doi.org/10.1109/SEGE.2017.8052827

Chanson, M., Bogner, A., Bilgeri, D., Fleisch, E., & Wortmann, F. (2019). Blockchain for the IoT: Privacy-preserving protection of sensor data. *Journal of the Association for Information Systems, 20*(9), 1271–1307. https://doi.org/10.17705/1jais.00567

Chaudhuri, A., & Holbrook, M. (2001). The chain of effects from brand trust and brand affect to brand performance: the role of brand loyalty. *Journal of Marketing, 65*, 81–93. https://doi.org/10.1509/jmkg.65.2.81.18255

Cheng, X., Fu, S., & de Vreede, G. J. (2021). Determinants of trust in computer-mediated offshore software-outsourcing collaboration. *International Journal of Information Management, 57*(1), Article 102301. https://doi.org/10.1016/j.ijinfomgt.2020.102301

Cho, S., Lee, K., Cheong, A., No, W. G., & Vasarhelyi, M. A. (2021). Chain of values: examining the economic impacts of blockchain on the value-added tax system. *Journal of Management Information Systems, 38*(2), 288–313.

Choi, J. (2018). Modeling the intergrated customer loyalty program on blockchain technology by using credit card. *International Journal on Future Revolution in Computer Science & Communication Engineering, 4*(2), 388–391. http://www.ijfrcsce.org.

Chong, A. Y. L., Lim, E. T. K., Hua, X., Zheng, S., & Tan, C. W. (2019). Business on chain: A comparative case study of five blockchain-inspired business models. *Journal of the Association for Information Systems, 20*(9), 1308–1337. https://doi.org/10.17705/1jais.00568

Chu, P. Y., Lee, G. Y., & Chao, Y. (2012). Service quality, customer satisfaction, customer trust, and loyalty in an e-banking context. *Social Behavior and Personality, 40*(8), 1271–1284. https://doi.org/10.2224/sbp.2012.40.8.1271

Costa, E., Soares, A. L., & de Sousa, J. P. (2020). Industrial business associations improving the internationalisation of SMEs with digital platforms: a design science research approach. *International Journal of Information Management, 53*, Article 102070. https://doi.org/10.1016/j.ijinfomgt.2020.102070

Culiberg, B. (2010). Identifying service quality dimensions as antecedents to customer satisfaction in retail banking. *Economic and Business Review, 12*(3), 151–166.

Da Xu, L., & Viriyasitavat, W. (2019). Application of blockchain in collaborative internet-of-things services. *IEEE Transactions on Computational Social Systems, 6*(6), 1295–1305.

De Filippi, P., Mannan, M., & Reijers, W. (2020). Blockchain as a confidence machine: the problem of trust & challenges of governance. *Technology in Society, 62*, Article 101284. https://doi.org/10.1016/j.techsoc.2020.101284

Di Silvestre, M. L., Gallo, P., Guerrero, J. M., Musca, R., Riva Sanseverino, E., Sciumè, G., & Zizzo, G. (2020). Blockchain for power systems: current trends and future applications. *Renewable and Sustainable Energy Reviews*, 119. https://doi.org/10.1016/j.rser.2019.109585

Diaz-Rainey, I., & Ashton, J. (2011). Profiling potential green electricity tariff adopters: green consumerism as an environmental policy tool? *Business Strategy and the Environment, 20*, 456–470. https://doi.org/10.1002/bse.699

Diestelmeier, L. (2019). Changing power: shifting the role of electricity consumers with blockchain technology – Policy implications for EU electricity law. *Energy Policy, 128*, 189–196. https://doi.org/10.1016/j.enpol.2018.12.065

Dietz, G., & Gillespie, N. (2011). Building and Restoring Organisational Trust.

Dolšak, J., Hrovatin, N., & Zorić, J. (2019). Can loyalty programs be effective in promoting integrated energy services? Evidence from Slovenian electricity consumers. *Energy Research & Social Science, 48*, 246–256. https://doi.org/10.1016/j.erss.2018.10.011

Dong, Z., Luo, F., & Liang, G. (2018). Blockchain: a secure, decentralized, trusted cyber infrastructure solution for future energy systems. *Journal of Modern Power Systems and Clean Energy, 6*(5), 958–967. https://doi.org/10.1007/s40565-018-0418-0

Dorfleitner, G., Muck, F., & Scheckenbach, I. (2021). Blockchain applications for climate protection: a global empirical investigation. *Renewable and Sustainable Energy Reviews, 149*(June), Article 111378. https://doi.org/10.1016/j.rser.2021.111378

Dowling, G., & Uncles, M. (1997). Do customer loyalty programs really work? *Sloan Management Review, 38*(4), 71–82.

Du, W. D., Pan, S. L., Leidner, D. E., & Ying, W. (2019). Affordances, experimentation and actualization of FinTech: A blockchain implementation study. *Journal of Strategic Information Systems, 28*(1), 50–65.

Dwivedi, Y. K., Hughes, L., Kumar Kar, A., Baabdullah, A. M., Grover, P., Abbas, R., … Wade, M. (2022). Climate change and COP26: Are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action. *International Journal of Information Management, 63*. https://doi.org/10.1016/j.ijinfomgt.2021.102456.

Bergaentzlé, C., GræstedJensen, I., Skytte, K., & JessOlsen, O. (2019). Electricity grid tariffs as a tool for flexible energy systems: A Danish case study. *Energy Policy, 126*, 12–21. https://doi.org/10.1016/j.enpol.2018.11.021.

Energy, C. for S (2013). Green electricity tariffs.

Fang, X., Cui, H., Du, E., Li, F., & Kang, C. (2021). Characteristics of locational uncertainty marginal price for correlated uncertainties of variable renewable generation and demands. *Applied Energy, 282*, Article 116064. https://doi.org/10.1016/j.apenergy.2020.116064

Gamma, K. (2016). Behavioral and attitudinal customer loyalty in the power sector. *Zeitschrift Für Energiewirtschaft, 40*(4), 211–232. https://doi.org/10.1007/s12398-016-0186-3

Ropsten Testnet, retrieved from https://github.com/ethereum/ropsten 2020.

Gomes, I., Melicio, R., & Mendes, V. M. F. (2021). Assessing the value of demand response in microgrids. *Sustainability, 13*(11). https://doi.org/10.3390/su13115848

Gorkhali, A., Li, L., & Shrestha, A. (2020). Blockchain: a literature review. *Journal of Management Analytics, 7*(3), 321–343.

Gorski, T., Bednarski, J., & Chaczko, Z. (2019). Blockchain-based renewable energy exchange management system. *26th International Conference on Systems Engineering, ICSEng 2018 - Proceedings*, 1–6. https://doi.org/10.1109/ICSENG.2018.8638165

Govier, T. (1994). Is it a jungle out there? Trust, distrust and the construction of social reality. *Dialogue, 33*(2), 237–252. https://doi.org/10.1017/S0012217300010519

Gregor, S., & Hevner, A. R. (2013). Positioning and presenting design science - types of knowledge in design science research. *MIS Quarterly, 37*(2), 337–355. https://doi.org/10.2753/MIS0742-1222240302

Guo, X., Liu, H., Mao, X., Jin, J., Chen, D., & Cheng, S. (2014). Willingness to pay for renewable electricity: a contingent valuation study in Beijing, China. *Energy Policy, 68*, 340–347. https://doi.org/10.1016/j.enpol.2013.11.032

Hamburger, Á. (2019). Is guarantee of origin really an effective energy policy tool in Europe? A critical approach. *Society and Economy, 41*(4), 487–507. https://doi.org/10.1556/204.2019.41.4.6

Hameed, K., Barika, M., Garg, S., Amin, M. B., & Kang, B. (2022). A taxonomy study on securing Blockchain-based Industrial applications: an overview, application perspectives, requirements, attacks, countermeasures, and open issues. *Journal of Industrial Information Integration*, Article 100312.

Hansla, A., Gamble, A., Juliusson, A., & Gärling, T. (2008). The relationships between awareness of consequences, environmental concern, and value orientations. *Journal of Environmental Psychology, 28*(1), 1–9. https://doi.org/10.1016/j.jenvp.2007.08.004

Hartmann, P., & Apaolaza Ibáñez, V. (2007). Managing customer loyalty in liberalized residential energy markets: The impact of energy branding. *Energy Policy, 35*(4), 2661–2672. https://doi.org/10.1016/j.enpol.2006.09.016

Hasankhani, A., Mehdi Hakimi, S., Shafie-khah, M., & Asadolahi, H. (2021). Blockchain technology in the future smart grids: a comprehensive review and frameworks. *International Journal of Electrical Power and Energy Systems, 129*, 1–70. https://doi.org/10.1016/j.ijepes.2021.106811

Hawlitschek, F., Notheisen, B., & Teubner, T. (2018). The limits of trust-free systems: A literature review on blockchain technology and trust in the sharing economy. *Electronic Commerce Research and Applications, 29*, 50–63. https://doi.org/10.1016/j.elerap.2018.03.005

Hevner, A. R. (2007). A three cycle view of design science research. *Scandinavian Journal of Information Systems*, 19.

Hevner, A. R., & Chatterjee, S. (2012). Design research in information systems. *In Springer* (Vol. 28). https://doi.org/10.1007/978-1-4419-6108-2

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly: Management Information Systems, 28*(1), 75–105. https://doi.org/10.2307/25148625

Hoess, A., Roth, T., Sedlmeir, J., Fridgen, G., & Rieger, A. (2022). With or Without Blockchain?: Towards a Decentralized, SSI-based eRoaming Architecture. Proceedings of the Hawaii International Conference on System Sciences 2022.

Hofman-Kohlmeyer, M. (2016). Customer loyalty program as a tool of customer retention: literature review. *CBU International Conference Proceedings, 4*, 199–203. https://doi.org/10.12955/cbup.v4.762

Hua, W., Jiang, J., Sun, H., & Wu, J. (2020). A blockchain based peer-to-peer trading framework integrating energy and carbon markets. *Applied Energy, 279*(July), Article 115539. https://doi.org/10.1016/j.apenergy.2020.115539

Ibrahim, M., & Ribbers, P. M. (2009). The impacts of competence-trust and openness-trust on interorganizational systems. *European Journal of Information Systems, 18*(3), 223–234. https://doi.org/10.1057/ejis.2009.17

Jang, H., Han, S. H., & Kim, J. H. (2020). User perspectives on blockchain technology: user-centered evaluation and design strategies for DApps. *IEEE Access, 8*, 226213–226223. https://doi.org/10.1109/ACCESS.2020.3042822

Jarvenpaa, S. L., & Majchrzak, A. (2010). Vigilant interaction in knowledge collaboration: challenges of online user participation under ambivalence. *Information Systems Research, 21*(4), 773–784. https://doi.org/10.1287/isre.1100.0320

Järvinen, P. (2007). Action research is similar to design science. *Quality and Quantity, 41*, 37–54. https://doi.org/10.1007/s11135-005-5427-1

Jensen, T., Hedman, J., & Henningsson, S. (2019). How TradeLens delivers business value with blockchain technology. *MIS Quarterly Executive, 18*(4), 221–243. https://doi.org/10.17705/2msqe.00018

Jeon, H. G., Kim, C., Lee, J., & Lee, K. C. (2021). Understanding E-commerce consumers' repeat purchase intention: the role of trust transfer and the moderating effect of neuroticism. *Frontiers in Psychology, 12*, 2059. https://doi.org/10.3389/fpsyg.2021.690039

Jonas, K., Broemer, P., & Diehl, M. (2000). Attitudinal ambivalence. *European Review of Social Psychology, 11*(1), 35–74. https://doi.org/10.1080/14792779943000125

Kandampully, J., Zhang, T., (Christina), & Bilgihan, A. (2015). Customer loyalty: a review and future directions with a special focus on the hospitality industry. *International Journal of Contemporary Hospitality Management, 27*(3), 379–414. https://doi.org/10.1108/IJCHM-03-2014-0151

Khorasany, M., Dorri, A., Razzaghi, R., & Jurdak, R. (2021). Lightweight blockchain framework for location-aware peer-to-peer energy trading. *International Journal of Electrical Power and Energy Systems, 127*, Article 106610. https://doi.org/10.1016/j.ijepes.2020.106610

Kley, F., Lerch, C., & Dallinger, D. (2011). New business models for electric cars-a holistic approach. *Energy Policy, 39*(6), 3392–3403. https://doi.org/10.1016/j.enpol.2011.03.036

Kramer, R. M. (1999). Trust and distrust in organizations: emerging perspectives, enduring questions. *Annual Review of Psychology, 50*, 569–598. https://doi.org/10.1146/annurev.psych.50.1.569

Kuechler, W., & Vaishnavi, V. (2012). A framework for theory development in design science research: multiple perspectives. *Journal of the Association for Information Systems, 13*(6), 395–423. http://aisel.aisnet.org/jais/vol13/iss6/3.

Lacity, M. C. (2018). Addressing key challenges to making enterprise blockchain applications a reality. *MIS Quarterly Executive, 17*(3), 201–222.

Lee, J., Lee, J. N., & Tan, B. C. Y. (2015). Antecedents of cognitive trust and affective distrust and their mediating roles in building customer loyalty. *Information Systems Frontiers, 17*(1), 159–175. https://doi.org/10.1007/s10796-012-9392-7

Lewicki, R., & Brinsfield, C. (2011). Measuring trust beliefs and behaviours. *Handbook of Research Methods on Trust*, 29–39. https://doi.org/10.4337/9781781009246.00013

Li, F., Pieńkowski, D., Van Moorsel, A., & Smith, C. (2012). A holistic framework for trust in online transactions. *International Journal of Management Reviews, 14*(1), 85–103. https://doi.org/10.1111/j.1468-2370.2011.00311.x

Lockl, J., Schlatt, V., Schweizer, A., Urbach, N., & Harth, N. (2020). Toward trust in internet of things ecosystems: design principles for blockchain-based IoT applications. *IEEE Transactions on Engineering Management, 67*(4), 1256–1270. https://doi.org/10.1109/TEM.2020.2978014

Luke, M. N., Anstey, G., Taylor, W., & Sirak, A. (2019). *Blockchains in Power Markets: Decentralized Disruption or Incremental Innovation?*

Luke, M. N., Lee, S. J., Pekarek, Z., & Dimitrova, A. (2018). *Blockchain in Electricity: a Critical Review of Progress to Date*.

Lustig, C., & Nardi, B. (2015). Algorithmic authority: the case of bitcoin. *Proceedings of the Annual Hawaii International Conference on System Sciences, 2015*, 743–752. https://doi.org/10.1109/HICSS.2015.95

MacDonald, S., & Eyre, N. (2018). An international review of markets for voluntary green electricity tariffs. *Renewable and Sustainable Energy Reviews, 91*, 180–192. https://doi.org/10.1016/j.rser.2018.03.028

MacPherson, R., & Lange, I. (2013). Determinants of green electricity tariff uptake in the UK. *Energy Policy, 62*, 920–933. https://doi.org/10.1016/j.enpol.2013.07.089

Martínez, P., & Rodríguez del Bosque, I. (2013). CSR and customer loyalty: the roles of trust, customer identification with the company and satisfaction. *International Journal of Hospitality Management, 35*, 89–99. https://doi.org/10.1016/j.ijhm.2013.05.009

Mattke, J., Hund, A., Maier, C., & Weitzel, T. (2019). How an enterprise blockchain application in the U.S. Pharmaceuticals supply chain is saving lives. *MIS Quarterly Executive, 18*(4), 245–261. https://doi.org/10.17705/2msqe.00019

Maurer, B., Nelms, T., & Swartz, L. (2013). "When perhaps the real problem is money itself!": the practical materiality of Bitcoin. *Social Semiotics*, 23. https://doi.org/10.1080/10350330.2013.777594

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). Model of Trust Theory. *The. Academy of Management Review, 20*(3), 709–734.

McAllister, D. (1995). Affect- and cognition-based trust formations for interpersonal cooperation in organizations. *Academy of Management Journal, 38*, 24–59. https://doi.org/10.2307/256727

McCall, M., & McMahon, D. (2016). Customer loyalty program management: what matters to the customer. *Cornell Hospitality Quarterly, 57*(1), 111–115. https://doi.org/10.1177/1938965515614099

McKnight, D. H., & Chervany Norman, L. (2001).). Trust and distrust definitions: One bite at a time. Lecture Notes in Artificial Intelligence (Subseries of Lecture Notes in Computer Science). *2246*, 27–54. https://doi.org/10.1007/3-540-45547-7_3

McKnight, D. H., & Choudhury, V. (2006). Distrust and trust in B2C e-commerce: do they differ? *Proceedings of the ACM Conference on Electronic Commerce*. https://doi.org/10.1145/1151454.1151527

McKnight, D. H., Cummings, L. L., & Chervany, N. L. (1998). Initial trust formation in new organizational relationships. *Academy of Management Review, 23*(3), 473–490. https://doi.org/10.5465/AMR.1998.926622

McKnight, D. H., Lankton, N. K., Nicolaou, A., & Price, J. (2017). Distinguishing the effects of B2B information quality, system quality, and service outcome quality on trust and distrust. *Journal of Strategic Information Systems, 26*(2), 118–141. https://doi.org/10.1016/j.jsis.2017.01.001

Mengelkamp, E., Schlund, D., & Weinhardt, C. (2019). Development and real-world application of a taxonomy for business models in local energy markets. *Applied Energy, 256*, Article 113913. https://doi.org/10.1016/j.apenergy.2019.113913

Merlo, O., Eisingerich, A., Auh, S., & Levstek, J. (2018). The benefits and implementation of performance transparency: the why and how of letting your customers 'see through' your business. *Business Horizons, 61*(1), 73–84. https://doi.org/10.1016/j.bushor.2017.09.007

Mezger, A., Cabanelas, P., López-Miguens, M. J., Cabiddu, F., & Rüdiger, K. (2020). Sustainable development and consumption: the role of trust for switching towards green energy. *Business Strategy and the Environment, 29*(8), 3598–3610. https://doi.org/10.1002/bse.2599

Miles, et al. (2018). *Qualitative data analysis: A methods sourcebook*. SAGE Publications.

Moody, G. D., Galletta, D. F., & Lowry, P. B. (2010). Unifying conflicting models of trust and distrust for enhanced understanding and predictive power in organizational relationships: proposing the unified trust-distrust model (UTDM). *SSRN Electronic Journal, 10*(68). https://doi.org/10.2139/ssrn.2287398

Moody, G. D., Galletta, D. F., & Lowry, P. B. (2014). When trust and distrust collide online: The engenderment and role of consumer ambivalence in online consumer behavior. *Electronic Commerce Research and Applications, 13*(4), 266–282. https://doi.org/10.1016/j.elerap.2014.05.001

Moody, G. D., Lowry, P. B., & Galletta, D. F. (2017). It's complicated: explaining the relationship between trust, distrust, and ambivalence in online transaction relationships using polynomial regression analysis and response surface analysis. *European Journal of Information Systems, 26*(4), 379–413. https://doi.org/10.1057/s41303-016-0027-9

Muzahid, A., & Noorjahan, P. (2009). Impact of service quality, trust and customer satisfaction on cunsumer loyalty. *ABAC Journal* (Vol. 29,(1), 24–38.

Myers, M., & Newman, M. (2007). The qualitative interview in is research: examining the craft. *Information and Organization, 17*, 2–26. https://doi.org/10.1016/j.infoandorg.2006.11.001

Nguyen, N., Leclerc, A., & LeBlanc, G. (2013). The mediating role of customer trust on customer loyalty. *Journal of Service Science and Management, 06*(01), 96–109. https://doi.org/10.4236/jssm.2013.61010

Ning, Y., Feng, M., Feng, J., & Liu, X. (2019). Understanding clients' experience of trust and distrust in dwelling fit-out projects. *Engineering, Construction and Architectural Management, 26*(3), 444–461. https://doi.org/10.1108/ECAM-03-2018-0115

Nunes, J., & Drze, X. (2006). The endowed progress effect: how artificial advancement increases effort. *Journal of Consumer Research, 32*, 504–512. https://doi.org/10.1086/500480

Olsen, S. O., Wilcox, J., & Olsson, U. (2005). Consequences of ambivalence on satisfaction and loyalty. *Psychology and Marketing, 22*(3), 247–269. https://doi.org/10.1002/mar.20057

Ozaki, R. (2011). Adopting sustainable innovation: what makes consumers sign up to green electricity? *Business Strategy and the Environment, 20*(1), 1–17. https://doi.org/10.1002/bse.650

Paymans, T., Lindenberg, J., & Neerincx, M. (2004). Usability trade-offs for adaptive user interfaces: Ease of use and learnability. https://doi.org/10.1145/964442.964512.

Peffers et al. (2012). Design Science Research in Information Systems: Advances in Theory and Practice. Information Systems and Applications, 7th International Conference, DESRIST 2012.

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems, 24*(3), 45–77. https://doi.org/10.2753/MIS0742-1222240302

Peng, L. Y., & Wang, Q. (2006). Impact of relationship marketing tactics (RMTs) on switchers and stayers in a competitive service industry. *Journal of Marketing Management, 22*(1–2), 25–59.

Perrons, R. K., & Cosby, T. (2020). Applying blockchain in the geoenergy domain: the road to interoperability and standards. *Applied Energy, 262*, Article 114545. https://doi.org/10.1016/j.apenergy.2020.114545

Peter, V., Paredes, J., Rivial, M. R., Sepúlveda, E. S., & Astorga, D. A. H. (2019). Blockchain meets energy: digital solutions for a decentralized and decarbonized sector. *German-Mexican Energy Partnership (EP) and Florence School of Regulation (FSR)*, 1–45.

Portes, A., Cases, A.-S., & N'Goala, G. (2020). Should digital marketing practices be more transparent? *An Empirical Investigation on the roles of Consumer digital Literacy and Privacy concerns in self-Service Technologies*, 1–11. https://hal.archives-ouvertes.fr/hal-02502389.

Raadal, H. L., Dotzauer, E., Hanssen, O. J., & Kildal, H. P. (2012). The interaction between electricity disclosure and tradable green certificates. *Energy Policy, 42*, 419–428. https://doi.org/10.1016/j.enpol.2011.12.006

Raspberry Pi Foundation. (2016). Raspberry Pi 3 Model B. https://www.raspberrypi.org/products/raspberry-pi-3-model-b/.

Rieger, A., Lockl, J., Urbach, N., Guggenmos, F., & Fridgen, G. (2019). Building a blockchain application that complies with the EU general data protection regulation. *MIS Quarterly Executive, 18*(4), 263–279. https://doi.org/10.17705/2msqe.00020

Rieger, A., Roth, T., Sedlmeir, J., & Fridgen, G. (2021). The privacy challenge in the race for digital vaccination certificates. *Med, 2*(6), 633–634. https://doi.org/10.1016/j.medj.2021.04.018

Risius, M., & Spohrer, K. (2017). A blockchain research framework - what we (don't) know, where we go from here, and how we will get there. *Business & Information Systems Engineering, 59*(6), 385–409. https://doi.org/10.1007/s12599-017-0506-0

Rosell, J. I., & Ibáñez, M. (2006). Modelling power output in photovoltaic modules for outdoor operating conditions. *Energy Conversion and Management, 47*(15–16), 2424–2430. https://doi.org/10.1016/j.enconman.2005.11.004

Rossi, M., Mueller-Bloch, C., Thatcher, J. B., & Beck, R. (2019). Blockchain research in information systems: current trends and an inclusive future research agenda. *Journal of the Association for Information Systems, 20*(9), 1388–1403. https://doi.org/10.17705/1jais.00571

Roth, T., Stohr, A., Amend, J., Fridgen, G., & Rieger, A. (2022). Blockchain as a driving force for federalism: a theory of cross-organizational task-technology fit. *International Journal of Information Management*, Article 102476.

Saha, S., Ravi, N., Hreinsson, K., Baek, J., Scaglione, A., & Johnson, N. G. (2021). A secure distributed ledger for transactive energy: The Electron Volt Exchange (EVE) blockchain. *Applied Energy, 282*, 1–49. https://doi.org/10.1016/j.apenergy.2020.116208

Sarker, S., Henningsson, S., Jensen, T., & Hedman, J. (2021). The use of blockchain as a resource for combating corruption in global shipping: an interpretive case study. *Journal of Management Information Systems, 38*(2), 338–373.

Sedlmeir, J., Buhl, H. U., Fridgen, G., & Keller, R. (2020). The energy consumption of blockchain technology: beyond myth. *Business and Information Systems Engineering, 62*(6), 599–608. https://doi.org/10.1007/s12599-020-00656-x

Sedlmeir, J., Smethurst, R., Rieger, A., & Fridgen, G. (2021). Digital identities and verifiable credentials. *Business & Information Systems Engineering, 63*(5), 603–613.

Seebacher, S., & Schüritz, R. (2017). *Blockchain Technology as an Enabler of Service Systems: A Structured Literature Review*. https://doi.org/10.1007/978-3-319-56925-3_2

Sousa, T., Soares, T., Pinson, P., Moret, F., Baroche, T., & Sorin, E. (2019). Peer-to-peer and community-based markets: a comprehensive review. *Renewable and Sustainable Energy Reviews, 104*, 367–378. https://doi.org/10.1016/j.rser.2019.01.036

Stathopoulou, A., & Balabanis, G. (2016). The effects of loyalty programs on customer satisfaction, trust, and loyalty toward high- and low-end fashion retailers. *Journal of Business Research, 69*(12), 5801–5808. https://doi.org/10.1016/j.jbusres.2016.04.177

Tams, S., Thatcher, J. B., & Craig, K. (2018). How and why trust matters in post-adoptive usage: The mediating roles of internal and external self-efficacy. *Journal of Strategic Information Systems, 27*(2), 170–190. https://doi.org/10.1016/j.jsis.2017.07.004

Thomas, L., Zhou, Y., Long, C., Wu, J., & Jenkins, N. (2019). A general form of smart contract for decentralized energy systems management. *Nature Energy, 4*(2), 140–149. https://doi.org/10.1038/s41560-018-0317-7

Uncles, M. D., Dowling, G. R., & Hammond, K. (2003). Customer loyalty and customer loyalty programs. *Journal of Consumer Marketing, 20*(4–5), 294–316. https://doi.org/10.1108/07363760310483676

Upadhyay, N. (2020). Demystifying blockchain: a critical analysis of challenges, applications and opportunities. *International Journal of Information Management, 54*, Article 102120. https://doi.org/10.1016/j.ijinfomgt.2020.102120

Vaishnavi, V., & Uechler, W. (2008). Design Science Research Methods and Patterns: Innovating Information and Communication Technology.

van Aken, J. E. (2004). Management research based on the paradigm of the design sciences: the quest for field-tested and grounded technological rules. *Journal of Management Studies, 41*(2), 219–246. https://doi.org/10.1111/joms.2004.41.issue-2

van der Werff, L., Legood, A., Buckley, F., Weibel, A., & de Cremer, D. (2019). Trust motivation: the self-regulatory processes underlying trust decisions. *Organizational Psychology Review, 9*(2–3), 99–123. https://doi.org/10.1177/2041386619873616

Vesel, P., & Zabkar, V. (2009). Managing customer loyalty through the mediating role of satisfaction in the DIY retail loyalty program. *Journal of Retailing and Consumer Services, 16*(5), 396–406. https://doi.org/10.1016/j.jretconser.2009.05.002

Walls, J. G., Widmeyer, G. R., & Sawy, O. (2004). Assessing information system design theory in perspective: How useful was our 1992 initial rendition? *Journal of Information Technology Theory and Application, 6*, 43–58.

Warkentin, M., & Orgeron, C. P. (2020). Using the security triad to assess blockchain technology in public sector applications. *Int. J. Inf. Manag, 52*, Article 102090.

Watanabe, H., Fujimura, S., Nakadaira, A., Miyazaki, Y., Akutsu, A., & Kishigami, J. (2016). Blockchain contract: securing a blockchain applied to smart contracts. *2016 IEEE International Conference on Consumer Electronics, ICCE 2016*, 467–468. https://doi.org/10.1109/ICCE.2016.7430693

Webster, J., & Watson, R. T. (2002). Analysing the past for prepare the future: writing a review. *MIS Quarterly, 26*, 2.

Werbach, K. (2018). The Blockchain and the New Architecture of Trust. https://doi.org/10.7551/mitpress/11449.001.0001.

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation: an introduction to the concept. *Energy Policy, 35*(5), 2683–2691. https://doi.org/10.1016/j.enpol.2006.12.001

Yen, Y.-S. (2010). Can perceived risks affect the relationship of switching costs and customer loyalty in e-commerce? *Internet Research, 20*, 210–224. https://doi.org/10.1108/10662241011032254

Yi, Y., & Jeon, H. (2003). Effects of loyalty programs on value perception, program loyalty, and brand loyalty. *Journal of the Academy of Marketing Science, 31*(3), Article 229. https://doi.org/10.1177/0092070303031003002.

Zhang, H., Wang, J., & Ding, Y. (2019). Blockchain-based decentralized and secure keyless signature scheme for smart grid. *Energy, 180*, 955–967. https://doi.org/10.1016/j.energy.2019.05.127

Zhang, W., Wei, C.-P., Jiang, Q., Peng, C.-H., & Zhao, J. L. (2021). Beyond the block: a novel blockchain-based technical model for long-term care insurance. *Journal of Management Information Systems, 38*(2), 374–400.

Ziolkowski, R., Miscione, G., & Schwabe, G. (2020). Decision problems in blockchain governance: old wine in new bottles or walking in someone else's shoes? *Journal of Management Information Systems, 37*(2), 316–348. https://doi.org/10.1080/07421222.2020.1759974

Zoerner, T. (2020). GrünstromIndex - Vorhersage von regionalem Ökostrom. https://gruenstromindex.de/.

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