Thomas Iversen Ramm
Erling Roll

How sign-in solutions and payment options impact the customer journey and dropout rate in eCommerce

A study of data science as a tool for digital platform service innovation

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NTNU
Norwegian University of
Science and Technology

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Abstract

Digital platforms are found everywhere around us. They provide services which many use on a daily basis. Competition, user needs and an ever-changing platform ecosystem makes the importance of service innovation abundantly clear. There exists a plethora of different design frameworks and techniques utilized to perform this innovation. Design science is needed more than ever as the problems of service innovation become more diverse and expand and create new environments. Applying rigorous methods to existing design frameworks can enhance their ability to tackle the complexity of the problems which digital platform ecosystems present. Data science is a mature field and provides rigorous methods which synergises well with the data generation digital platforms can provide.

The aim of this study is to provide insight into how digital transaction platforms perform service innovation through design science. The practical goal of this study is to look for correlation and possible synergies between user choice of sign-in solution and payment option in an eCommerce store environment. The eCommerce store acts as the artifact and the target of the design science research framework. Data science is tested as a tool for performing evaluation of the artifact in the design science research framework by gathering quantitative data on the use of the app components. Supplemental qualitative data from questionnaires will identify relevance and confirm findings of data analysis.

Sammendrag

Digitale plattformer finnes overalt rundt oss. De tilbyr tjenester som mange bruker daglig. Konkurranse, brukerbehov og et plattformøkosystem i stadig endring tydeligjør verdien av tjenesteinnovasjon. Det finnes et mangfold av forskjellige designrammeverk og teknikker som brukes for å utføre denne innovasjonen. *Design science* er nødvendig mer enn noen gang ettersom problemer i tjenesteinnovasjon utforskes i stadig nye miljøer. Å bruke velkjente og utprøvde metoder på eksisterende designrammeverk kan forbedre deres evne til å takle kompleksiteten til problemene som digitale plattformøkosystemer presenterer. *Data science* er et modent felt og tilbyr metoder som synergi godt med datagenereringen digitale plattformer kan tilby.

Målet med dette studiet er å gi innsikt i hvordan digitale transaksjonsplattformer utfører tjenesteinnovasjon gjennom *design science*. Det praktiske målet med denne studien er å se etter sammenheng mellom brukervalg av påloggingsløsning og betalingsalternativ i en nettbutikk. Nettbutikken fungerer som designgjennstanden og målet for designrammeverket for *design science*. *Data science* testes som et verktøy for å utføre evaluering av designgjennstanden i designrammeverket ved å samle inn kvantitative data om bruken av komponentene i appen. I tillegg brukes kvalitative data fra spørreskjemaer til identifisere relevans og bekrefte funn av dataanalyse.

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Introduction

Background

"A platform-based ecosystem consists of two major elements—a platform and complementary app." (Tiwana, 2014, p.5). Facebook and Instagram are examples of global platforms. A platform has several roles. End users can log in, app developers can create apps for the platform, and platform owners control the platform (Tiwana, 2014). An example of an app developer for Facebook is an online store that has integrated its support system with the Facebook Messenger chat. By doing this, they create a positive cross-site network effect (Tiwana, 2014). They take advantage of a different role in the platform and create value for them. In this way, they make it more attractive for end-users to use the platform.

Facebook also offers an SSO (single sign-on) solution to everyone who wants a "sign in with Facebook"- button. An SSO solution means delegating the authentication process to a third party. In the case of Facebook, the technologies OAuth 2.0 and OpenID Connect are used. The former is responsible for the authentication and returns a valid token if the login is successful. OpenID Connect allows the third party to retrieve additional information about the user e.g. name, email, mobile number, or other information the user has stored in the platform. If an online store integrates Facebook SSO in its login solution, Facebook becomes a component of the online store's login app (Tiwana, 2014).

Another approach to offering functionality in a platform is to swallow the market of others. An example is when Instagram added the Stories feature. My Story was originally an idea from Snapchat. When Instagram offers functionality from another platform in an adjacent market, they envelop functionality to their platform (Tiwana, 2014). Another example is that they recently enveloped their Reels functionality from TikTok. The platforms then normally have an overlap in end-users of their platforms (Tiwana, 2014). Envelopment is therefore a good way to add value to its end-users. Platform owners can add functionality that they already see working in another platform.

In order for a platform to remain viable for a longer period of time, they depend on innovation: *"The goal is to rapidly develop new capabilities and foster innovations*

unforeseeable by the platform's original designers" (Tiwana, 2014, p. 5). The platform has a starting point and offers some components. "*All actors are resource integrators in a network of other actors, and thus all actors are potential innovators or co-creators of value.*" (Lusch & Nambisan, 2015, p. 160). As end-users and app developers use the platform, they use the components of the platform in other ways than the platform owners had envisioned. App developers sometimes have a completely different view of the potential of how a component can be used in their ecosystem. Then the innovation starts and the platform owners open their eyes to new opportunities that open up. Nevertheless, they have enough common understanding so that they add value to each other on the platform.

A type of service innovation that has enabled transaction platforms are components that simplify the customer journey (Cusumano et al., 2020). Payment transaction platforms such as PayPal, Klarna, and Vipps are perfect examples of that. They offer payment components that make it possible to charge end-users. By taking the user into a familiar flow, they may simplify the customer journey. To verify that, we need to have a good way to design and evaluate the components. The design being design science research and data science is the new core factor that will be utilized to allow this process.

Concepts and terms

App: A program or web application. E.g., a shopping cart on a website could be an app.

Component: A part of a submodule of an app. E.g., The summary page in a shopping cart.

BankAxept: Payment provider, that provides approx 80% of all card payments in Norway

BankID: Norwegian authentication and ID-provider

Dropout rate: Where the user starts the customer journey but does not purchase anything.

ID server: Portal where users can choose between different sign in options.

SMS auth: The user receives an SMS with a new OTP (one time password) for each sign in.

SSO: Single sign-on. Makes it possible to use the same user to authenticate on multiple services

Vipps Logg inn: An SSO service from Vipps. Offers verified phone number, name, email, birth date, national identity number, bank account number, and addresses (unverified)

Wireframe: A visual representation of a web page's main components and features

Motivation

We studied the subject of digital service innovation and platform ecosystems (TDT4257) in the spring of 2021, where we investigated Vipps as a platform ecosystem. We found the combination of login and payment interesting because this lets the same company supply components for two big steps in the customer journey and potentially deliver a better overall customer journey and will deduce why in the coming paragraphs. We investigated it further in our project report (IT3915) in the autumn of 2021. The basis for the preparation was made on these topics. In the next sections, we shall go through the work that is relevant to this study.

Service innovation

We studied the subject TDT4257 - Digital platforms and service innovation the autumn of 2020 and researched Vipps as a platform ecosystem in TDT4257. One of our findings is that Vipps wants to combine ID (login) + payment. We were not able to find other providers that offer both a single sign-on (SSO) and payment solution. We found this combination interesting and want to study it further (Ramm, T. I. & Roll, E., 2021). We discovered that Vipps does not have clear measurements of the combination of Vipps payment and Vipps Logg inn (service innovation) and therefore decided to do further research on combined ID and payment service.

Vipps has 4.2 million unique Norwegian end-users registered per 1st quarter 2022. (Vipps, 2022-a). People associate Vipps with payment to friends and "å vippse" (eng: to vipps) has become a verb that is a synonym for sending money to someone (Språkrådet, 2020). The fact that it's not possible to send money to non-Vipps users and as large a share as 78% of Norway's population are Vipps users leads to a strong positive same-side network effect. Vipps has launched their own mobile subscription and Vipps sign-in to their users which are

not services that belong to their primary domain in payment. This is a form of horizontal envelopment (Kran et. al, 2021, ex. 1).

The platform owner, Vipps, was originally started by DNB in 2015. Sparebank 1 alliance, the Eika alliance, Sparebanken Møre, and 15 independent savings banks bought into Vipps in February 2017. DNB was still the main owner with around 45% share rate (Kran et. al, 2021, ex. 1). Vipps was merged with BankID and BankAxept in July 2018 (Kran et. al, 2021, ex. 2). On 30 June 2021, the news came that Vipps will merge with the two Scandinavian mobile wallets: Danish Mobile Pay and Finnish Pivo. In the same operation, BankAxept and BankID were split out from Vipps into a single company (Shifter, 2021). This demerger is still awaiting approval by the authorities (Hope-Paulsrud, 2022). Vipps is offering its services to the mass market and as a platform owner and they transfer the cost and risk to the app developers as other platforms do (Kran et. al, 2021, ex. 1).

App developers are an important part of Vipps' platform. "Vipps app business model is to earn money from the corporate market and offer free services to the consumers" (Kran et. al, 2021, ex. 1, p.6). It's free to sign-in and pay for individuals (end-users). When someone pays companies (app developers), Vipps charges a transaction fee and makes money on payments to companies. An interesting thing for us was that Vipps doesn't charge either app developers or end-users for sign-ins. It makes sense for Facebook and Google not to monetize logins when they can collect data and later monetize ads, but Vipps does not sell ads or earn money from their login component at all.

Tiwana describes multisidness in the following way: "*The need to attract at least two distinct mutually attracted groups (such as app developers and end-users) who can potentially interact more efficiently through a platform than without it.*" (Tiwana, 2014, p. 25). Vipps offers various APIs that allow app developers to take paid and exchange information more easily than without using the platform (Kran et. al, 2021, ex. 1). End-users use Vipps to pay friends or companies, settlements with friends, request money, pay invoices, sign-in, and share information with companies.

One of two events we found interesting during our study about Vipps as a platform ecosystem was the merger between Vipps, BankID, and BankAxept. BankID is a digital ID

provider and BankAxept is the provider of the national payment system in Norway. There is a natural overlap between Vipps and BankAxept, but it is not obvious why two payment companies want to merge with an ID provider. However, all three companies had banks as owners (Kjærnes, n.d. & Kran et. al, 2021, ex. 1). More services within the companies opens up new opportunities to innovate (Gawer, 2014). The merger with BankID led them to launch Vipps Login a year and a half later (Kran et. al, 2021, ex. 2). As mentioned above Vipps plan to demerge BankID and BankAxept into a single company due to the merger with international mobile wallets. BankID has still been an important part of the preconditions for the innovation of Vipps Login.

The second event we found interesting was the launch of Vipps Login in January 2020. The great advantage of Vipps as a payment company is that they are required by law to have good control over who the customer is for anti-money laundering reasons (Finanstilsynet, 2021). This is one of the main benefits of a Vipps Login. They have verified all users' identity and know that one user only occurs once in the system. Names, phone numbers, email, birthdates, national id numbers, and bank account numbers for all users are verified (Vipps, 2022-b). It makes it possible for an e-commerce store to simplify the customer journey by fetching the information needed automatically from Vipps instead of the user entering it manually, which may reduce the dropout rate and has high commercial value for companies.

Komplett.no reduced its dropout rate during a login process from 30% to 17% by integrating Vipps Login into their site (Larsen & Vipps, 2021 via Kran et. al, 2021, ex. 1). A platform offers a technological foundation to app developers. They let them create services without reinventing the wheel (Tiwana, 2014). In Komplett's case, they get market access to more potential buyers (logged in users). It is still difficult to say whether there is any direct connection between a logged-in user and a potential sale. This laid the foundation for us to study the combination of login and payment methods further in our project report.

Project report (pre-study)

The starting point was to study: "*Does synergizing login and payment solutions affect conversion rate, usability and user experience in eCommerce stores?*" (Ramm & Roll, 2021, ex. 1). We developed a wireframe and outline of the functionality which will be

implemented. The next step was to implement checkout solutions such as Vipps and Klarna checkout. We also needed an introductory page with information about our study, how the data will be analyzed, and collect consent to participate.

Our initial plan was to use a test rig. It will naturally have fewer errors and distractions. The main benefit of a test rig is that we have full control and know which mission the user tries to solve. A disadvantage is the increased conversion rate due to users being set to complete the task assigned to them. A test rig loses some important moments of uncertainty during the decision-making process of a potential buyer. It will not be possible to measure whether the dropout rate is higher for different combinations of login and payment. Therefore, it is desirable to investigate whether we can partner with a company to obtain actual purchase data that we can analyze instead of test data. The user will receive a questionnaire to fill out after completing a purchase which lets us collect data on how the user experienced the customer journey.

State of the art

Simplicity

The measurement of simplicity in an information system is not trivial. Nielsen J. (1999) describes simplicity's five defining attributes as learnability, efficiency, memorability, errors, and satisfaction. Finding values that can measure any of these attributes in an IS will therefore say something about the overall simplicity of the system. Karvonen K. (2000) comments on Nielsen J.'s definition of simplicity and notes that simplicity, in his definition, has nothing to do with beauty or aesthetics. Karvonen K. (2000) refers to Spool & al. (1999) who "... found that user preferences of Web pages is not so strongly affected by success, nor by the amount of graphical elements, than it is by interest to content." This underlines the complexity of defining and measuring simplicity in an information system. Quantitative data such as time spent, buttons clicked and errors does not necessarily give enough evidence of simplicity and may even be partially irrelevant according to Spool & al. (1999). A survey to study simplicity in an IS should not only gather quantitative data but also qualitative data. The qualitative data should include the subjective view of the IS through open-ended

questions that can then be used to support or conflict the results of the quantitative data analysis. The reason why this is valuable is because it can help confirm or deny the causality of any correlation found through data analysis. The necessity of a complex method of combining quantitative and qualitative analysis is explained by the nature of the problem.

Wicked problems

Wicked problems (Brooks 1987, 1996; Rittel and Webber 1984 as cited in Hevner et al. 2004) are characterized by:

- Unstable requirements and constraints based upon ill-defined environmental contexts
- Complex interactions among subcomponents of the problem and its solution
- Inherent flexibility to change design processes as well as design artifacts (i.e., malleable processes and artifacts)
- A critical dependence upon human cognitive abilities (e.g., creativity) to produce effective solutions
- A critical dependence upon human social abilities (e.g., teamwork) to produce effective solutions

Hevner et al. (2004) describes the difference between routine design and system building from design research. The use of routine design in many cases is the application of best practice to an application in a business environment. Best practice in this case relies on a sufficient knowledge base. A lack of knowledge base can exist for many reasons. The knowledgeable solution space grows as an existing problem is actively and purposefully studied. Changes within the problem such as to the environment or the actors involved hinders progress in acquiring a knowledge base. This also means that a problem which exists in a business environment or situation which has not been studied before or is constantly changing is most likely a wicked problem. There are variations to the degree to which each characteristic applies. An interpretation which simplifies the definition of a wicked problem is that it is a problem which a single artifact created through routine design will not likely solve. As Hevner et al. (2004) concludes, creating artifacts which try to address wicked problems relies on creativity and trial-and-error search. eCommerce is a relatively new

environment for both organizations and end users compared to physical commerce. This means the knowledge base needed to solve problems in this environment is lacking. The rapid progress of technology within eCommerce makes problems prone to change and requires robust, yet malleable solutions. Solutions within eCommerce in most cases rely on multiple subsolutions or subcomponents such as login and payment modules which are our investigation targets. Creating a solution which satisfies the same complex problem within multiple different environmental contexts requires creativity. A creative solution which inherently allows trial-and-error search suggests that our problem is a wicked problem which makes the design-science framework appropriate to apply.

Data science in design-science

Design-science consists of seven research guidelines each with a different but cooperating part of solving a problem. As Hevner et al. (2004) states, "The fundamental principle of design-science research from which our seven guidelines are derived is that knowledge and understanding of a design problem and its solution are acquired in the building and application of an artifact." Another way to look at it is that the value of the proceedings of a guideline is proportional to the information retrieved about the artifact, the environment and the retrieval method itself. Hevner et al (2004) mentions the use of mathematical evaluation when appropriate but does not elaborate further on this evaluation method. We believe that the process of design evaluation is one of the most important guidelines. First and foremost because it has the potential to give the most valuable insight into an artifact's environment but also because it is the primary guideline which allows a trial-and-error search. Explicitly applying data science with the purpose of developing an evaluation process which is compliant with the design-science principle is a correct way to reinforce the framework. The overall academic goal of this study is to find the value of applying data science in design-science research.

Case

In collaboration with Motkraft, we developed a real online store based on our wireframes.

About Motkraft

Motkraft was launched in the autumn of 2021 and is Norway's first and only non-profit electricity company. They are registered as a non-profit company and can not make money. Their business model is to make money on products other than electricity, and they should launch an online store (Motkraft, 2022).

The online store

As mentioned, a test rig was set up to collect purchases that did not involve real money. The challenge with a test rig was that we would get an almost 100% conversion rate (completed purchases). Therefore, we could not include the conversion rate as a variable in the buying process from a test rig. We initiated a collaboration with Motkraft in December 2020 to get accurate data. In partnership with them, we integrated two login methods in an ID server and three different payment options in their online store, so we were able to analyze their purchase data for this study. In early May, they launched their merch collection to bring in sales. In this way, we are able to collect data from a natural decision-making process from an e-commerce store. Another advantage is that their store does not offer other services such as a wish list etc., which lets us avoid data from users who are out on other missions. The store was launched in connection with this study and therefore has no previous buyers who know the user experience of the store from before. All buyers have seen the store with new eyes.

Sign in solutions

To make it possible to do a study on the combination of sign-in + payment, two sign-in methods were chosen:

On January 24, 2020, a new product was launched, Vipps Login, a Vipps' SSO service. This launch initially aroused interest in the combination of sign-in and payment solutions for this study. We found the variety of sign-in and payment solutions interesting. Furthermore, Vipps is the only widespread supplier in Norway that offers sign-in and payment solutions. It, therefore, became natural to include this as a sign-in method.

It was desirable to have an alternative sign-in method that is simple and competitive. One of the most common solutions used on websites is email sign-in. However, it presents some challenges with the user having to verify the email as a step in the sign-in process and having to go through many steps beyond our control. It will therefore be challenging to say something about usability.

Another common sign-in method that is widely used in mobile applications is SMS auth. There, the user receives a one-time code via SMS for each sign-in. This method involves fewer different user interfaces and is better suited for our use so that all users are measured on the same basis. The user does not have to remember if they have created an account before and it is not possible to forget the password when they get a new code for each sign-in. SMS auth was therefore chosen as the second sign-in method.

Payment solutions

The choices of payment solution fell quite naturally on Vipps, Klarna, and a neutral card solution:

Vipps eCom

Vipps is a widespread payment app in Norway with 4.2 million Norwegian users (Vipps, 2022-c). Vipps for eCommerce works as follows:

1. The user selects Vipps as the payment method
2. The user enters the mobile number

3. The user enters the notification on the mobile and approves the payment

As mentioned earlier Vipps is the only widespread supplier which offers id and payments solutions and therefore became a natural choice in our study.

Klarna checkout

Klarna was founded in 2005 and is one of Europe's largest banks with 147 million active customers (Klarna, n.d.). Klarna offers another strategy which is "buy now, pay later" which means that a customer can complete the purchase, receive the item, and pay the invoice within 30 days from the purchase date. This solution is widely used in Norwegian online stores. Klarna and Vipps have similar visions: Klarna wants to offer smooth payments and Vipps wants to offer simplicity (Skjelsbæk, 2021). We find it appropriate to choose Klarna buy now, pay later as a payment solution as they compete with Vipps on usability, which is one of several factors in the choices consumers make.

Card payment (neutral card solution)

The third payment solution we offer is a neutral card solution. Neutral card payment is a good comparison because it is available for everyone and the whole population is informed of how it works and most likely has an opinion about it already. Klarna and Vipps have built a brand around their payment solutions which will affect the customer's opinion of the payment solution. This will not be the case for a neutral card solution.

Research problem

The purpose of this study is to execute a design evaluation using data science to look for correlations between the usage of different components in an app. This study will use an eCommerce store created by Motkraft as the artifact of design-science. The components measured in the evaluation are the sign-in and the payment solutions of the eCommerce store. The evaluation will use simplicity as the measurement of the success of a component. In this context, we wish to answer these research questions:

- **RQ1**: How does the choice of sign-in solution affect which payment solution a customer chooses in an eCommerce store?
- **RQ2**: To which degree is simplicity present in components which are used together in a system?

The practical problem which the research question derived from questions the relationship between two app features which are the login and the payment components. The aim is to gain a further understanding of a specific part of this relationship and if it exists at all. This means that the foundation of the value of any results lies within its ability to describe an aspect of the relationship between these two features. The hypothesis which motivated this study believes that the simplicity created when attaching a component to an app extends the value proposition of the app. Furthermore, the hypothesis believes that appending multiple components which are created from the same platform will have a synergistic effect. The synergistic effect is hypothesized to derive from two different concepts. The first reason is that each component does not only give value to the app but to each other as well. The second factor is the increase in the relational control that the platform exerts in the app.

Research methods

The overall strategy in this study will be based on the design-science research framework. The framework is a process that aims to gain knowledge about the artifact and its application in an appropriate environment as well as study the process and methods for building and evaluating the artifact and the environment themselves (Hevner et al., 2004). The purpose of this study is to find how digital service innovation is done in transaction platforms. We want to investigate how data science enables digital innovation by serving as an evaluation tool in the design-science research framework.

This study was primarily survey based and utilized quantitative data to perform data analysis. Applying data science in this context requires two prerequisites. The first part is to find and justify what information to extract from the artifact as well as the data necessary to perform the appropriate analysis.

There are three parts to the execution of this study. First of all, to understand the practical problem and what analysis and results would answer it. The second part is twofold and consists of identifying and then gathering observations which the analysis depends upon to create results. The last part is performing the analysis and investigating any correlating factors.

Data generation

This study will feature two data generating methods. The first method is to automatically generate observations while users are going through the eCommerce store. The usage of each feature is tracked and stored along with a randomly generated identification number per device which uses the eCommerce store. The second method is to use a questionnaire which customers receive after purchasing an item in the eCommerce store.

Figure 2.1: The overarching research process and plan of action of the data.
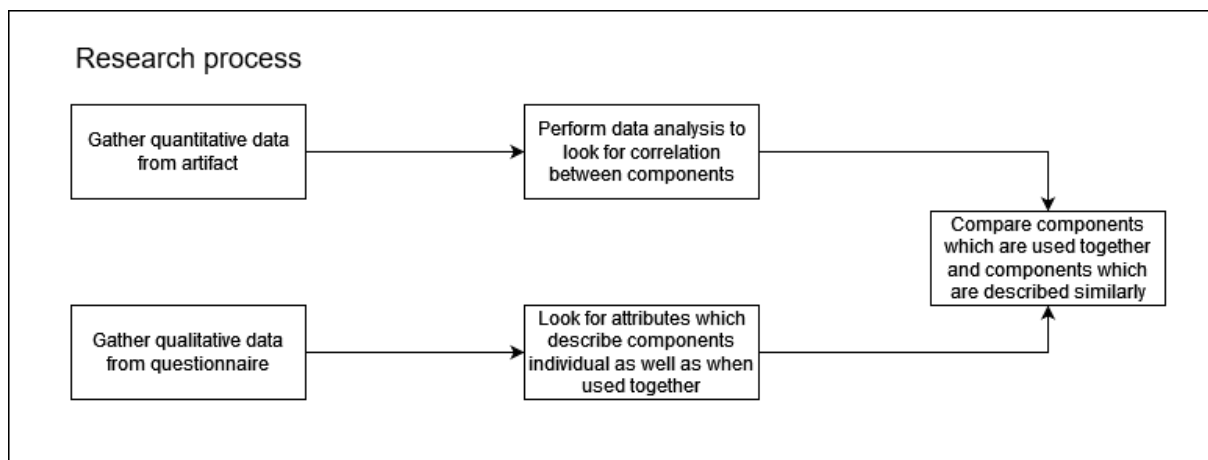

The population which this study applies to are all users of eCommerce stores. There are many different types of eCommerce stores and they each cater to different customers. This means that the results of this study are highly contextual. The problem of a wicked problem is that a solution might only be applicable in a specific situation. However, the method presented is still suited for almost all eCommerce contexts. The observations are collected from all customers who interact with Motkraft's eCommerce store. The selection of quantitative data will be explained in the *Data selection* part of the method. The questionnaire is only sent to everyone who purchases something from the eCommerce store

because it contains questions which ask about the payment solutions presented during their interaction with the eCommerce store.

Data purpose and analysis

In the design-science framework there are two main concepts which must be fulfilled to ensure that the research is both purposeful and that the process and results are trustworthy and valuable. These two concepts are relevance and rigor.

Figure 2.2: A conceptual framework for understanding, executing and evaluating IS research (Hevner et al., 2004, p. 80).

Figure 2. Information Systems Research Framework
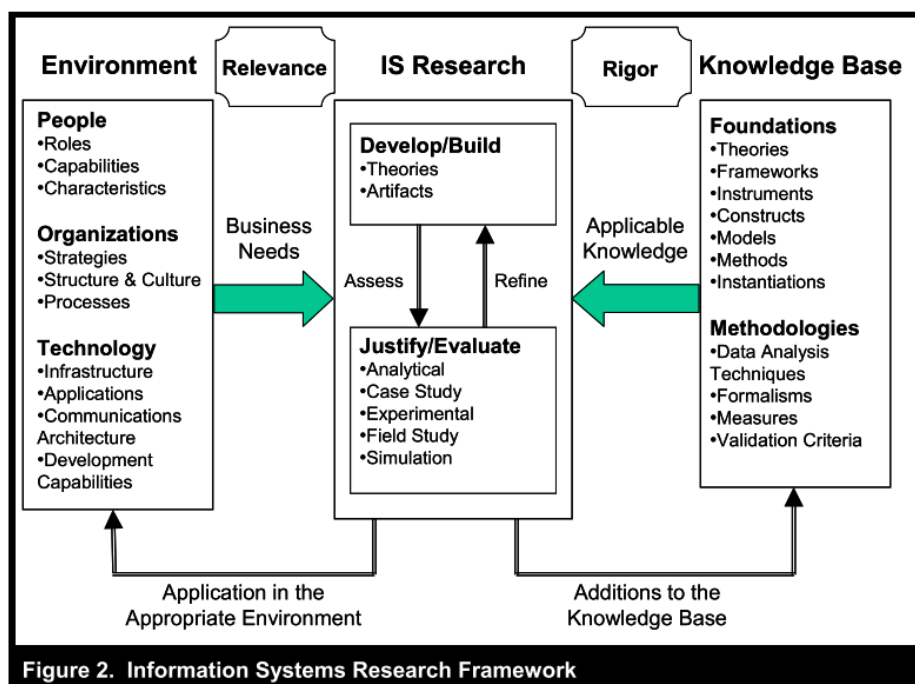
Rigor

Exploratory data analysis is a well developed field and has existed much longer than the design-science research framework. The methods procured are well tested, proven and utilized in a wide variety of fields and studies. Cramér's V is a method of finding the association between two categorical variables. This method was created by Harald Cramér in 1946 and has been frequently used since then and is a fundamental part of correlation research.

The first question to investigate is the main research question which asks whether or not the choice of sign-in affects which payment solution a customer uses. This means that the two main variables which will be investigated are the choice of sign-in and payment solution. In this study there will only be two sign-in options available however as the method should be reproducible with any amount of options it is important that a correlation coefficient can be calculated from any two nominal variables. The correlation coefficient can therefore be calculated using Cramér's V.

Relevance

The second part of the study will investigate the reason behind any found correlation and will utilize statistical analysis. Answering the hypothesis requires seeing if there are commonalities of attributes within any correlation. More specifically, in this context, attributes which according to Nielsen J. (1999) encourage or prohibit the simplicity of components in the app. To identify these attributes the questionnaire will contain open-ended questions about the reason for each component preference. An important note is that the data collected is contextual because the choice of components and their implementation varies between systems. It is also worth mentioning that more data might be beneficial, however it comes at the cost of a more abstract and complex interpretation. We chose the data selection because we believe it is sufficient to indicate simplicity.

Measuring simplicity is what gives this research relevance. In multiple meetings with Vipps, they expressed the value of simplicity and that they would like to know if their components help app developers implement this attribute in their artifacts. They currently do not have a lot of knowledge about the reasons behind the effectiveness of their components. In the meetings it was agreed upon that getting information about findings in a real business environment allows them to further improve their own components as well as being able to advertise the platform's value.

Data selection

As mentioned earlier, a part of measuring simplicity in an information system is to collect observations which will give information about any attributes which contributes to the overall simplicity. The main method of this study revolves around quantitative data analysis and therefore requires choosing the observations from the users interactions with the eCommerce store. The following type of observations are chosen:

Sign-in: When the user signed in with a specific sign-in option.

Payment: When the user paid with a specific payment solution.

Dropouts: Events where a user signs into the eCommerce store but does not purchase anything.

Errors: Any errors, both system and user created, which occurred during the interaction between the user and the IS.

The main factor we shall look at is Cramér's V. The two variables which we wish to find the correlation between are the sign-in solution and the payment options. For this we need to make observations during customer sign-in and payment. We also wish to look at the effectiveness of each solution as this is relevant because it allows validation of the results by the platform owner Vipps. Dropouts will be aggregated to customer journeys and will be used to look at whether choice of sign-in solution affects dropouts. Tracking errors helps making sure that the artifact, components and the observation gathering is working correctly as it should in the environment we wish to study them in.

Results

Correlation between sign-in solution and payment option

As explained in the *Research methods* section, the main statistic we shall be looking at to investigate correlation between custom choice of sign-in solution and payment option is Cramér's V (explained in the *Research methods* section under *Data purpose and analysis*). The following results answers **RQ1**.

Table 1.1: This table contains a table where the number of times each combination of sign-in solution and payment were used. This table is based on users who always chose the same sign-in solution and the same payment option. This table represents the matrix to calculate Cramér's V.

		Payment option			
		Vipps	Klarna	Neutral	**Total**
Sign-in solution	Vipps	20	1	2	23
	SMS	4	3	8	15
	Total	24	4	10	38

Cramér's V is calculated as followed:

$$V = \sqrt{\frac{x^2}{n * min(r-1, c-1)}}$$

The resulting V ranges from 0 to 1 where 0 indicates no association between the two variables and 1 indicates perfect association.

Using the matrix above gives us a Chi-Square (x^2) value and a V:

$$x^2 = 14.212 \qquad V = 0.6115$$

A Cramér's V of 0.618 suggests that there is strong association between the two variables. Considering a significance level where $p < 0.001$ and the degrees of freedom being 2, a Chi-Square value of 14.212 is above the critical value of 13.82 which shows a rejection of the null hypothesis and that the association is statistically significant.

Sign-in solution choice per user

Figure 3.1: This pie chart shows the usage of each sign-in solution per user regardless of whether or not they made a purchase.
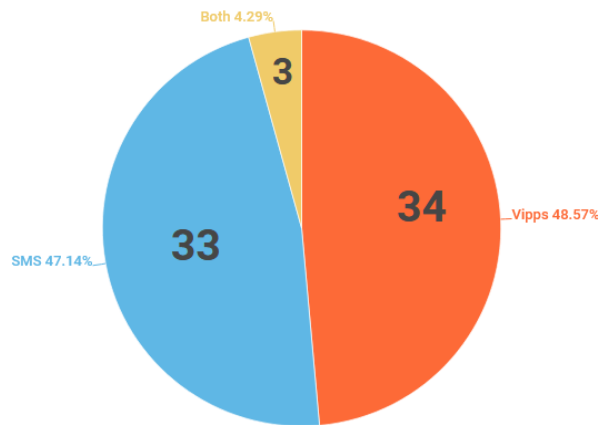
The usage of both sign-in solutions presented are very even. Under 5% of users chose to use both sign-in solutions.

Payment option choice per user

Figure 3.2: This pie chart shows the usage of each payment option per user regardless of which sign-in solution they chose.
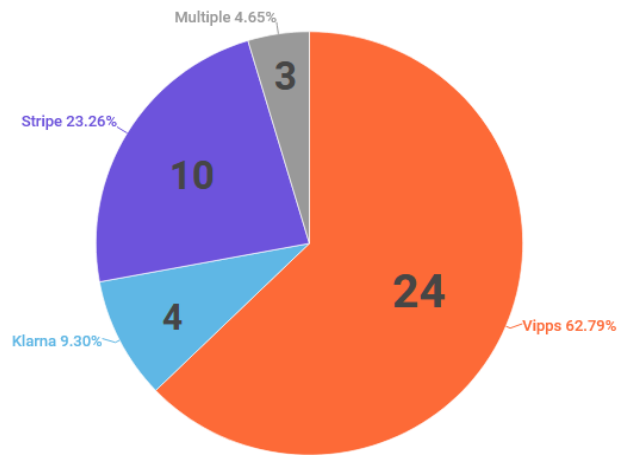
Under 5% of users chose to use both payment options.

Payment option per sign-in solution

Figure 3.3: This stacked bar chart shows the amount of times a combination of each sign-in solution and payment option. This chart is based on users who always chose the same sign-in solution and the same payment option. This is the same data used to calculate Cramér's V and the values are presented in Table 1.
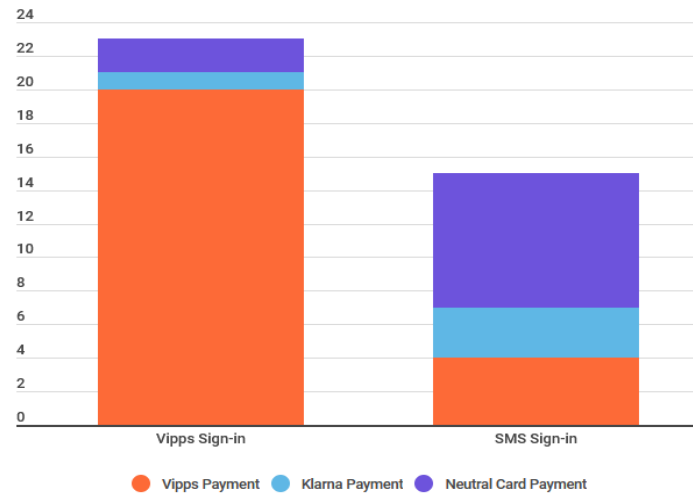
Dropouts per sign-in solution

Figure 3.4: This chart is based on users who always chose the same sign-in solution.
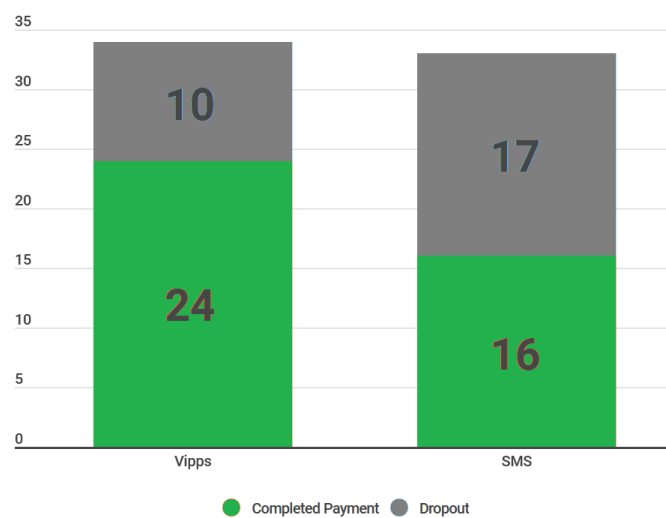
Table 1.2: The table contains the number of responses where a user's reasoning was the same when describing the reason for the choice of sign-in solution and payment option. There were 33 responses in total.

Reasoning	Number of responses where the reasoning where both for the sign-in solution and the payment option
Simple	9
Easy	2
Familiar	1
Habit	1
Fast	1

There was no component which was significantly more frequently described as simple than any other.

Discussion

In the design-science research framework, guideline 4 states that "Effective design-science must provide clear contributions in the areas of the design artifact, design construction knowledge (i.e., foundations), and/or design evaluation knowledge (i.e., methodologies)" (Hevner et al., 2004, p. 87). As explained in the introduction, the motivation behind this study roots in the interest of design artifact itself and the search for improving it. The practical goal of the study is precisely to provide insight into the artifact and the environment which surrounds it. Through the planning and execution of the process which utilized the design-science research framework, we made some aimed but also some unforeseen observations and findings. These observations and findings help increase the knowledge base in the uncharted terrain of data science and data gathering methods in a design-science research context.

Investigating correlation between two variables is a simplification of the practical problem we want to solve. The practical goal requires finding out the reason behind the correlation. The problem with finding causation is that the methods which identify causation are either more complex or are unable to test multiple components at once. As Hevner et al. (2004, p. 88) states, "In particular, with respect to the construction activity, rigor must be assessed with respect to the applicability and generalizability of the artifact". For an evaluation process to conform with the design-science research framework guideline it needs to be applicable to all similarly relevant design-research research instances. In the case of this study, this means that the evaluation process should be relevant for service innovation on transaction platforms.

The first thing we looked for was if there was anything to investigate. The primary reason for using a correlation coefficient such as Cramers' V is, in our case, not to prove association but rather to test how a mathematically rigorous method could be used to identify components of an artifact which affected each other. Cramers' V was an effective way of seeing if there are relationships between any components as it was mathematically calculated and did not rely on a human interpreting the data. This would have become more useful if there was a

much larger quantity of data as the value of the method increases as the quantity and complexity of data increases.

Oates et al. (2006) describes these two disadvantages of quantitative data analysis:

1. The analysis can only be as good as the data initially generated.
2. You have to be clear about what statistical test you will use, and what kinds of quantitative data they require, before you even start data generation.

These two constraints create a problem which we did not consider thoroughly. Since quantitative data analysis requires planning of what data is required before the data generation begins, there is not always a way of knowing whether or not the data will be available. In our case, due to the constraint that a user can pay multiple times without signing out of the eCommerce store, each customer journey could have multiple payment options connected to the same sign-in solution. The opposite could also happen where a user could sign out and then sign in again with a different solution. We were only interested in users who chose a single sign-in solution and a single payment option. As Figure 3.2 and Figure 3.3 shows, the cases in which users chose different enveloping components were under 5%. Even if a case where everyone chose multiple enveloping components would give insight and valuable information, there might have been other more valuable results which could have been extracted with a different analysis. Knowing what a representative sample is in our case would have required its own research which would have depended on its own data generation. We could however confirm whether or not we had a representative sample afterwards due to the fact that we had collected data about each component used individually. Knowing we had a representative sample meant results from the data analysis would be relevant.

Measuring Cramer's V shows that there was a strong association of the choice of sign-in solution and payment option chosen by users who only chose one of each. In the questionnaire we directly asked why the user chose the sign-in solution and payment option they did. Out of 33 responses only one user commented on a synergy between a sign-in and payment solution. However, as Table 1.2 shows, 13 of the responses answered the first question very similarly to the second question, in which the reasoning behind their choice

was an attribute of the components or their relationship with the component. This shows that there might be some value in value in implementing components which share attributes. Vipps tries to use simplicity as control mechanism to "...provide an overarching collective goal for the platform ecosystem; a sort of shared identity that defines the character of the platform ecosystem and rallies app developers around it by harmonizing their own goals with those of the platform" (Tiwana, 2014, p. 125). However there was no component which was significantly more frequently described as simple than any other. It is therefore not possible to say that relational control of the platform is playing a part. It could be that app developers prefer/use components which share the same attributes despite being owned by different platforms. This would mean that the value comes from the norm from the usage or purpose of the components itself.

In this study we are not changing the artifact testing different designs. The evaluation step of the design science research framework was only performed once. The description of guideline 6 of the design science research framework starts with: "Design science is inherently iterative. The search for the best, or optimal, design is often intractable for realistic information systems problems" (Hevner et al. 2004, p. 88). As later explained in the limitations of this study, we cannot be sure that the same data gathering and analysis are able to utilize the same technical techniques or yield valuable results when changing the artifact. In short, the robustness of data science in an iterative design process is uncertain.

Conclusion

This study provides insight into the uncharted terrain between data science and design-science research. The purpose and results are not aimed to gain a complete picture of new industry standards, but rather a step towards creating a dominant design. We are fully aware that the data analysis is utilized in the absolute best way possible. The main contribution, however, is that we provided a proof of concept which displays the pragmatic value of utilizing data science to enable digital service innovation.

Digital service innovation has shown to be a fast changing field. There is an enormous amount of different people, organizations and technologies which are working, changing and

improving this field. Platform ecosystems are complex and constantly present wicked problems which require human creativity as well as constant adaptation of solutions. It is important to note that solving these problems does not necessarily mean creating completely new methodologies or foundations. Vipps' platform ecosystem relies on simplifying existing solutions. An inherent trait of using existing solutions is that they are tried and tested. In the same way, this study relies on the existing solutions which were built in data science and design science research. By doing innovation based on different rigorous methods gives a supported foundation when exploring new fields.

Limitations and future work

The most prominent limitation which we were aware of in this study was the limited constraint. A prerequisite for gathering the data necessary to conduct this study is the need for an eCommerce store which will provide the needed data. In the original pre-study we were considering creating a prototype artifact with the only purpose of testing and gathering data. The environment of a prototype is not the same as an artifact in a real business environment and would lessen the relevance of the research. The major advantage of using a prototype is the cost reduction in time as only a partial amount of features of an eCommerce store need to work for the purpose of data gathering. Creating a real artifact in a real business environment meant that producing the data was much more costly as we had to develop and provide the business needs with full functionality. Provided the short time we had to produce this artifact, we had less time to gather data which meant that the data science related methods were not exploited to their full extent.

It is extremely important to be aware that this is meant to be a pilot study in an uncharted field and processes and results which were procured must be understood in the context of digital service innovation in the specific environment of eCommerce stores. Future work should carefully consider the type of data gathering and data science applied as this is not easily generalizable. Future work should also use different data science techniques with a much larger quantity of data than used in this study. This will reinforce the value and provide rigor to the methodologies used.

As the design science research framework is an iterative process each step should be repeated multiple times if possible. Future work should look at the robustness and generalizability of the data science evaluation in a more complete utilization of the framework.

References

Bridging differing perspectives on technological platforms: Toward an integrative framework.

    (2014). *Research Policy*, *43*(7), 1239–1249. https://doi.org/10.1016/

    j.respol.2014.03.006

Cusumano, M. A., Yoffie, D. B., & Gawer, A. (2020). The Future of Platforms. *MIT Sloan*

    Management Review, (Spring 2020).

    https://sloanreview.mit.edu/article/the-future-of-platforms/

Finanstilsynet. (2021, October 27). *Tilsynsrapport - Vipps AS*. Finanstilsynet. Retrieved June

    6, 2022, from

    https://www.finanstilsynet.no/nyhetsarkiv/tilsynsrapporter/2021/tilsynsrapport---vip

    ps-as/

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems

    research. *MIS quarterly* (pp. 75-105).

Hope-Paulsrud, O. (2022, May 13). Tror ikke det blir utviklerflukt når Mobilepay, Vipps og

    Pivo slås sammen. *Digi.no*.

    https://www.digi.no/artikler/tror-ikke-det-blir-utviklerflukt-nar-mobilepay-vipps-og-p

    ivo-slas-sammen/519448?key=rxDCfV89

Karvonen, K. (2000, November). The beauty of simplicity. In *Proceedings on the 2000*

    conference on Universal Usability (pp. 85-90).

Klarna. (n.d.). *Om oss*. Klarna. Retrieved May, 2022, from

    https://www.klarna.com/no/om-oss/

Kran, M. E., Ramm, T. I. & Roll, E. (2021, February 28). *VIPPS as a Platform Ecosystem,*

    Deliverable 1 - Actors Involved

Kran, M. E., Ramm, T. I. & Roll, E. (2021, April 6). *VIPPS as a Platform Ecosystem, Deliverable 1 - Dynimics of the evolution og the platform and its apps over time*

Larsen, J. I., & Vipps. (2021, February 18). *Hør Komplett fortelle hvordan de forenklet nettsalget med Vipps Logg inn*. Vipps.no. Retrieved June 8, 2022, from https://www.vipps.no/om-oss/webinar/webinar3-logg-inn/

Motkraft. (2022, April). *Om Motkraft - Hvordan vi er så billige på strøm*. Motkraft. Retrieved May 03, 2022, from https://www.motkraft.no/om-oss

Nielsen, J. (1999). Designing Web Usability. The Practice of Simplicity. New Riders Publishing, Indiana.

Oates, B. J., Griffiths, M., & McLean, R. (2006). *Researching information systems and computing*. Sage.

Ramm, T. I. & Roll, E. (2021, December 15). IT3915 - Master inn Informatics, *Preparatory Project*

Shifter. (2021, June 30). Vipps slår seg sammen med dansk og finsk betalingsselskap. *Shifter*. https://shifter.no/nyheter/vipps-slar-seg-sammen-med-dansk-og-finsk-betalingsselskap/214910

Skjelsbæk, J. (2021, November 10). Herr Forenkling og Mr Smooth. *Shifter*.

https://shifter.no/fintech/herr-forenkling-og-mr-smooth/226736

Spool, J. et.al (1999). Web Site Usability. A Designer's Guide. Morgan Kaufmann Publishers Inc, San Francisco, California

Språkrådet. (2020, August 14). *Å vipse penger (ikke vippse)*. Språkrådet. Retrieved June 5, 2022, from

https://www.sprakradet.no/svardatabase/sporsmal-og-svar/a-vipse-penger/

Tiwana, A. (2014). *Platform ecosystems: Aligning architecture, governance, and strategy*.

Newnes. https://doi.org/10.1016/B978-0-12-408066-9.09999-9

Vipps. (2022-a, March 4). *Vipps Markedstrender Q1 2022*. Vipps. Retrieved June 5, 2022,

from https://vipps.no/documents/243/Kvartalsrapport_Q1_2022.pdf

Vipps. (2022-b, May 9). *Vipps login API*. GitHub. Retrieved June 6, 2022, from

https://github.com/vippsas/vipps-login-api/blob/master/vipps-login-api.md#scopes

Vipps. (2022-c, May 18). *Nordmenn koste seg til ny Vipps-rekord på 17. mai*. Vipps. Retrieved

May 18, 2022, from

https://www.vipps.no/om-oss/nyheter/nordmenn-koste-seg-til-ny-vipps-rekord-p%C

3%A5-17-mai/