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# BETTING ON THE BLOCKCHAIN

## - Applying design science to develop a smart contract solution for a new business model of the betting industry

Master thesis

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# Abstract

Betting on the blockchain

Applying design science to develop an innovative solution
to improve the betting industry

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The potential to decentralize industries by combining the blockchain with smart contracts is currently gaining recognition worldwide. The collaboration of these emerging technologies enables a unique opportunity to create new business ventures. Continuously, businesses across the spectrum are exploring new ways to adopt these technologies.

In order to exploit the potential of this combination, our thesis aims to use smart contracts and blockchain technology to develop a new artifact in the form of a prototype. In this research, we will focus on a global industry, namely the online betting industry, to identify how smart contracts and blockchain technology can further evolve the online betting industry's current business model. Thus, we will merge existing literature and knowledge on the online betting industry, blockchain technology, and smart contracts to develop a peer-to-peer based solution. We will utilize a design science approach to design, build, and evaluate the proposed blockchain solution to demonstrate its feasibility and utility.

By using this approach, our thesis evolves current research. The research seeks to identify the gap between smart contracts, blockchain technology and the online betting industry. The end result being an alternative business model, which demonstrate how smart contracts and the blockchain can be used to:

1. Establish a peer-to-peer betting solution, which facilitates the betting process between users,
2. Create and evaluate a solution, which illustrates the potential of an alternative business model, and
3. Provide recommendations based on qualitative feedback from the evaluation of constructed scenarios, which enables further development of the utilization of smart contracts and blockchain technology.

Overall, this study seeks to contribute knowledge to the smart contracts and blockchain field, which despite the recent increases in interest, remains a relatively unexplored area.

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## Introduction

In a matter of a decade, cryptocurrencies have introduced the potential for sweeping changes across fiat currencies globally. Cryptocurrencies, which are a digital currency where encryption techniques are used to operate independently of a central bank, have marked the beginning of a widespread revolution of decentralizing businesses. This was sparked in November 2008 in light of Satoshi Nakamoto's (a pseudonym of either a group or an individual) whitepaper called "The bitcoin – a peer-to-peer electronic cash system" (Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System, 2008). Based on this work, Nakamoto introduced the concept of the bitcoin, which is deemed the first decentralized cryptocurrency.

Upon sending out an email to peers in 2009, Nakamoto announced the launch of the bitcoin client (Nakamoto, Mail-Archive.com, 2009). The bitcoin client runs on a public ledger, known as the blockchain, which keeps track of every bitcoin transaction (Antonopoulos, 2014). By the end of 2015, predictions were estimated that there would be more than 1 billion USD in venture capital funding directed at the bitcoin (Taylor, 2015). The anticipation is that these figures will continue to increase in years to come.

This is made possible by the potential that the blockchain offers. In fact, the blockchain has recently been considered the key innovation of Nakamoto's whitepaper. The blockchain is the technology behind the bitcoin. Despite the complexity of the blockchain technology, the concept put simply is that it is an extensive, globally distributed ledger or transparent database, which operates on millions of devices and is open to anyone. Rather than relying on traditional intermediaries, such as governments and banks to establish trust, the distributed ledgers generates security through a widespread peer-to-peer collaboration of complex algorithms. The blockchain allows information as well as anything of value (I.e. money, votes, and intellectual property) to be transferred and stored privately and securely[1]. To make this a reality, the blockchain is constantly growing through the mining (i.e. adding) of blocks.

Since the discovery of the blockchain, the potential use cases have increased. In fact, the notion of the decentralized business model that the blockchain enables continues to attract a wide range of interest across industries, as seen in the following examples:

1. IBM has joined a hyperledger group with sights set on becoming the major provider of blockchain solutions across various industries[2].
2. Because cryptocurrencies would erode the need for intermediaries like banks, the banking industry is investing heavily in the blockchain technology. Rather than succumbing to the threat that the blockchain poses, large banks are collaborating to be a frontrunner in driving the technology. This can be seen as an attempt to ensure their position in the market[3].
3. Finally, there is a growing focus on the collaboration and sharing economy. This is apparent as solutions like AirBnB and Uber gain traction. These solutions facilitate sharing, as individual customers, rather than centralized organizations, arrange and execute the service transactions[4].

As is apparent in these cases, the blockchain technology poses a number of opportunities for businesses. A main potential use being the adoption of smart contracts. With the ability to execute agreements automatically on a blockchain, a smart contract is a contract, which is capable of enforcing itself

[1] https://hbr.org/2016/05/the-impact-of-the-blockchain-goes-beyond-financial-services
[2] http://www.ibm.com/blockchain/
[3] http://www.distributedledgergroup.com/blockchain-101/
[4] https://www.pwc.com/us/en/technology/publications/assets/pwc-consumer-intelligence-series-the-sharing-economy.pdf

automatically without the interaction of an intermediary. A smart contract is a written code rather than a legally enforced agreement (Tuesta, 2015).

Parring smart contracts and the blockchain technology creates a unique combination. This amounts to a transparent network, which is able to execute contracts by itself, thus removing the need for an intermediary.

For this research, we seek to unravel the potential of the blockchain by investigating the foundation of the emergent technologies (I.e. Smart contracts and blockchain). To achieve this, attention will be directed at a single global industry, namely the online betting industry. We will assess how blockchain and smart contracts can be applicable to the online gambling industry by applying the design science research methodology. Upon executing this research approach, we will propose an alternative business model for the online betting industry.

## Problem statement

Existing literature, on blockchain technology, which is limited to articles and news, focuses predominantly on the technology's potential to alter current business infrastructures (Forbes, 2016).

However, up until this point many of the projects, such as IBM's Hyperledger or the R3 groups, are closed experiments. This limits the widespread knowledge sharing required to further develop the technology on a large scale. Currently, the only project, which shares the findings of its work, is the Ethereum project. Despite this project's findings, its aim is solely to create an open ecosystem, which individuals still need to develop on their own to be able to utilize its potential. So far, the applications that exist on Ethereum are not suitable for mainstream use (State of the DApps, 2016).

Nevertheless, various betting companies have started to use cryptocurrencies, such as bitcoin. Their approach is to replace fiat currencies with cryptocurrencies used for gambling (Fortunejack, u.d.). Given this, these gambling companies are not investigating further evaluation of the blockchain technology. As a result, a void is created inviting the need for further investigation into the blockchain and smart contracts technology.

Recognizing this gap in knowledge, this thesis adapts an academic perspective with the aim to build a business on the blockchain. To accomplish this, existing literature will be explored and rigorous methods will be implemented. As a result, a concrete artifact, which illustrates how a business model can connect online betters directly by using smart contracts, will be proposed. Overall, the intent is to create a novel approach to fill gaps in current literature as well as remove uncertainties regarding the emerging technologies.

## Research goal

The goal of this thesis is to develop a new business model for the betting industry. The business model will illustrate how we can facilitate betting online on the blockchain by using smart contracts to connect betters directly with each other. In achieving this, the proposed business model aims to change the way people bet online by creating a more transparent environment. As such, the proposed business model will enable people to bet easily with friends or strangers by setting their own odds. Ultimately, the adapted business model will illustrate how the need for bookmakers will be reduced if the trust element of betting is built into the process rather than relying on an intermediary.

## Research objectives

Given the preceding research goal, the aim of the thesis will be to address the following research objectives:

1. Merge existing literature to explore the topics of smart contracts, blockchain technology and the online betting industry business model.
2. Consider how smart contracts and blockchain technology can be combined to arrive at an alternative business model for the online betting industry.
3. Implement the proposed business model by designing, evaluating and iterating a prototype.

## Research question

When considering the research goal and objectives, this thesis will explore the ensuing research question.

*How can the current business model of the betting industry be further evolved to realize the following:*

- Enable people to bet directly with each other using emerging technologies,
- Develop an artifact illustrating the business model, and
- Improve the usefulness of the artifact and business model through continuous iterations?

## Scope of research

Overall, the design science research approach will serve as the basis for outlining the purpose and scope of our research. In outlining research, this methodological approach will initially be used to guide the development of the research purpose, scope, problem definition and objectives (Shirley Gregor, 2013). With the research aim in place, focus will be placed on the blockchain technology, smart contracts and the online betting industry. Accordingly, existing theory and the current state of the online betting industry will be explored. This will provide a foundational understanding of how the emerging technologies can be combined to address the research question. From here, a methodological model within design science research will be selected and then used to serve as the basis for the solution. Using this approach, an initial solution will be offered. An evaluation process is implemented to determine whether there is a need for further iterations. Ultimately, a refined solution will be arrived at.

Upon following these steps, the research focuses more on developing a conceptual rather than a detailed solution. Thus, the development of a fully functional blockchain solution will not be within the scope. As a result, this research will focus merely on the development of a business model with a functioning prototype that can be implemented on the blockchain technology. Accordingly, the thesis will offer additional avenues for further development and implementation of the prototype.

### *Class of problems*

When using design science research, it is important to address the classification of the problem, which the research intents to solve (Shirley Gregor, 2013). By reviewing the problem classes, we conclude that our research tackles a type four problem (Keen, 1974). The definition of this class is the research type, and the categorization of this problem is *"search for cues and by generations of explanatory concepts"* (Keen, 1974). The type four's definition the typical outcome of the research is the development of new products, which highly relates to the aim of our solution (Keen, 1974).

### *Structure of the research*

This paper will be structured using the Design Science Research Publication Schema. Shirley Gregor and Alan Hevner proposed the schema in 2013, as a means to help design science researchers to publish their findings. The authors developed the schema because they felt that, *"literature provides insufficient advice on how Design Science Research is communicated and its contributions to knowledge established"* (Shirley Gregor, 2013).

With this sentiment, the authors create a schema that outlines seven sections to use in a design science research paper. However, it is a set of guidelines and not a checklist. As concluded in their paper, other patterns are possible and many articles will not include every component within the seven steps (Shirley Gregor, 2013).

The seven steps are defined as follows: Introduction Section, Literature Review Section, Method Section, Artifact Description Section, Evaluation Section, Discussion Section, and Conclusion Section. An overview of what content will be provided in each of these sections is provided below

**The Introduction Section**
Here lies our research objectives and problem formulation, which specifies what findings we aim for with this thesis. We will also outline the purpose and scope.

**Literature review**
This section contains in depth analysis and description of our problem area. Here we explain the fundamentals of the blockchain, smart contracts and betting industry to underpin the development of our business model artifact.

**Method section**
In the method section, we walk through various design science research approaches. From here, we discuss and evaluate which framework to use for the development of our business model artifact. We then explain choices of data gathering and choosing the evaluation methods.

**Artifact Description**
Here we explain how we design our artifact. This includes outlining the series of iterations we make and providing findings of each iteration round.

**Evaluation**
In this section, we will evaluate all of our artifact feedback as well as our gathered knowledge throughout the process. This is to demonstrate that the artifact achieves the goals set in our introduction. In addition, makes sure that the contributions to the design science research are explicitly listed.

**Discussion**
Following the evaluation, we will assess how we perceive the results to be and how well the findings relate to the aims and goals we set in the introduction. Finally, we explore the limitations of our thesis and the areas that have potential for additional research.

**Conclusion**
Finally, we sum up the key takeaways of our work.

This approach was described by (Shirley Gregor, 2013), as a framework for presenting design science research with maximum impact. This this design science research method will the serve to outline the approach of this research.

## Literature review

The need for a literature review was established in the introduction, which is in line with the research approach outlined by Shirley Gregor, et al (2013).

The literature section serves the purpose of including relevant descriptive theory, and any other knowledge, which has relevance to the problem. This section also capture any kernel theory, and is later used in the artifact description section for informing the specific aspect of design (Shirley Gregor, 2013).

The literature review needs to address some, but not necessarily all of the following objectives (Hart, 1998):

- A distinguish of what has been done from what needs to be done;
- The discovering of important variables, which is relevant to the topic;
- Production and gaining of a new perspective;
- Identify the relationship between existing ideas and practice;
- Establish context of the topic or problem;
- Focus and acquiring of the subjects vocabulary;
- Develop an understanding of the structure of the subject;
- Relate ideas and theory to applications;
- Identification of the main research techniques and methodologies available within the topic;
- Placement of in the research in a historical context, showing state of the art developments.

## Origination of currencies

Throughout the 19$^{th}$ and the 20$^{th}$ century the most successful currencies was fixed and could be converted into gold or other metals, and before that currencies was trading gold or silver (Yermack, 2013).

Most economies was in a tough situation after financing the two World Wars because the production of gold was not in line with the economic growth. This resulted in mostly any major economy started to issue paper fiat currency, where the value relies on the public's trust that national governments and central banks will not increase the banknote supply with a too high velocity (Yermack, 2013).

## Bitcoin

In the introduction of this thesis, we introduced the concept of bitcoin cryptocurrency. However, in order to establish a background for the blockchain, it is relevant to explain how the bitcoin emerged and how it is constructed.

Bitcoin is aiming to reduce the issue with the government increasing the rate of banknotes supply, because no government has the possibility of manipulation the supply of bitcoins. Bitcoins are controlled by a decentralized network.

The maximum amount of bitcoins are fixed at 21 million units, and the way the bitcoin is structured, is that the frequency of mining new coins will decrease over time, and the difficulty will increase over time (Antonopoulos, 2014).

## What is Bitcoin?

In November 2008, Satoshi Nakamoto released an eight-page whitepaper, which described the bitcoin protocol and how the timestamp server functioned. At the time, no one knew that this whitepaper was about to revolutionize the possibilities of cryptocurrencies.

Bitcoin is the world's first decentralized cryptocurrency (Yermack, 2013). This means that before the bitcoin there was other 'cryptocurrencies', which was issued as a digital currency. However, these cryptocurrencies where backed by a national currency or precious metals like gold and by that centralized (Antonopoulos, 2014).

Bitcoin is both the leading and the first of the emergent currencies known as cryptocurrencies. A cryptocurrency is a currency, which facilitates the exchange of a medium and while doing that disrupts the centralized money services by using a peer-to-peer approach and cutting out the intermediary (Hobson, 2013).

Bitcoin is a cryptocurrency that is based on a peer-to-peer network, which in basic means that you can transfer money from person to person without having the interference of a bank. The peer-to-peer network both lower the cost and makes the transaction closer to real time.

### *How does Bitcoin work?*

To be able to develop the first electronic payment system where o intermediary such as banks are necessary, Satoshi Nakamoto had to utilise multiple years of research into cryptography and computer science (Moore & Christin, 2013).

The cryptography that previously have been used to build digital currencies has always been centralized and by that being very sensitive to attacks from either government or hackers. The bitcoin protocol is a culmination of years of research cryptography and distributed systems, leading into four key innovations, whereas the public transaction ledger, which is also known as the blockchain has been the innovation capturing most attention from companies. The four key innovations is as follows:

- *"A decentralized peer-to-peer network (also known as the bitcoin protocol).*
- *A decentralized mathematical and deterministic currency issuance (distributed mining).*
- *A decentralized transaction verification system (transaction script).*
- *A public transaction ledger (the blockchain)"* (Antonopoulos, 2014).

### *Bitcoins disadvantages*

Bitcoins has its disadvantages as well as any other technology. According to a project by Onies, Daniele, and Olayinka at Standford University, they list some of the following disadvantages on the bitcoin:

1. Bitcoins are not widely acceptable
   1.1. Bitcoins are to this day, only accepted by a very limited amount of merchants. There is also the possibility of any government going in and regulating merchants so it is not allowed to use bitcoins as a currency.
2. Wallets can be lost

2.1. If a harddrive crashes, is infected by a virus or anything else happens to corrupt the wallet, the bitcoins in the given wallet will essentially be lost. This makes it possible for even a wealthy bitcoin wallet to go broke in a matter of seconds.

3. Bitcoin valuation fluctuates
   3.1. The bitcoins are very volatile, which makes it hard to determine how to handle transactions of goods. Imagine you buying a shirt for 2 bitcoins one week, and exchange it next week, where the value can have gone up/down – should you then have the same amount back or should the merchant adjust for the value increase/decrease?
4. Built in deflation
   4.1. Since the total amount of bitcoins are capped at 21 million, it will cause deflation. The closer you get to maxing out the bitcoin, the more each bitcoin will be valued (Giancarlo Daniele, 2011).

If you look at these and combine it with the privacy that the anonymous aspect of the bitcoin, which makes it vulnerable based on the possibility of people with bad intentions with their purchases on the black market on the dark web.

### *Bitcoin - more than just money*

As previously stated in the introduction of this thesis, our focus will be the blockchain and the possibilities this has created. Not just to decentralize cryptocurrencies but as an innovation that is applicable to both to digital currencies as well as anything that you can think of, involving transactions or an exchange of goods.

As seen in the beginning of this section, the blockchain was not the only original focus in the whitepaper by Satoshi Nakamoto. Instead, the possibility of decentralising any business logic and make it into code, and being able to make transactions without an intermediary where later known as the real discovery.

## The Blockchain

The blockchain or timestamp server as it is called by Satoshi Nakomoto, is a bi-product of the bitcoin, as it was not the first thing for that was the focus when the whitepaper was released it is now known as one of the key innovations of the bitcoin.

### What is a blockchain

The blockchain is from the point of a bitcoins perspective a public ledger of all transactions ever made with bitcoins. It is constantly growing as completed blocks are added, the blocks in a blockchain are added chronological so each node in the network will get a copy of the blockchain, and because a blockchain is a series of blocks 'chained' together, it is possible to track it back to the first block (Project B. , 2016).

One way to think about the blockchain is to think of it as the ground of the earth. The top layer will change over time through different seasons before it has actual time to settle, but as soon as you start to dig further into the ground, the structure will become more and more stable. When you are 50 meters into the ground, you can be looking at ground that has been undisturbed for millions of years. The blockchain works the same way. The six top blocks are like the top of the earth as it might end up having to be recalculated, but once you go beyond the top six blocks it is less likely to change. After one hundred blocks, the chain is stable, and if you go a thousand blocks back the blockchain is settled (Antonopoulos, 2014).

#### *How does a blockchain work*

The blockchain's data structure is a list of blocks of transactions. Blocks all link 'back', where each new block will refer to the previous block, this is also known as the parent block (Antonopoulos, 2014). Each block has the parents block through the previous block hash field in the block header, so the sequences of blocks will all refer to its parent and by that creating a chain, this chain refers all the way back to the first block, which is also known as the genesis block (Antonopoulos, 2014).

*Table 8-3. The structure of the block header*

| Size | Field | Description |
|---|---|---|
| 4 bytes | Version | A version number to track software/protocol upgrades |
| 32 bytes | Previous Block Hash | A reference to the hash of the previous (parent) block in the chain |
| 32 bytes | Merkle Root | A hash of the root of the Merkle-Tree of this block's transactions |
| 4 bytes | Timestamp | The approximate creation time of this block (seconds from Unix Epoch) |
| 4 bytes | Difficulty Target | The Proof-of-Work algorithm difficulty target for this block |
| 4 bytes | Nonce | A counter used for the Proof-of-Work algorithm |

FIGURE 1 - ANTONOPOLOUS 2014 STRUCTURE OF BLOCKHEADER

By connecting the blocks by the block header, the child block will have the parents block in its hash in the block header, this will affect the child blocks hash.

This also means – that if you want to modify the parent block, the block header has to change in the previous block hash pointer of the child, which then would cause the child's hash to change, which would then require a change in the pointer of the grandchild, and so it will continue. The cascading effect of a

blockchain guarantees that once a block has many generations following it, the blockchain cannot change without obliging recalculations on all following blocks (Antonopoulos, 2014).

### *Transparency and the distributed ledger*

Whenever a transaction is made or a smart contract is deployed that action will become part of a block. This we explain in an ensuing section. On the Bitcoin and Ethereum blockchain, all blocks are publicly available. Etherscan has made 'Block explorer'[5] where you can see all blocks and their transactions all the way back to the genesis block. Similar exists for the bitcoin network[6].

This is what is referred to as the distributed ledger[7]. Unlike your normal bank account where only you and your bank advisor can see the ledger of transactions, the distributed ledger makes it possible for everyone to see all transactions from any given wallet. With the distributed ledger, you can track which wallet the crypto-currency originates from and if you know, who owns the wallet you can track every spending the owner has ever made. It creates a very high level of transparency, when everyone in the network can see everything. The high level of transparency is adds to the level of trust. Even though wallet owners are anonymous.

### *Trust the network*

As previously mentioned the blockchain is a peer-2-peer network. There is no central part in control of the network. Every node is equal and have a direct link to each other (Antonopoulos, 2014). The trust is a part of the network protocol. This is the proof-of-work algorithm, sometimes referred to as "Mining", which we will explain later. Because the blockchain operates as an autonomous network, there is no need for a central party to control the activities. Everyone can participate by either downloading an app to pc or mobile.

### *Block structure*

A block is a data container, which primarily consists of the block header and the transactions. The block header is 80 bytes, where a transaction on an average is around 250 bytes and a block contains over 500 transactions, which then makes the transaction list within the block the largest by far (Antonopoulos, 2014).

The block header consists of three sets of block metadata. The first set of metadata is a reference to the previous block in the chain, which then connects the two blocks in the blockchain. The second set of metadata relates to mining of blocks, it consists of the difficulty, the timestamp and nonce. The third set of metadata is a Merkle Tree root, which is a data structure utilized to efficiently summarize all the transactions in the block (Antonopoulos, 2014).

### *How to identify a block*

A block consists of two different identifiers. The first and the primary identifier is a blocks cryptographic hash, which can be translated as a blocks digital fingerprint. The hash is called the block hash, but more accurately could go as the block hash header, as the block header is actual the only used to compute it (Antonopoulos, 2014).

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[5] https://etherscan.io/
[6] https://blockexplorer.com/
[7] http://www.blockchaintechnologies.com/blockchain-definition

The block hash is not stored within the blocks data structure, but instead each node computes it as they receive the blocks from the network (Antonopoulos, 2014).

The second way to identify a block is the block height. The block height is defined as adding each subsequent block on top of each other. Imagine blocks as building bricks where you stack them on top of each other, the block stacked on the previous block will always be one position higher on the list. The first block will have the number zero and the next will then have the block height 1. Compared to the block hash the block height is not a unique identifier.

FIGURE 2 - ILLUSTRATION OF BLOCK HEIGHT

If you look at a single block individually, it will always have a specific block height, but the block height does not necessarily only identify one individual block. This scenario defined as a blockchain fork (Antonopoulos, 2014).

### *Merkle trees*

Every block in the bitcoin blockchain, have to contain all of the transactions within the block, and with up to 500 transactions within each block, this can be quiet data heavy, so the bitcoin blockchain are using a Merkle Tree to keep the data consumption at a minimum. A Merkle Tree is a data structure, which is used for efficiently summarizing and verifying larger sets of data (Antonopoulos, 2014).

The merkle trees used in a blockchain serves three purposes as it is used to summarize all transactions in a block, and producing an overall digital fingerprint for the entire sets of transactions, which is a very effective way to verify if a transaction is included in a block (Antonopoulos, 2014).

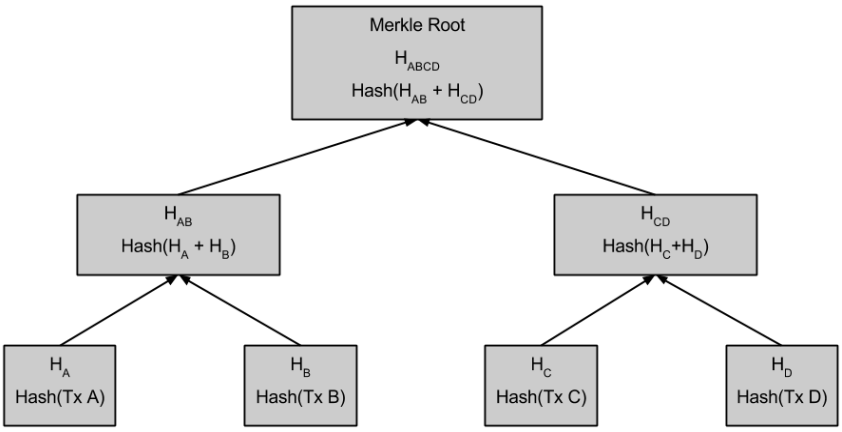


FIGURE 3 - SIMPLE MERKLE TREE (ANTONOPOULOS, 2014)

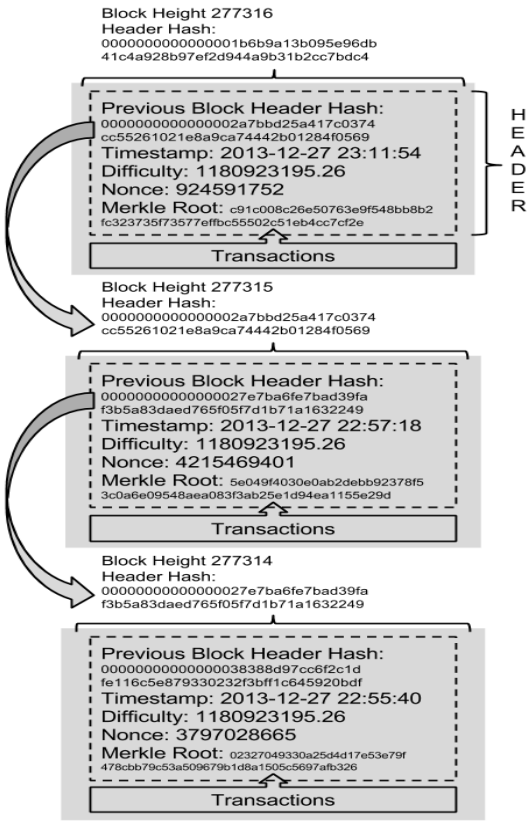


FIGURE 4 - THE BLOCK HEADER (ANTONOPOULOS, 2014)

The merkle tree is a bottom up construction, as you can see in the figure we have four transactions, A, B, C and D, together they form the 'leafs' of the merkle tree. The data is not stored in the merkle tree root itself, it is stored within each node of the merkle tree, where the resulting hash is $H_a$, $H_b$, $H_c$ and $H_d$. Sequential pairs of leaf nodes are summarized into a parent node, by concatenating two hashes, in the figures case it would be $H_a$ and $H_b$ into $H_{ab}$ and $H_c$ and $H_d$ into $H_{cd}$ (Antonopoulos, 2014).

Therefore, the block header would have all the information it needs to be able to verify the integrity of the next block in the blockchain. An example is showed, where the three sets of metadata and the Merkle Root are shown in a block header.

### *Mining*

In order for a transaction to be valid, it has to be part of a block on the network. Creating valid blocks containing transactions is a process called mining (Antonopoulos, 2014). Earlier we list the different elements of the blockheader. In the mining process, the two important elements are the 'Difficulty Target' and the 'Nonce'. The difficulty target is determining how low the SHA-256 hash value of the entire blockheader must be in order for the block to be accepted on the network (Antonopoulos, 2014). While the nonce is the only changeable value that makes the difficulty target reachable.

### *SHA-256*

Secure Hash Algorithm 256 is a one-way cryptographic hash function. It creates an unpredictable 256 bit value of a data input (technology, u.d.). The output is an almost unique hexadecimal hash number that depends on the entire input. If you change one character in the input, the entire output will change (technology, u.d.). This can be illustrated by an example. We have created the following using an online SHA-256 encrypter (Xorbin.com, 2016).

| Input | SHA-256 hash value |
|---|---|
| Blockchain0 | 1170bfd4266d3ff0472740483fd69223e04365054e621a72ef2482d5401d1f4d |
| Blockchain1 | 0fc6e34f6899f5e2ca06688e49bb42cc104a45d5bb86c55eafe8c7d588204a48 |
| Blockchain2 | 4f07e031df167abda5623314c19c38e11358853f1c876b892a1d2ae494cc1058 |
| Blockchain3 | 20e39c7046b6be85eb64afacec02847fb217293cd7962b87667265cc159132c2 |
| Blockchain4 | 2c7b2f1bcc04491890c56839d656ef80e710aeea99de670f43a08399c19aaca7 |

TABLE 1 - TABLE ILLUSTRATING THE HASHES GENERATED BY THE SHA-256 ENCRYPTION

This table illustrates that even though we only change one value in our input the entire hash changes. This algorithm only works one way, it is not possible to decrypt the string "1170bfd4266d3ff0472740483fd69223e04365054e621a72ef2482d5401d1f4d" and end up with "Blockchain0" as the result.
Nor is it possible to predict what the hash value of "Blockchain05" will be, before actually encrypting it.

These two characteristics is the foundation of the mining process (Antonopoulos, 2014).

### *The difficulty target*

For a block to be valid, the difficulty target must be met. The target is a maximum the SHA-256 hash value of the entire blockheader can be. If the difficulty target is "0xxx", then the hash value of the header shall start with 0. Since the hash value is a hexadecimal, the chance of this is 1/16 (Antonopoulos, 2014).

In our example the input "Blockchain1" generates a hash value that starts with 0, so this would meet the difficulty target. If the target were set to "00xx" then the chance would be 1/256. This would take a lot more inputs before hitting.

On the bitcoin client, the difficulty target is adjusted every 2016 blocks. The aim is to have a new block created every 10 minutes (Antonopoulos, 2014). If there are many nodes mining the difficulty target will be lowered to prevent new blocks being mined too often.

### *The Nonce*

All content in the blockheader is determined before a block is mined, except for the nonce (Antonopoulos, 2014).

The version is determined by the software used, previous block hash is the given by the latest block on the chain, the Merkle root as described is the sum of all the transactions in the block, timestamp is when the block is mined, difficulty target is set by the network after every 2016 blocks.

The only adjustable part of the header is the nonce, so to meet the difficulty target a miner is changing the nonce until the target is met. In our example used to describe the SHA-256 algorithm, we use "Blockchain" as the predetermined part of the header while the integer we increment is illustrating the nonce (Antonopoulos, 2014).
By incrementing the nonce, enough times it will be possible at some point to meet the difficulty target. However, the lower the target is, the more work it will require a miner to generate a valid block.

### *Reward*

The reason for mining is the reward and the fees included in the transactions. Each time a block is mined, the miner receives a reward of newly created bitcoins.
On the bitcoin network, this reward started at 50 bitcoins per block. This reward is halved every 210000 blocks. This will limit the total amount of bitcoins to be created to almost 21 million (Antonopoulos, 2014).

### *Blockchain Forks*

As the bitcoin works, each node connected to the network are mining blocks, and as the blockchain is decentralized, which means that there is no definite correct chain (Danova, 2015). Every now and then, it happens there is two different blocks who links up to the same parent block. Then these two blocks are forming each their own chain (Danova, 2015).

Imagining that you have chain where there is mined two blocks at the same time, which then links up to the same parent, one will form a chain to the left and one to the right. Ten minutes after this occurs there will be another block mined on the left chain, which the network would then approve as the 'correct' chain, and will then disregard the other, which would then lead to the other chain orphaned (Danova, 2015).

To sum up blockchain forking are very simple. The chain has the same genesis block and are identical up until the fork happens, and then they will be forming two chains parallel, eventually the network will decide on one of the chains, the longest and one with highest level of difficulty, and the other will be disregarded and end up being an orphaned block (Danova, 2015).

### *Making blockchains flexible*

The original Bitcoin blockchain is purely "proof of work" based. While that has proved powerful in a completely decentralized peer-2-peer system where everyone is equal.
In order for organizations to utilize blockchains there needs to be some more flexibility in terms of what users can do.

### *Proof of work*

The Bitcoin blockchain is working by a principle called proof of work. Proof of work means that whenever someone is doing a transaction, that transaction will wait on the network until someone mines the next block. By mining the transaction and including it in the next block, it will be valid using a secure hash algorithm that will verify that the transaction. Verifying a transaction the chain is calculating against all

previous blocks and ensuring that the person making the transaction has coverage in the wallet and the public and private key matches. This complex process is called proof of work (Project T. b., 2016).

The proof of work runs many algorithms to make sure that all transactions on the network is valid. Other peers on the network then checks the result. If they find the solution correct then you have made proof of work and a new block is ready (Project T. b., 2016).

The proof of work is what makes the blockchain able to run without a central party to trust by building the element of trust into the network itself. The mining process is very complex and requires a lot of computation to create even the smallest transactions. When designing larger systems mining can be a very costly energy consuming process (Project T. b., 2016).

### *Permissioned chains and Proof of stake*

As mentioned the proof-of-work algorithm can be quite cumbersome to work with and it does not take into account that not all users of the blockchain should be able to perform the same actions. When using blockchain technology and smart contracts, you might want someone to administrate the smart contracts, someone to control the users that are able to interact with the blockchain (Eris, Eris DB Permissions, 2016). To resolve this several organizations have created permissioned chains. They do not rely solely on the proof-of-work algorithm used for mining on the Bitcoin blockchain (Eris, Eris DB Permissions, 2016).

They also verify the permissions that a user have when interacting with the chain. These permissions are set when deploying the blockchain and stored as part of the Genesis.json. Permissions is connected to your public key, which is similar to your public address on a permission less blockchain, is how you as a user are identified. This way of validating transactions is proof of stake. Instead of proving that a transaction is valid by calculating block hashes. The blockchain instead proofs that you have the permission or stake to perform a given action (Eris, Permissioned Blockchains, 2016).

### *Known Validators and the Byzantine fault tolerance*

To use the blockchain in a permissioned network it is possible to replace the mining process with a set of known validators. The known validators are here responsible for the mining process. Instead of mining, the validators reach consensus using the byzantine fault tolerance principle (Leslie Lamport, 1982). The byzantine fault tolerance states that 2/3 of the validators needs to agree (Kwon, 2016).

To replace the power consuming mining process, validators take turn to propose new blocks. Which is then added if 2/3 of the network can agree on the block (Kwon, 2016).

## Ethereum

The leading blockchain platform for app development is Ethereum. *”Ethereum is an open blockchain platform that lets anyone build and use decentralized applications that run on blockchain technology”* (Ethereum, what is ethereum, 2016). It works like the Bitcoin blockchain, but on Ethereum it is possible to build decentralized applications which is known as DApps. Instead of bitcoins, Ethereum uses Ether as cryptocurrency (Ethereum, what is ethereum, 2016).

### *Decentralized applications*

The aim of Ethereum, and what separates it from the bitcoin network is the decentralized applications. A decentralized application is not an application, as we know it from our smartphones, computers or websites,

"*A dapp is service that enables direct interaction between end users and providers (e.g. connecting buyers and sellers in some marketplace, owners and stores in file storage). …Dapps would typically have their own suite of associated contracts on the blockchain which they use to encode business logic and allow persistent storage of their consensus-critical state"* (Ethereum, Dapps, 2016).

Decentralized applications are a network of smart contracts that holds the logic of the application. The users can interact with them on the blockchain to execute whatever task the contract support (Ethereum, Dapps, 2016).

### *Ethereum virtual machine*

To execute and run the smart contracts Ethereum uses something they call the 'Ethereum Virtual Machine'. Instead of just having a small set of predefined commands such as 'transfer' or 'mine' used on the bitcoin network (Ethereum, Ethereum Virtual Machine, 2016).

"*The Ethereum Virtual Machine ("EVM"), which can execute code of arbitrary algorithmic complexity. … Allows users to create their own operations of any complexity they wish"* (Ethereum, Ethereum Virtual Machine, 2016).

This means that a developer can create a smart contract to run an unlimited amount of operations using existing programming languages. The two main languages supported by the Ethereum virtual machine for smart contract development is Solidity and Serpent. Solidity is a JavaScript based language, which has some added functionality to interact with the blockchain. Serpent is Python based, but like Solidity, it has added functions to use when interacting with the blockchain (Ethereum, High Level Languages, 2016).

### *Fees for using Ethereum*

There is a fee for making transactions on Ethereum as well as there is a fee for making a transaction on the Bitcoin network. Rather than paying a fee directly in Ether, Ethereum uses something called gas. Gas is bought from miners when doing transactions or other operations on the blockchain (Ethereum, what is gas, 2016).

"*The Ethereum protocol charges a fee per computational step that is executed in a contract or transaction to prevent deliberate attacks and abuse on the Ethereum network"* (Ethereum, what is gas, 2016).

It can hard to measure beforehand how many computational steps are required when interacting with contracts. Therefore, you buy the gas from the miner that computes the operations (Ethereum, what is gas, 2016).

### *Calculating the operational fee in Ether*

It is almost impossible to predict what the Ether fee for interacting with a smart contract will be. The people behind Ethereum have created some tools to help with this. On Ethereums website there is a fixed gas price list. Here different kind operations execution cost on the blockchain is listed (Ethereum, Gas Fees, 2016).
By analyzing the smart contract, it is possible to calculate the required amount of gas. However, it is a prerequisite that you are familiar with smart contract programming languages. Even if you know the amount of gas needed for a given action, the price of Ether and gas is constantly fluctuating because of market forces (Ethereum, what is gas, 2016).
Therefore it is likely that the same action performed in block x and block x+1 will result in different fees.

To somewhat simplify and make a qualified guess on what the fee for transferring 100 ether, to a smart contract performing some computation, Ethereum have made a calculator which uses their recommended values for the network (Ether.Fund, 2016).
Using this calculator transferring 100 Ether to a smart contract and doing some computation will cost 0.1 ether in fee, calculated to percent 0.1% (Ether.Fund, 2016).

While 0.1% Ether in fee is a generalization, we see this as the most qualified estimate on a fee for using Ethereum. Therefore, this is the number we will use going forward in this thesis for calculating the use of the blockchain.

### *Blockchain Oracle*

While the idea of the blockchain is to trust the decentralized network and not depend on on third parties. Some decentralized applications can rely on information that is not on the network or does not make sense to have resolved on the blockchain. This could be weather reports or sport results. To resolve this it is possible to feed information to the blockchain using an Oracle service (Ethereum, Can ethereum contracts pull data using third party apis, 2016). With an Oracle service, it is possible to push information from external sources such as websites or APIs to smart contracts.

### *The blockchain landscape*

The blockchain landscape is constantly evolving. We have only described two of the major networks, Ethereum and Bitcoin. Other companies are developing their own blockchain network with different attributes. IBM and Linux are cooperating on something called Hyperledger (Rizzo, 2016). While Coinprism, a startup are working on a blockchain called Openchain (Coinprism, 2015).

With this rapid evolvement, it is impossible to give a comprehensive overview of the blockchain landscape; most likely, we have only seen the start of the development.

## Smart Contracts

### Definition of a contract

According to the Danish law regulations, a contract – or agreement – is binding when an offer and answer to this have been given, then the offer-given part is legally bind to hold up his end of the agreement (Retsinformation, 1996).

This normal definition on a contract applied to the term ‘smart contract’ and the agreement are moved to the digital platform, and function as a software able to execute the terms that has been agreed in the contract itself.

### What is smart contracts?

The concept of smart contracts can be a simple logic; a smart contract is a software that executes the terms of a contract (Szabo, 1994).
It applies that you make a digital agreement between two parties, where the smart contract makes sure that both parties holds up on their end of the deal. In essence, the smart contract helps that a transaction or a deal will become trustless, because it makes sure that both parties will hold up their part of the bargain (Szabo, 1994).

A simple example could be if we looked at the betting industry. Imagine that you with a friend, agreed to a bet on a football game. Team A vs B, you place your bet on Team A, and your friend place the bet on Team B. Step one would be that you both place your money in a neutral account, which would be controlled by the smart contract. When the game is over and the winning team revealed, then the smart contract would

through an online sports service, be able to determine which team won, and place the winnings of the bet in either you or your friends account. That way it prevents any of you from backing out of the agreed deal (Cassano, 2014).

The idea of applying smart contracts to payments, trading or matters of finance, where the relationship between both parties very rich or with the interference of an intermediary (ex. bank) usually is needed to authenticate both parties. Where applying crypto protocols secures that, there should be no need for an intermediary, because the first of the two parts tell the other to 'trust the key' (Grigg, 2004).

The assumption is that the hash encryption used is so complicated; if the users receives a payment, this payment must have the hash. The hash will not be descriptive, so this implies that the user has the contract, in order to be able to interpret the payment. When humans are not able to read and understand the encryption, you realize that the software is able to store the source of information, so that the full contract will be on the software, and then eliminating the need for an intermediary (Grigg, 2004).

When the hash is working as the identifier, then the software is able to identify a unique financial arrangement and is able to confirm this based on their digital signatures. The hash will imply that the user has had the contract available at all times, and the user is not able to change the contract without it being notice (Grigg, 2004). This gives the smart contracts the possibility of significantly reducing fraud, and enforcement costs on transactions (Szabo, 1994).

### *Limitations of smart contracts*

We will not be going into the discussion of the law regulations of smart contracts, and the big question, if the smart contracts actually are legally binding. Although this is one of the major challenges that smart contracts would be facing. Then we do not find this as the interesting aspect of smart contract, as we are more interesting of the utilization of smart contract, and the possibilities of applying business logic to code. As multiple of the use-cases would potentially be invalid, if we have to take in the legal aspect as well.

## Betting

As one of our research objectives, we will be assessing the current online betting industry. This we will do by reviewing the current bookmaker's business model, and looking at the amount of online betters there are.

### The betting industry

The betting industry makes billions of dollars each year[8].The way online bookmaker's makes money on sports betting is by acting as an intermediary taking bets from customers. They do this by setting the odds to achieve a bookmaker's margin. We will explain this in the 'How bookmakers make money' section. By adjusting the odds, bookmakers can control how big a profit they will gain on each match or whatever type of bet they offer.

[8] http://www.statista.com/statistics/270757/revenue-sports-betting-companies/

## Online betting platforms

The question that now remains is, how much does bookmakers actually make on an average bet? In this section, we map out the average earnings of different bookmakers. This we do to justify the idea of facilitating the bets could be feasible for the customer as well as a business model.

The table below illustrates facts about the different bookmaker sites. Common for them all, is that they all need identification on the gambler, this they acquire by either uploading pictures of identification, or using the Danish online identification (NemID). Secondly, all the betting sites is a traditional way of betting, the house creates the odds, and the customer can choose the different matches, and the amount they want to bet.

| Site | Signup | Betting type | Currency | Bookmaker Margin average | Bookmaker margin Tennis |
|---|---|---|---|---|---|
| Unibet | Confirmation on ID needed | Betting against house | Local | 4,7% | 4,0% |
| Bet365 | Confirmation on ID needed | Betting against house | Local | 4,5% | 5,6% |
| Ladbrokes | Confirmation on ID needed | Betting against house | Local | 4,4% | 5,8% |
| 888 | Confirmation on ID needed | Betting against house | Local | 5,0% | 4,5% |
| Nordicbet | Confirmation on ID needed | Betting against house | Local | 4,3% | 5,1% |
| Tipico | Confirmation on ID needed | Betting against house | Local | 5,9% | 5,6% |
| william Hill | Confirmation on ID needed | Betting against house | Local | 4,3% | 5,4% |
| Paddy Power | Confirmation on ID needed | Betting against house | Local | 5,2% | 5,5% |

TABLE 2 - BOOKMAKER ANALYSIS (REFERENCE - MADE BY AUTHORS)[9]

### *Laws and regulations*

According to Danish law and regulations, what we are developing would be characterized as 'betting-exchange'[10]. This meaning that the artifact will be facilitating bets, rather than actual taking a cut on the betting amount. Based on current Danish law and tax regulations, to have a system like this running, you are required to pay a 20% fee on the earnings made from facilitating such a bet[11]. So if the amount is 2% for facilitating the process, the amount of each bet will be 0,40% which will be required to pay as taxation.

[9] Statistics on margin taken from: http://www.top100bookmakers.com/profit-margin/
[10] https://www.retsinformation.dk/Forms/R0710.aspx?id=132426&#P6
[11] https://www.retsinformation.dk/Forms/R0710.aspx?id=132426&#P6

## How bookmakers make money

Making money in the betting industry is a matter of setting the odds to have a profitable margin so the house always wins.

There are two steps of setting the odds on a sports game.

First is to analyze the strength of the two competitors or competing teams to determine who is most likely to win. This involves many factors related to which kind of sport is involved. E.g. How has the competitors performed in their latest appearances, which team holds the home advantage, does any of the team has any injured players and so forth. This type of analysis will give the bookmakers insight in who is most likely to win the game and what the chances are for each possible outcome.

The second step, is to look at the analysis made in step one and then applying math to set the odds so the bookmaker statistically will make a profit. This profit is the bookmakers margin (Cortis, 2015).
Using a coin toss where the chance is 50/50 as an example. The odds for heads and tails should then be 2.0 for a 100% payout. However, a bookmaker would not make any money if the payout where 100%. Therefore, they skew the odds with the bookmaker's margin to build a profit in the odds statistically. How big the bookmaker's margin is calculated by taking the reciprocal value of the odds of all possible outcome (Cortis, 2015).

To illustrate it with a real life example we can take the odds set by danskespil.dk on the game between FC København and Brøndby IF Sunday 17 April 2016.

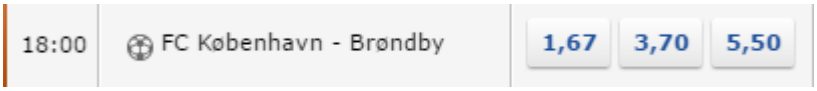


FIGURE 5 - DANSKESPIL.DK ODDS FOR FC KØBENHAVN - BRØNDBY IF 17 APRIL 2016

The bookmakers margin would then be:

$$\left(\frac{1}{1{,}67}\right)+\left(\frac{1}{3{,}70}\right)+\left(\frac{1}{5{,}50}\right)=1{,}050891=105{,}08\%$$

In this case, the bookmaker's margin is 5.08%. Statistically the bookmaker would make a 5,08% profit on all accumulated bets on this game (Cortis, 2015). From a players perspective this means that the payout is 94,92% thus the bookmaker will always make money when they are the one setting the odds.

If we extend this to look at other bookmakers for the same game, we can make following table:

| Bookmaker | 1 | X | 2 | Sum of reciprocal value | Bookmakers margin |
|---|---|---|---|---|---|
| Danskespil | 1,67 | 3,7 | 5,5 | 1,050890847 | 5,09% |
| Scandic | 1,67 | 3,8 | 5,75 | 1,035873333 | 3,59% |
| Sportingbet | 1,67 | 3,8 | 5,75 | 1,035873333 | 3,59% |
| NordicBet | 1,65 | 3,6 | 5,75 | 1,057751427 | 5,78% |
| Betsafe.dk | 1,6 | 3,6 | 5,75 | 1,076690821 | 7,67% |
| bet365 | 1,62 | 3,6 | 6 | 1,061728395 | 6,17% |

**TABLE 1 - BOOKMAKERS MARGIN FOR SEVERAL OF THE BIGGEST DANISH BOOKKEEPERS ON THE FC KØBENHAVN - BRØNDBY IF MATCH 17 APRIL 2016**

This gives an average bookmakers margin of 5,31%.

With these calculations, we can conclude that bookmakers takes above 5% in earnings on all bets by skewing the odds in their favor.

### *Limitations on betting*

We will not go into the discussion of existing 'know your customer' and anti-money laundry, as this is not in the scope of our thesis. Although this would be an interesting subject of discussion, as the blockchain offers transparency on every transaction on its network.

We will not be creating an industry review as such, as our focus is not how to strategical position our product in the existing environment.

## Section summary

To sum up on this section, it has the purpose of providing information for the understanding of a technology, and outlining of a problem. It lies in the nature of design science research, to approach a problem, by construction an innovative artifact (Alan R. Hevner, 2004).

The literature review outlines the origination of the blockchain technology, it explains the concept of smart contracts, and provides information on the betting industry. This we will later use to establish a problem in the development part and use this to design a suggested solution.

### *Key Learnings*

To sum this section up, we established a large amount of knowledge of the environment surrounding blockchain technology, smart contracts and online betting.

### *Blockchain key learnings*

Throughout the blockchain section, we look at the origination of the blockchain, this we do to establish some ground knowledge of how it came to be. The blockchain mainly enables how you can interact with each other without an intermediary.

- An understanding of the concept of mining, and the structure of blockchain.

    - Users are identified by their wallet, wallets are unique hence why they can be used as identifiers.
    - It is next to impossible to revert a blockchain, when new blocks are mined.
    - The blockchain technology is transparent system, this enables to see other users transactions (makes it possible to track other users bets).
    - When an agreement is created, it is not possible to go back, this enabling the smart contracts to execute.
- Understanding of the Peer-2-Peer network functionality.
- There exists multiple blockchain, and various/extra functionalities in these.
    - Ethereum allows for implementation of Smart Contracts.
    - Ethereum takes approximately 0.1% in fee to make transactions.
- Explanations of cryptocurrencies, what this virtual currency is.
- A blockchain oracle makes it possible to push information to the blockchain (e.g. possible to feed the blockchain with information such as sport results)

### *Smart contract key learnings*

The smart contracts explain the theoretical approaches from Richard Griggs, and Nick Szabo development in this area.

- Smart contracts are agreements by two parties, which is executed by a system
- The definition of smart contracts is that they are trustless, because there is no need for interacting with third party. It rely only on the expectation of a system to execute the agreed terms.
- It is possible to control smart contracts by other smart contracts.

### *Betting industry key learnings*

Throughout our betting industry section, we had the following key findings, which is relevant for establishing a problem.

- Regulations in Denmark has a fee of 20% of the earnings on each bet.
- Bookmakers earn 5-8% percent on average pr. game, according to our findings.
- Throughout our research on this subject, we came across no existing solution that offers facilitation of Peer-2-Peer betting.

*"Design is the Process of Realizing intensions"*
– (Eli, 2007)

# Methodology

Design science research calls for a clear rational decision when choosing the design methods (the building and evaluation part). Research rigor is what the method selection is striving for (Shirley Gregor, 2013). In the ensuing section, we will assess various frameworks to go from an initial problem stage to a practical solution, which we will then be able to evaluate.

## Design Science Research

The fundamentals of the design science paradigm originate from engineering fields and the sciences of the artificial (Alan R. Hevner, 2004).

Researchers argue that when using design science, the most efficient use of knowledge is by utilizing the Design science research process – from an initial problem selection, for evaluations and reflections, and to communicate findings accordingly (Shirley Gregor, 2013). Hence why we, as previously described, in this section, will assess different frameworks for development and evaluation.

In general, design science research is a set of synthetic and analytical techniques and perspectives for performing research in Information Systems (Kuechler, 2004). This research methodology seeks to create new knowledge through original or inventive artifacts while also reflecting and evaluating in an effort to understand and improve the behavior aspect of Information Systems (Kuechler, 2004). Because of this, "the design science paradigm is known as being a problem-solving paradigm" (Alan R. Hevner, 2004).

Over the course of history, the design oriented research approach in Information Systems has often gone under appreciated. This is largely attributed to a perceived lack of methodological rigor, which is closely related to the development and evaluation of IT artifacts (Rob Gleasure, 2012). According to Rob Gleasure, Joseph Feller, and Brian O'Flaherty (2012), "it is difficult to over-emphasize the significance of design work and design knowledge in Information Systems for both research and practice".

IT artifacts are typically defined in a relatively broad manner. According to Hevner et al (2004), IT artifacts are defined by four components, which include "constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices) and instantiations (implemented and prototype systems)" (March and Smith 1996; Nunamaker et al. 1991a; Cited by (Alan R. Hevner, 2004)).
The outlining of these four components is very helpful for IT researchers and practitioners when understanding and addressing problems and when developing and successfully implementing information systems (March and Smith 1996; Nunamaker et al. 1991a; Cited by (Alan R. Hevner, 2004)).

## Exploring the models

Several frameworks exist that build on the foundations of design science. Each of these frameworks presents a unique take on designing an artifact in terms of how to go about developing and evaluating this artifact. Although there are several frameworks, which focus on designing information systems, we will be assessing three fundamental frameworks in the subsequent discussion. These models include the work of Gleasure et al – Procedurally transparent design science research: a design process model, Takeda et al – modelling design process, and Hevners three cycle view of design science research.

Following this analysis, we will weigh the attributes and limitations of each of these frameworks and make a determination as to which model will optimally fit the scope of our thesis.

## The Process Model for increased Procedural Transparency (PMPT)

The research made by Gleasure et al (2012) established a framework, called "Process Model for increased Procedural Transparency (PMPT)"; in their paper, they state that one of the issues with design science the lack of transparency. They argue that "This historic underappreciation of design-oriented research in IS, is due largely to perceived lack of methodological rigor surrounding the development and evaluation of the 'IT Artifact,' processes central to DSR studies." (Rob Gleasure, 2012)

Their objective in in the research is to "develop a procedurally transparent process model for design oriented research in IS, in order to facilitate demonstrably rigorous design-oriented research." (Rob Gleasure, 2012).

The PMPT model aims to impact design science by increasing the procedural transparency and perceived rigor, this resulting in a model, which consists of 8 steps as seen in the figure:

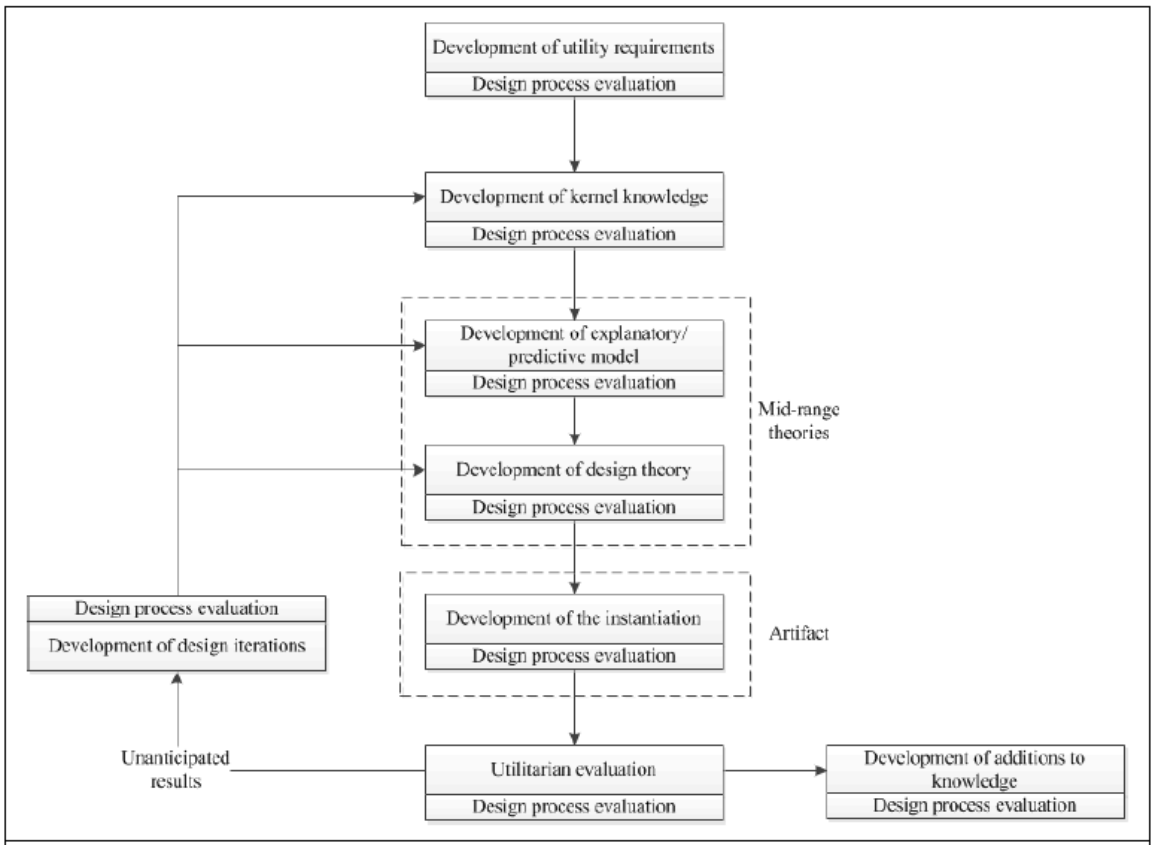


FIGURE 6 - GLEASURE ET AL. (2008) 8 STEPS MODEL

The first step, development of utility requirements serves the purposes of outlining the desired change in the problem, and describing the motivation for these changes (Rob Gleasure, 2012). Because design science research demands a detailed and IS specific prescriptive process model, it can then be utilized as a means to increase the procedural transparency of the design process (Rob Gleasure, 2012).

The second step is the development of kernel knowledge, which informing the utility requirements with existing academic and industrial knowledge (Rob Gleasure, 2012).

The third step, the development of the explanatory/predictive model, and while the utility requirements describes the required change in a problem system, the explanatory/predictive model provides a more detailed description of the system by dividing it into sets of independent and dependent variables (Rob Gleasure, 2012).

The fourth step, development of the design theory, is representable of the actual design prescriptions, which aim to impact upon the problem, described in in the utility requirements step (Rob Gleasure, 2012).

The fifth step, development of instantiation, represents where the transition of being design prescription from the abstract into the real setting. This transition has two central responsibilities to an instantiation; the first one of these is the demonstrate that the design theory can be instantiated (Rob Gleasure, 2012), "In much of the computer science literature it is realized that constructs, models, and methods that work 'on paper' will not necessarily work in real world contexts. Consequently, instantiations provide the real proof" (March and Smith, 1995; cited by (Rob Gleasure, 2012)).
The second responsibility of the instantiation is to proof how the described design theory can be implemented (Rob Gleasure, 2012).

The sixth step, development of the utilitarian evaluation, is in essence the conclusion on the design process. This step represents the first iteration of the design process, the utilitarian evaluation can begin as soon as the design theory have been completed and instantiated (Rob Gleasure, 2012).

> "This activity involves comparing the objectives of a solution to actual observed results from use of the artifact in the demonstration. It requires knowledge of relevant metrics and analysis techniques… Conceptually, such evaluation could include any appropriate empirical evidence or logical proof" (Peffers et al.; cited by (Rob Gleasure, 2012)).

The final two steps, development of design iterations and development of additional knowledge, will then be the next step, which in its essence brings the iterations to the process and by that extend be a circular process.

The step 'development of design process evaluation', is the ninth step however, this step is a featured in every stage of the development of the PMPT model. This step is described by Gleasure, et al. (2012) as a testable design hypothesis, "the design process should be evaluated on a continuous basis as the early identification of design faults impacts significantly upon the both the cost and likelihood of their remediation" (Holzinger, 2015; Cited by (Rob Gleasure, 2012)).

## Modeling design process

In 1990 Takeda et al, came up with a framework, even though this is now over 25 years old, it is still proven to be relevant, as it has been used for continuous development on different frameworks, as Vaishnavi and Kuechler in 2004, and they updated their research in 2008. Takeda et al's model consist of multiple iterative processes, and the design cycle consists of five sub-processes:

1. Awareness of the problem
2. Suggestion
3. Development
4. Evaluation
5. Conclusion

The design cycle illustrated in the figure:

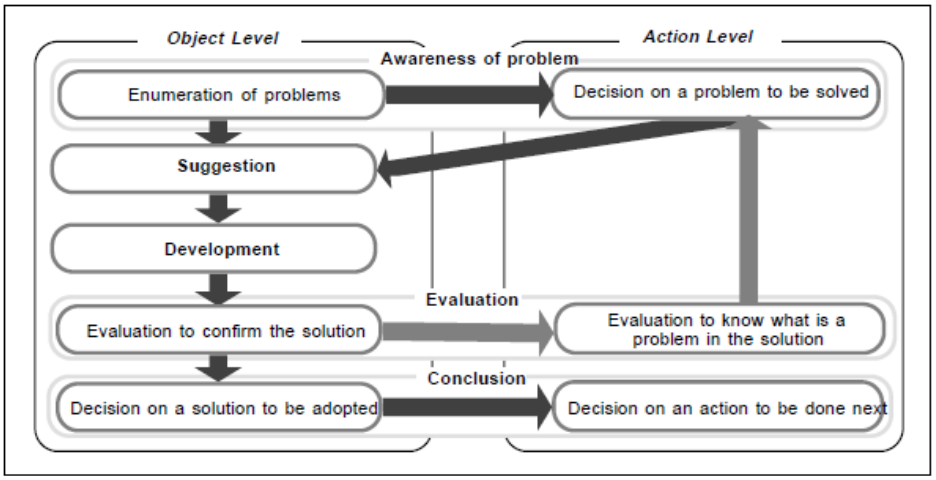


FIGURE 7 - TAKEDA ET AL - DESIGN CYCLE.

First phase in the design cycle, awareness of problem, an awareness of interesting research problem, can come from multiple various sources, such as new developments in an industry, or in a reference discipline (Kuechler, 2004). As Takeda et al. describes it of a designer's viewpoint to "pick up a problem, by observing an object and its specifications, to determine which problem to be solved next." (Hideaki Takeda, 1990). The output of this phase is a proposal for a new research area, either formal or informal (Kuechler, 2004). So in a simplified manner, this first phase 'enumeration of problems', leads to a proposed description of the problem to be solved.

The second phase is the suggestion part of this model, a key phase in the processing model. This follows immediately after the establishment of the problem awareness. The suggestion phase is the creative step, where the visualizing of the new functionalities are established, based on either existing or new and existing elements (Kuechler, 2004).

From a designer's perspective, this phase is where you "suggest of the key concepts needed to solve the problem" (Hideaki Takeda, 1990). In other words, the suggestion phase is where a proposal for a solution, and based on the suggestion the suggested solution it can be tested later after being developed.

The third phase of this model is the development phase; this is where the construction of solutions takes place, based on the obtained design knowledge in the first and second phase of the model. "The techniques for implementation will, of course, vary depending on the artifact to be created. " (Kuechler, 2004).

Once the artifact has been created, you are going into the fourth phase of the model, the evaluation phase, this is where the artifact is evaluated and seen if it is living up to the described expectation in the awareness phase (Kuechler, 2004). The evaluation phase is a crucial component of the research process (Alan R. Hevner, 2004). The evaluation phase contains an analytical sub-phase, where the hypotheses are made about the behavior of the artifact (Kuechler, 2004).

Hevner et al. (2004), describes the evaluation as being very essential component in design science research, as this is where the feedback are given to the construction of the artifact, and gives the foundation for the next iteration. In some cases the evaluation phase, leads to the discovery of new problems. This is regarded as the 'awareness of problem' phase, for the next cycle (Hideaki Takeda, 1990).

## Design science research cycles

Hevner et al. (2007), describes design science research as an "essential part of design research". He argues that design science research's focus should not only be to understand how the world is, but also how to change it (Hevner, 2007).

The three design science cycles view emerged from Hevner et al. (2004)'s work, the information system research framework. The model consists of an environment part, a knowledge base, and an IS research part. The Environment part focuses on defining the problem (Alan R. Hevner, 2004). In this part, are the goals, tasks, problems and opportunities that are used to define the business needs, and how these needs are perceived by people within a given organization (Alan R. Hevner, 2004).

The IS research is then conducted in two complementary phases, the first being the development and the second being the justification (Alan R. Hevner, 2004). This underlines Hevner et al (2004)'s description of Design Science, addressing how to change the world, through building and evaluation of artifacts. The IS research assessment is achieved through the justification/evaluation stage, where weaknesses in the theory or artifact are identified and reassessed (Alan R. Hevner, 2004).

The knowledge base consists of two types of knowledge, the experience and expertise, which defines the research domain of the research, and the existing artifacts and processes in the research's domain (Hevner, 2007). It then provides the material through which IS research is achieved (Alan R. Hevner, 2004). The knowledge base consists of foundations and methodologies, which then has the purpose of providing these for the development phase (Alan R. Hevner, 2004). Rigor is achieved when suitably applying existing foundations and methodologies, which is considered through evaluation of the artifact (Alan R. Hevner, 2004).

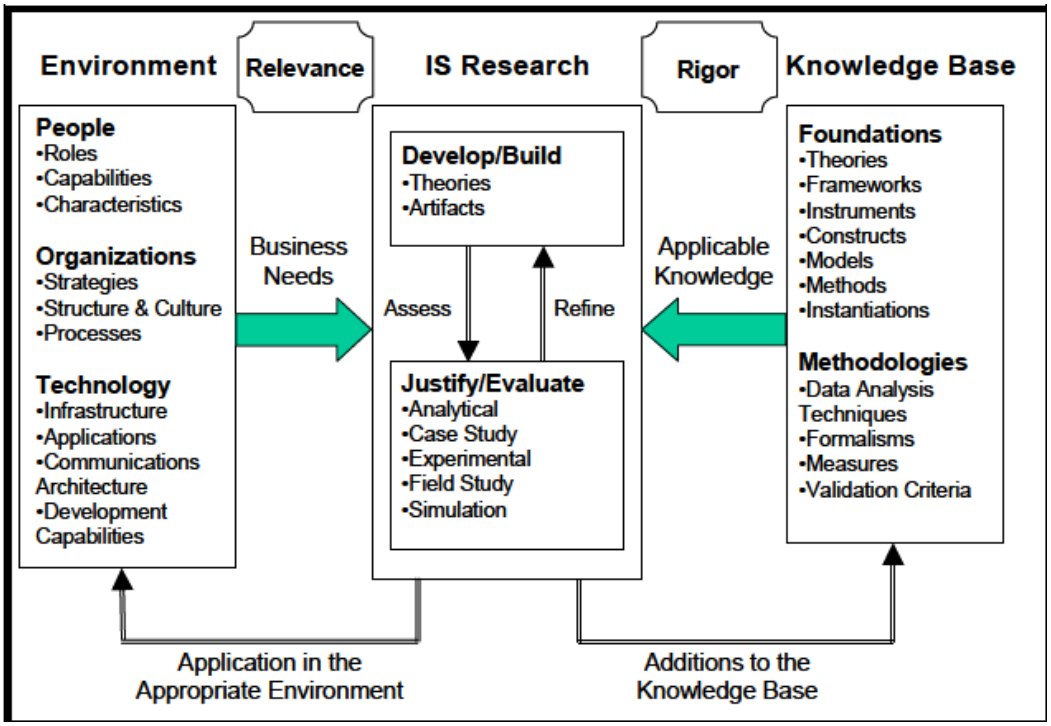


FIGURE 8 - INFORMATION SYSTEM RESEARCH FRAMEWORK

In later works, the framework is evaluated, and three cycles are built upon the existing framework, these are seen in the below figure (Hevner, 2007) :

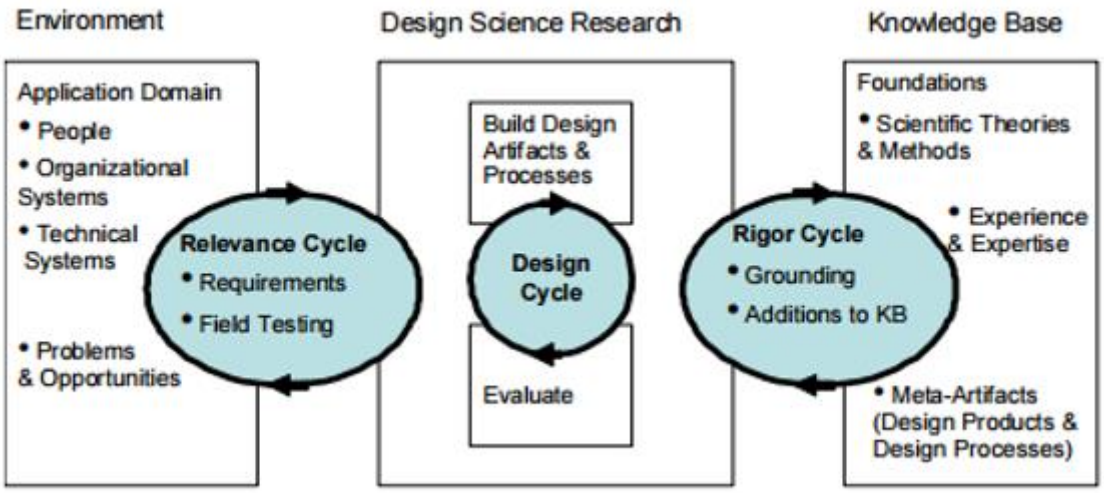


FIGURE 9 - DESIGN SCIENCE RESEARCH CYCLES

These three cycles represents the gaps between the environment, the design science research and the knowledge base.

**Relevance cycle**

The relevance cycle has the purpose of bridging the environment of the research project and the design science research (Hevner, 2007). The design science research's motivation lies in the desire of improving the environment through innovative artifacts and processes for building the artifact (Simon, 1996; Cited by (Hevner, 2007)). The relevance cycle provides the design science research with the requirements for the research, and outlines the acceptance criteria for the evaluation of the research results (Hevner, 2007). The results are acquired through field-testing (e.g. evaluation through test persons), and determines whether additional iterations of the design cycle is required (Hevner, 2007). Each iteration of the relevance cycle begins with feedback from the field-testing and will then require a reassessment of the requirements for the development phase (Hevner, 2007).

**Rigor cycle**

The rigor cycle then bridges the design research science with the knowledge base of foundations, experience and processes, which then provides these information's to the development phase (Hevner, 2007). The rigor cycle provides the past knowledge to the research, to ensure the innovation in the project (Hevner, 2007). Additions to the knowledge base is achieved throughout the research project, and the experiences gained will be added to the original theories and methods (Hevner, 2007).

**Design cycle**

The third and central cycle, the design cycle, is the connector of both environment and knowledge base, and is iterating between development of the artifact and evaluation (Hevner, 2007). Even though the relevance cycle provides the requirements, and the rigor cycle provides the existing knowledge for the design cycle, the design cycle is where the hard work of the research takes place (Hevner, 2007). When

designing the artifact, it is important to balance between the developing and evaluation to achieve the best result, as stated: “The essence of Information Systems as design science lies in the scientific evaluation of artifacts” (Hevner, 2007). The design cycle requires multiple iterations before research contributions are made to the relevance and rigor cycle (Hevner, 2007).

## Deciding the framework to be used

Based on the aforementioned design research, we have looked into; we would consider them all as guidelines on how to develop and evaluate an artifact. Throughout the previous section, we have assessed current methodologies. In this section, we are going to assess which framework will be optimal for our thesis, and the development of our prototype.

While the PMPT model has a definitely good approach for ensuring transparency and benefitting by that in the development process, the research methods does not provide a strong systematic framework and is instead highly emphasizing on the inputs of academical work. A systematic approach is however provided by Takeda et al (1990)s model, which provides a stepwise framework for the developing and implementation of a prototype. This however is accomplished with Hevner (2007) as well, where he combines the process of developing a prototype, with the knowledge base and environment, and explains the effect these processes all have on each other, thus creating a loop.

The choice for us boils down to the models by either Takeda or Hevner, either going with a framework that has a very systematical approach for the development of the prototype. Else, we would be using a framework, which provides an iterative approach for the development part, but also provides an iterative way of using the knowledge and contribute to the other phases.

For this thesis, we will be utilizing Hevner et al. (2007)’s three-cycle view, as this not only explains the steps for development, but also emphasizes the evaluation of the artifact, and the contributions to the knowledge base and environment. For our research, we see this as the most easily applicable model, as well as the most relevant for developing our prototype. As it is highlighted in the research method by (Hevner, 2007), it is important to show the novelty of the research.

### *Applying the three-cycle view*

As described in the previous section, the framework consist of three major stages of development, Relevance, Rigor and the Design cycle. Each of these stages consists of multiple elements. In the figure, we show how we will be applying the model. This is shown through the various stages within each of the cycles in the model.

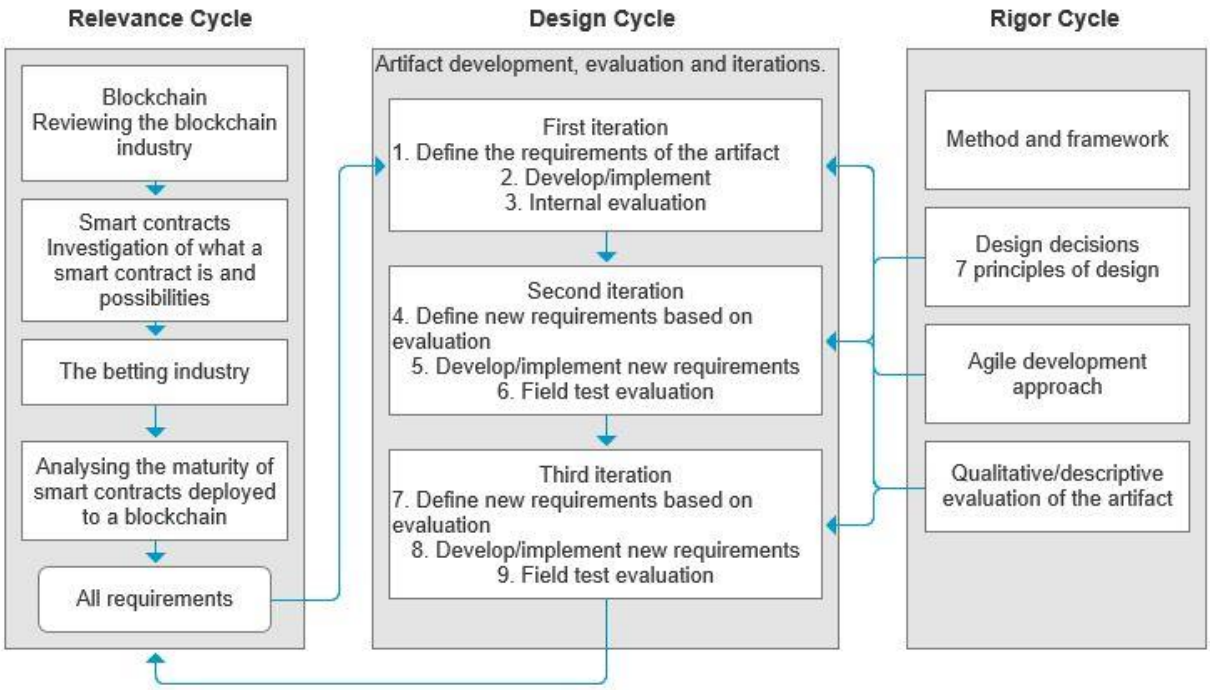


FIGURE 10 - OVERVIEW OF THE THREE CYCLES APPLIED IN OUR RESEARCH

### *Relevance cycle*

The focus of the relevance cycle is the two part, where we establish a problem, and then determining the elements required to create the solution. The relevance cycle in our research consists of the three elements in our literature review, review of the blockchain technology, smart contracts and a walkthrough of the online betting industry's existing business model. The second part of our relevance cycle is the determination of the requirements for building the artifact, this step consists of two parts. First, we gather knowledge of how deployment of smart contracts on the blockchain works, and then by combining the different elements in the relevance cycle.

### *Rigor cycle*

The rigor cycle in this research consists of the methodological framework, the design decisions and the qualitative and descriptive evaluation of the artifact. This research utilizes design science research as a methodological framework, and as described uses, the three-cycle design view for the development of the artifact. The rigor contributes the framework as well as the design decisions for the development cycle. In this phase, we introduce of the evaluation methods for the design cycle. These evaluations will serve as the basis for the next iteration.

### *Design cycle*

In the design cycle we develop the artifact with the use of the frameworks from the rigor cycle, we compare the artifact to the requirements of the relevance cycle. After each development phase, we apply the evaluation method introduced in the rigor cycle, to evaluate. This we do to establish requirements for the next iteration. In this research, we will be running three iterations to and are by that going through three evaluation phases.

## Data gathering

The data gathering in our thesis consists primarily of qualitative data research, assessing methodological researches and frameworks. The chosen framework by Hevner et al. (2007), the three-view design cycle, are used to develop a prototype. The theory used for this thesis, are qualitatively gathered, and limited mainly to a few sources, because the technology is a very new and innovative. The achieved data gathering is through extensive research on articles, webpages, as well as books revolving around the blockchain technology.

Through each iteration of the design cycle, we will be evaluation on the current design. Hevner et al (2004) also highlight this, as an essential and highly important part of design science research. We will be evaluating the prototype throughout the design cycle in various ways. In this thesis, we will have three iterations. The authors will internally review first iteration by using a functional black box testing, which is mentioned by (Alan R. Hevner, 2004), where we will be discussing the potentials of the blockchain technology, which will be approached in the first development phase. The second and third iterations evaluation phase, is conducted through a constructed scenario evaluation approach (Alan R. Hevner, 2004). The second evaluation phase, is the first field-tested iteration, we will conduct in-depth interviews with people who are familiar with betting, and the betting industry. The third iteration, will consist of developing on the key learnings from the second iteration, and re-evaluated by both evaluators from the second iteration but also by new evaluators. We will be doing this to ensure that we have both new eyes on the artifact, but also to confirm by some users from the previous iteration, that the newest design solution has improved the issues from previous evaluation. The test users are found through our personal network of people who has experience to betting prior testing our prototype. This should result in further ideas and suggestions, which we will then be evaluating.

### *Limitations*

Because this thesis timespan is over a limited period, we will be limiting our iterations of the design cycle to three times. Due to this, we will limit the three iterations and to contribute only once with experiences and knowledge to the relevance and rigor cycle once. We will not be using this research as a software development project, and instead focus on the possibilities of using the blockchain technology and smart contracts to apply a new business model for the online betting industry.

### *Key learnings*

Each framework emphasizes the evaluation part of their development phases. The PMPT model has an evaluation step after each step in the process, Takeda computing model has an evaluation phase after each iteration, and the three-view cycle has an evaluation step after each iteration of the design cycle. This underlines the statement by Hevner et al (2004) that at the heart of design science research lies the evaluation of a proposed solution. The evaluation and the development in the design cycle, which will lead to the contributions to relevance and rigor is the key learnings of this framework review, we will be running the iterations throughout these two phases, and by that achieving the solution.

## Artifact Description

This section serves the purpose of describing the design artifact, and the development process, that lead to the realization of the artifact (Shirley Gregor, 2013). In the ensuing section, we will utilize the information obtained in the literature review, for the design specifications.

As we concluded in the method section, we will applying Hevner et al. (2007)'s design three cycles research methodology for developing the solution. This we will do by applying three iterations of the design cycle. In the figure, we show the flow through the designing of the artifact. This is to illustrate how we will approach the three cycles.

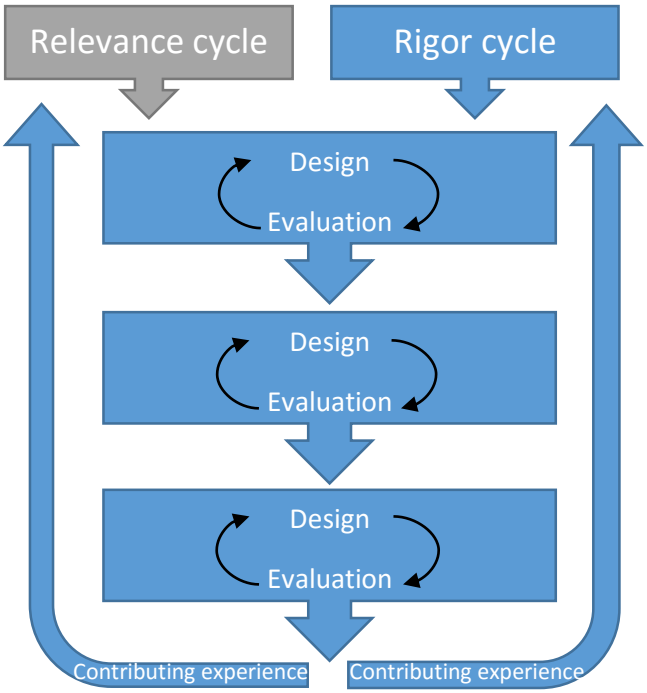


FIGURE 11 - FLOW THROUGH THE DESIGN CYCLES

As stated in the methodological section, this flow will have the relevance and rigor cycle once each. The relevance cycle to ensure the connection between the environment and the design cycle. In the relevance cycle, more specific in the environment, it is where the definition of the problem space lies (Alan R. Hevner, 2004). We will in this cycle, be establishing the problem, and a suggested solution for the problem. The relevance cycle, is a combination of an assessment of the technology, informed by the literature review, and the capabilities of the people involved. We will apply a SWOT analysis to review the potential of creating a business model. The rigor cycle ensues the connection between design cycle and the knowledge base. In the rigor cycle, we combine the methodological framework with the chosen evaluation methods.

In this thesis, we will as aforementioned do three iterations of the design cycle, and at the end of the third cycle, we will evaluate the contributions from the design cycles, to the relevance and rigor cycle. The figure shows the flow of information which contributes to the relevance and rigor cycle, after the three iterations of the design cycle.

## Relevance cycles

In this section, we will establish the problem, and introduce how the design of the solution will take place.

For this research, it is important, that we gather firsthand experience with the blockchain technology, for us to be able to design a realizable prototype. We needed to build an understanding of the main components in the blockchain, which includes how to deploy a smart contract on a blockchain, and how you can execute certain commands through a smart contract.

## Establishing problem

Through the relevance cycle, we will assess the blockchain technology, in the literature review, we introduced the concept of smart contracts and we reviewed the betting industry. This section will serve the purpose of outlining the problem, and how solve this by suggesting a solution. In this section, we will be investigating the blockchain technology, and the smart contract concept. This we will do by establishing a private chain, where we will deploy a smart contract, hence we will illustrate how smart contracts work on a blockchain. We apply a SWOT analysis to determine the problem ideas strengths and weaknesses. Finally, we will be establishing some requirements for the development cycle, all this we do to establish a foundation for the prototype.

### *Investigating problem space*

For our initial development we used the “Eris: The smart contract application platform”. It’s a tool that makes it possible to roll different kinds of permissioned and unpermissioned blockchains, such as Ethereum and bitcoin as services (ErisIndustries, Eris-services, 2016).

It also has the Ethereum Virtual Machine built in, so it supports Smart Contracts build in Solidity (ErisIndustries, the-eris-stack, 2016). Which we wil use when we deploy our simple Smart Contract named Idi.

```
gilbro@ubuntu:~$ eris chains new simplechain
gilbro@ubuntu:~$ eris ls
The known chains on your host kind marmot:

                                        gilbro_118b8d43
                                        gilbro_1802dc80
                                        gilbro_c00d858e
                                        simplechain
                                        test_chain

Active chains containers:
     NAME       MACHINE   RUNNING        CONTAINER NAME
                 PORTS
 ------------ --------- --------- ------------------------- -----------------
-----------------------------------------------------------
  simplechain            Yes       eris_chain_simplechain_1   0.0.0.0:1337->133
7/tcp 0.0.0.0:46656->46656/tcp 0.0.0.0:46657->46657/tcp
  test_chain             No        eris_chain_test_chain_1
```

FIGURE 12 - CREATING AND STARTING OUR OWN LOCAL HOSTED BLOCKCHAIN 'SIMPLECHAIN'

To deploy our smart contract we first need a running blockchain. Eris has made this quite simple. By running the command ‘eris chains new chain name’ it creates and start a blockchain with the name you choose. Creating the chain will also pull some configuration files, which determines the attributes of the

chain. Whether it is a permissioned or un-permissioned chain, and who will be able to interact with the chain and so forth. This however, is not something we will explain further in this thesis. The focal matter is that we have a working blockchain, which we can use to deploy smart contracts on, and execute commands.

With the command “eris ls”, we can see all the chains created on the machine and if they are running or not. In the figure we can see that we have two chains. ‘test_chain’ and ‘simplechain’. Only ‘simple chain’ is running.

```
gilbro@ubuntu:~/.eris/apps/idi$ eris pkgs do --chain simplechain --address $addr
Performing action. This can sometimes take a wee while
Executing Job Named                     defaultAddr
Executing Job Named                     setStorageBase
Executing Job Named                     deployStorageK
Contract Address                        FB5B23A6E2EC437D9AE01724391C5B9DA79F9685
Transaction Hash                        23E9670B716BFAE3A8D96A3E4E085AFC06FE44F4
Executing Job Named                     setStorage
Transaction Hash                        BF5865089E9811C7B19A56D97A502EEEE15F41E5
Executing Job Named                     queryStorage
Return Value                            5
Executing Job Named                     assertStorage
Assertion Succeeded
```

FIGURE 13 - DEPLOYING THE IDI CONTRACT

With a working blockchain that is running, we can now deploy our smart contract.

### *Deploying our smart contract*

When the blockchain is running, we can deploy our smart contract. We have created a simple smart contract called ‘Idi.sol’ with a template from Eris Industries (ErisIndustries, Eris Industries, 2016). The already written contract is located in a local folder at the path ‘gilbro@ubuntu:~/.eris/apps/idi$’. In the Idi folder, some support files help interacting with the smart contract. These are necessary here, when the contract are deployed on the blockchain. One of these is the app.js file, which we will explain later.

To deploy the smart contract we use the command ‘gilbro@ubuntu:~/.eris/apps/idi$ eris pkgs do --chain simplechain --address $addr’.
The command runs from the directory where our contract is located. The Eris package manager is run with a ‘do’ command. This command deploys a smart contract or package of smart contracts to a chain (ErisIndustries, 2016).

The chain is set as our already running local chain “simple chain” and the storage address ‘§addr’ will take an address from our configuration file.

Successfully running this deploy command, the expected outcome is at follows that the command prompt then shows that the contract is deployed to the address ‘FB5B23A6E2EC437D9AE01724391C5B9DA79F9685’ and the deployment transaction hash is ‘3E9670B716BFAE3A8D96A3E4E085AFC06FE44F4’. After this is established, we can now start to interact with our smart contract on the blockchain.

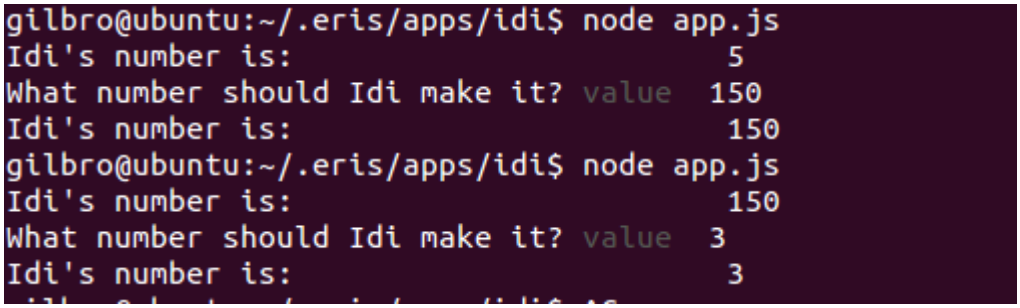


FIGURE 14 - INTERACTING WITH THE IDI CONTRACT

### *Interacting with our smart contract*

In this section, we will go through how to interact with the Idi contract using Node.js. This is a JavaScript runtime environment, which makes it possible to run JavaScript and Solidity on the command line (Node.js, 2016).

"Node.js is a JavaScript runtime built on Chrome's V8 JavaScript engine[12]. Node.js uses an event-driven, non-blocking I/O model that makes it lightweight and efficient. Node.js' package ecosystem, NPM, is the largest ecosystem of open source libraries in the world" (Node.js, 2016)[13].

The interaction shown here is happening by calling a JavaScript called app.js. When we deployed Idi, app.js stored all the data needed for interacting with Idi on the blockchain such as deployment address. The app.js also calls the get and set function for Idi's 'storedData'.

Idi is a simple smart contract that only holds one value of the type unsigned integer. Calling the contract returns the value. Then awaits a new unsigned integer, which will then be stored as the new value. This value 'storedData' could just as well be the odds set on a sports bet. As the prototype serves as a facilitator of betting, instead of the typical central business model of betting. The prototype needs to be able to both create bet, and take bets created by others.

This concludes our investigation on the blockchain technology; we can conclude that we do not have the capacity of developing a fully functional solution on the blockchain. This is both due to the time limitations of this thesis, but also due to issues with the blockchain technology matureness. This includes the facts that it needs to have access each user's command prompt, and by extend actually being able to change root stuff on user's computers.

### *SWOT*

The SWOT model is often used by organizations in decision-making situations or when planning. However, it is also applicable on ideas, technologies and designs. This SWOT analysis serves the purpose to analyze when to apply smart contracts on a blockchain, and reviewing the potential of the online betting business model. We will be applying the SWOT analysis, to determine the strengths and weaknesses of the business model of facilitating betting on a blockchain.

[12] https://developers.google.com/v8/
[13] https://www.npmjs.com/

### *SWOT analysis*

| | | |
|---|---|---|
| Internal factors | **Strengths** | **Weaknesses** |
| | - Transparent<br>- Decentralized<br>- Autonomous<br>- Final<br>- Quick spread of information<br>- Cheaper than existing betting business models | - Poor scalability<br>- Hard to control<br>- Power consuming<br>- General understanding of cryptocurrencies |
| External factors | **Opportunities** | **Threats** |
| | - Get rid of intermediaries<br>- Disrupt existing markets<br>- The emerging sharing economy | - Other IT systems<br>- Already established betting industries<br>- Prejudices of cryptocurrencies<br>- Prejudices of the blockchain technology<br>- Putting all trust in an automated system |

TABLE 4 - SWOT ANALYSIS OF BLOCKCHAIN, AND SMART CONTRACT STRUCTURED BETTING BUSINESS MODEL

### *Strengths*

- Transparent: Everything that happens on the blockchain is stored in an open shared ledger. This means that the betting industry would be able to track every transaction, and track each transaction their customer has done before signing on to the solution. This transparency aspect could potentially help decriminalize the betting industry, as each user would not be able to bet for more money than they actually have.
- Decentralized: Running a blockchain requires no intermediaries, all trust is located on the network, as the majority of each nodes (miners), needs to agree on every transaction. Therefore, for a larger distributed ledger, any potential threats would have to have the majority of the blockchain CPU power to be able to change previous blocks, which to this day, no one has actually managed to do.
- Autonomous: Once you roll out your blockchain, it will be self-governing. This is because miners gets compensation for maintaining the network.
- Final: When something is part of a block on the blockchain, then it is not possible to change it. This brings us back to the problematic for any threats to the blockchain. It is not possible to change any of the blocks, unless it is within highest the three blocks.
- Quick spread of information: When something happens on the blockchain, all other miners will be informed as quick as possible. When a new block is mined, this is broadcasted to the entire network.
- The betting business model on a blockchain would due to the structure of a blockchain, become less expensive for the company to run as well as the average earning from the company pr. bet would be less, hence it would create a higher potential winning for the customer.

### *Weaknesses*

- Poor scalability: When everything is consensus driven and everyone has to agree then it is hard to process large amounts of data.
- Hard to control: If you want to make changes to the network, you first need to convince 50% of the network to adapt to these changes. Therefore you cannot deploy hot-fixes overnight or easy roll back if they contain defects. Similar it is not possible to test the changes on a small group of clients in production.

- Power consuming: The proof-of-work algorithm used by miners are quite power consuming compared to what the value that the miner get in return. If you just want to write data to a public database for everyone to see. Then you can probably find more sensible solutions than a blockchain.
- General understanding of cryptocurrencies: As the bitcoin is the main known cryptocurrency it is often associated with a bad reputation. As the majority of the public only knows about the illegal potential of the bitcoin (example would be the Silk Road case, which definitely was not a good advertisement for the potentials of cryptocurrencies), it can be hard to change the interpretation of the bitcoin[14].

### *Opportunities*

- Get rid of intermediaries: When all trust is on the network, the blockchain has the potential to get rid of any kind of intermediary, this enables innovation on a large amount of industries
- Disrupt existing markets: Based on the prior information on the blockchain, it is possible to disrupt any kind of market. Especially the use cases where there is a trusted network, which can replace an intermediary or trusted third party.
- The sharing economy: In recent years, there has been an increase in the so called sharing economies, such as Airbnb, the business model that we want to establish, is very much in line with the sharing economy thinking – instead of facilitating lending out apartments, we simply facilitate bets.

### *Threats*

- Other IT systems: The blockchain is an emerging technology with targeted threats so to speak. However, it still has to prove its worth among well-known IT systems that have proven their worth for many years. Such as mainframes, SQL databases and so forth.
- Prejudices of cryptocurrencies: As mentioned in the threat part, the interpretation that the common person has surrounding cryptocurrencies will have to change.
- Prejudices of the blockchain technology: The entire blockchain technology is not widely known, as already mentioned, it still has to compete among other well-known technologies.
- Putting all trust in an automated system: The base of smart contract, is to put all trust into the system, and therefore the network. As the current industries is built around a centralized system, where the odds are delivered to a user by a company they trust, this facilitation of bets, will have to prove its value before it actually will be able to bring in late adopters.

Based on all the prior information, we will now be suggest an artifact to address our problem space. As our problem space is to define how we can utilize smart contracts and blockchain technology to develop a peer-to-peer business model for online betting.

Our solution will be tying all these industries and technologies together, which we have assessed through the literature review and relevance cycle. In order to illustrate how a business model can facilitate betting on a blockchain using smart contracts. This we will be doing through the design cycle where we will be developing a prototype.

[14] https://www.theguardian.com/technology/2015/may/29/silk-road-ross-ulbricht-sentenced

## Suggesting a solution

In the previous section, we interacted with a blockchain and smart contracts. Based on this experience, we established a foundation of knowledge. We will combine the environment knowledge gathered in our literature review with the investigation of our problem space to suggest an artifact solution that will support us in achieving our research aims and objectives.

From our own experience of interactions with the blockchain, and SWOT analysis we rationalize that a peer-2-peer business model is realizable. However, the aim of this research is to validate that our business model has potential to evolve the online betting industry. To justify this potential we will have to create an artifact that is easy to comprehend and use by our evaluators. Our target group of evaluators will consist of people who has experience with betting online and have no prior knowledge about the smart contracts and blockchain technology. Therefore, our artifact should not deviate too much from existing solutions in terms of usability and interaction platform.

The suggested solution is an artifact that illustrates and facilitate the complicated task of peer-2-peer betting on a blockchain. The artifact design shall simulate a browser-based solution, comparable to other online betting sites. It shall be usable without knowing how to code smart contracts or explicit knowledge on how to operate on a blockchain. To achieve this in timely manner and within the range of this thesis we will design and develop an artifact consisting of interfaces illustrating constructed scenarios. Our artifact will not have any core interactions with a blockchain. It is purely to visualize our business model so that we can gather qualitative feedback to aid our research goals and objectives.

In the following sections, we will explicate our requirements and design decisions that lead to the instantiation of our first design.

### *The use of Smart contracts in the business model*

The solution needs to able to execute different commands on the blockchain, such as transferring money from one wallet to another, holding the amount that is on the line while the bet is ongoing. The figure illustrates by a simple example, what the contract needs to be able to execute in the solution.

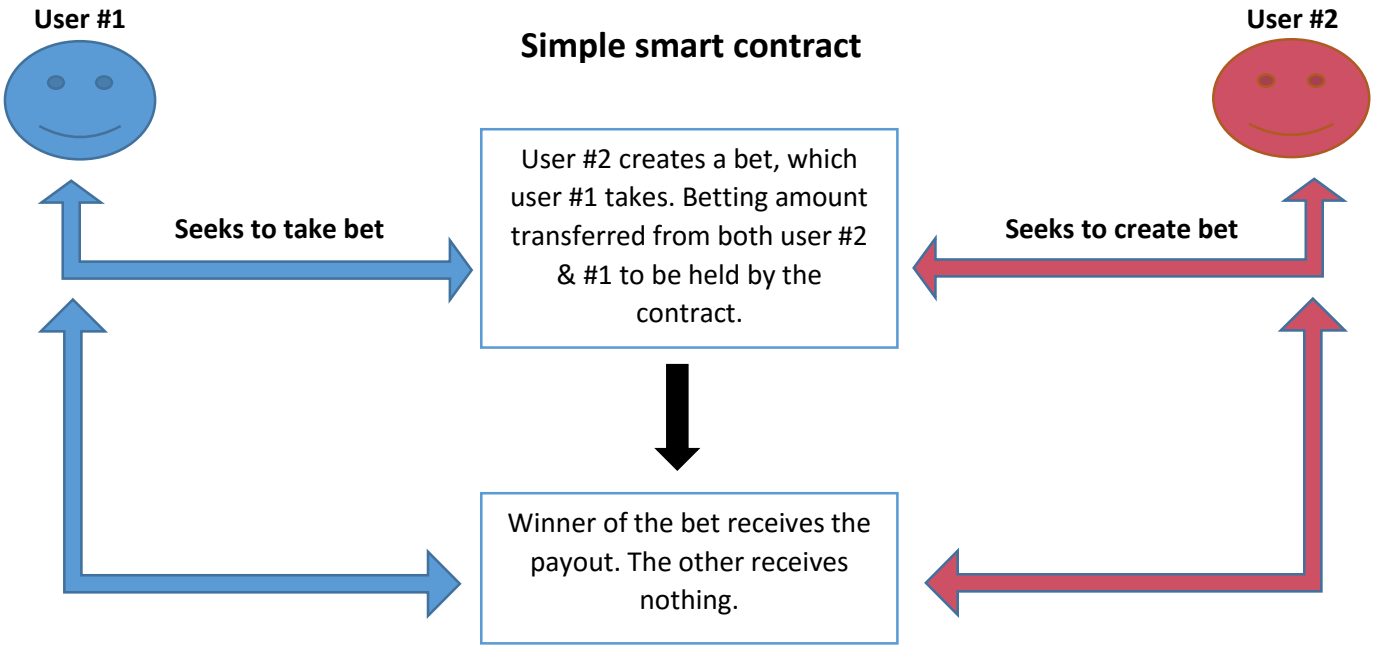


FIGURE 15 - A SIMPLE SMART CONTRACT

The example illustrated, has a user #1 and a user #2, both are users of the blockchain service. In this contract, user #2 creates a bet, this bet is then available, and user #1 who is seeking to take a bet, agrees to user #2's proposal. The contract then checks the user's wallets to verify, that they both have sufficient funds, and the contract is then holding the amount, while the bet is ongoing into the smart contracts wallet.

After the match is over, and the bet is completed, the smart contract will get the information, and execute the agreed contract – in this case, the smart contract will transfer the amount to either user #1 or user #2.

This is what is required from the smart contracts, in the prototype. The smart contracts serves as the binding between the blockchain and the users. The facilitation of all the bets, which is created in the prototype, will be executed by a smart contract. This ensures that there is no centralized involvement in the prototype, and it keeps the concept of a facilitating betting business model compared to the current betting solutions. This also means, that when the smart contract is executing, it will check that the user do not bet for more than what is in their wallet. It is simply not possible to agree on a contract, of which a user cannot hold up their end of the bargain.

### *Funding the business model*

In order to create a sustainable business model there need to be a source of income. The idea by constructing the business model on the blockchain is that the system should be able to maintain and control itself. However, the ultimate aim of the business model is to create an attractive solution that can

compete with the existing bookmakers. This will require continuous improvements and new functionality, which will generate a need for funding.

In our literature review, we calculate a fee for using the Ethereum blockchain. This fee is approximately 0.1% of the total amount transferred when interacting with smart contracts. However, as we stated there are several uncertainties related to this number.

From the literature review, we can also conclude that the Danish authorities classifies our business model as a "betting exchange". Thus they tax fee is 20% of the commission we take for facilitating the bet.

To fund our business model we therefore propose a fee of all payouts at 2%. This will place us well below the bookmaker's margin we analyzed in the literature review. We see this as the best value to compare against our fee. Taking less than half of our competitors create a unique selling point and gives us a competitive advantage, which will be hard to contest by the existing bookmakers.

With a 2% fee a bet worth 100 ether will generate a profit of 1.52 ether after transaction fees and taxes are withdrawn. Which we see as a reasonable value going forward[15].

Since the value of ether is fluctuating and this thesis does not take development and hosting costs into account, we do not see any reason to start doing a cost/benefit analysis or calculate how many active betters we would need to break even. The vast amount of uncertainties surrounding such calculation will undermine any academic value of making such calculations.

### *Choosing a sport to illustrate our flow*

To illustrate our flow we will have people taking and creating bets on a sport. To simplify our mockups and limit our need for development we will only include one type of sport per instantiation.

Both authors of this thesis are enthusiastic football players, which is also the most popular sport worldwide[16]. We therefore see it as the obvious choice to illustrate our business model. It will significantly increase the chance of our evaluators recognizing the teams and feeling more at ease with the artifact. Utilizing our own knowledge regarding football will also enable us to create enhanced scenarios, more realistic odds and better examples.

### *Prototype requirements*

We will conclude our relevance cycle by gathering a set of requirement to implement in our artifact. These requirements we have shaped and created by examining our literature review and our relevance cycle.

For the prototype, we outlined requirements, before starting to develop a prototype. This is to establish an overview of the prototype, which will be the first view of a suggested solution.

The following table shows the requirements for the first initial prototype.

| **Req #** | **Requirement** | **Reasoning for the requirement** |
|---|---|---|
| # 1 | The prototype needs to be able to have a login page, to be able to identify the better | This login page, in the prototype serves the purpose of identifying the user. |
| # 2 | A page to take bets, based on the bets created by other user. | This page serves the purpose of take bets created by other users |

[15] ((100*0.02)-0.1)*0.8)=1.52

[16] http://www.biggestglobalsports.com/

| Req # | Requirement | Reasoning for the requirement |
|---|---|---|
| # 3 | A page where it is possible to create bets and set odds.<br>The possible winning shall be visible for the user as well as reflect that we take 2% of all winnings. | This page serves the purpose of creating bets, which others can then take.<br>Giving users the freedom of setting their own odds and visualize how much their potential winnings are. |
| # 4 | A landing page, with the content the following:<br>• Bets that other users has created<br>• Welcome text, explaining the rules of our solution<br>• Upcoming matches to bet on | This page serves the purpose of giving the consumer an overview, and able to start betting reading the information. |
| # 5 | A confirm to take bet page | This page serves the purpose of making the user available of its choice of taken bet, and the price and odds the user will commit too. |
| # 6 | A created bet confirm page | This page serves the purpose of making the user confirming its proposed bet, and commit to the amount and odds in the agreement. |
| # 7 | A splash function sending you back to the first page. With confirmed information on the choice of the either taken bet, or created bet. | This function serves the purpose of letting the user know that the bet is on, and users can now take the bet. Alternatively, it will tell the information that the user has taken a bet, created by another person. |
| # 8 | A functional requirement, making the smart contract executing. When a user has either created a bet, or accepted one, the smart contract will take the betted amount from each player, and hold this, until bet is complete.<br>When the bet is complete, the smart contract will execute the contract agreements, and send the amount to the winning user. | After each user has agreed to the terms, this function will make the blockchain execute the smart contract, hence the agreed terms of the bet, is binding. |

TABLE 5 - REQUIREMENTS TABLE 1. ITERATION

### *Choice of development tool*

For the prototype, we assessed different tools, as there is a vast amount of tools for creating and developing prototypes, such as Balsamiq (Balsamiq, 2016), inVision (inVision, 2016), Axure RP (Axure, 2016), etc. All of these tools are capable of designing mockups and prototypes of web applications and mobile apps.

We both have experience of working with Axure RP. We know that it can fulfill the requirement we have to our artifact and achieve the aims we have set for this thesis. It supports the artifact development process in

all steps from creating flows and wireframes to a semi-functional dynamic prototype that testers can click through and give feedback on (Axure RP, 2016).

Therefore, we choose to work with Axure RP pro as our artifact development tool.

### *Choice of platform*

Most of the big bookmaker's offers online sports betting on both mobile apps and web (Bet365, 2016) (888sport, 2016). From a user perspective we could do both.
The concept of peer-2-peer betting is quite different from betting directly with a bookmaker. As well as the process of setting, your own odds will require some guidance. This is why the flow in the solution needs to be very easy to understand, so users can utilize the time to look at the requirements for setting their odds. While we do not expect our users to be blockchain experts or smart contract programmers in order to understand how the infrastructure works, we foresee a need of explaining how we hold their betting stakes until the bet is settled and they can actually follow the transactions behind the scene.

With these considerations in mind, we decided to go with a web application as our platform. The larger screen is needed in order to fully visualize our idea and enable the users to go through the peer-2-peer betting flow while also providing them with the needed information to understand what is happening.

Designing our solution for mobile is possible. However, with the aim of this thesis, a mobile solution will bring no additional knowledge to further aid our research and thus we will not construct such.

## Rigor cycle

The framework provided in the methodology section and the described existing research on the blockchain technology is combined in the designing of the prototype, these two sections are vital for the understanding of the blockchain structure, and how the smart contracts function.

Throughout the assessment of the chosen design framework, and other similar frameworks, we gained knowledge about the vitality of the evaluation phase to the development phase.

According to Hevner et al. (2007), the rigor cycle makes sure that the use of know theory is applied to the research, to ensure the novelty of the research. However, the blockchain technology has no prior theory, or larger systems developed, except from what is known through the bitcoin blockchain, and other blockchains. Thus, the literature review covers the main knowledge base about the technology, prior to this section in the research. The rigor is in general a shorter section, because if this takes the focus, the results are often corresponding in lowering of relevance (Lee, 1999; cited by (Alan R. Hevner, 2004)).

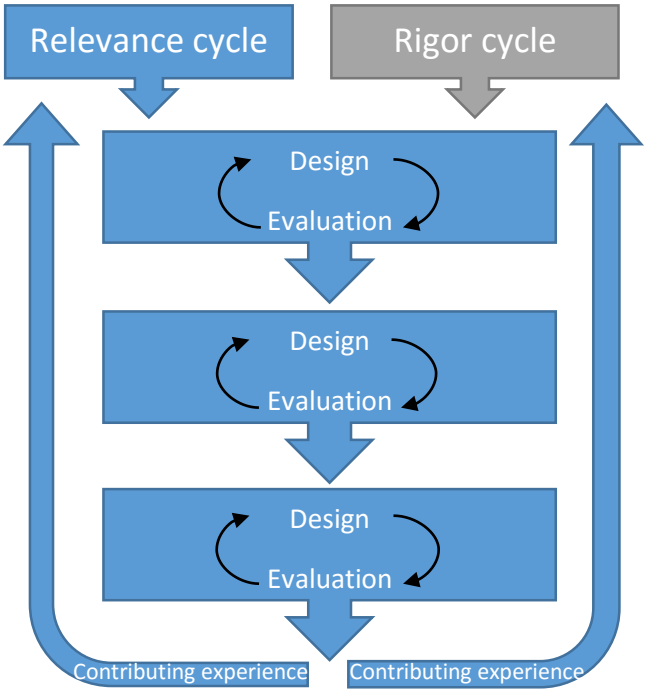


FIGURE 16 - FLOW THROUGH THE DESIGN CYCLES

## Design process

### *Usability guidelines*

To design our mockups we aim for an interface with great usability. Betting against others are, to our knowledge, not an area where, online betters have vast amounts of experience. Something we also concluded in the literature review.

Our artifact will have to make the concept and flow of peer-to-peer betting on a novel infrastructure eloquent for the average better.
It is a central part to fulfill our research goals that our artifact clearly expresses our idea and business model. This will create a solid foundation for our iteration and give us the best possible feedback to our evaluation.

We therefore design our artifact by following a variation of Normans 7 principles outlined for transforming difficult tasks into simple ones. This will ensure a user centered design that will support our evaluation and iteration process. With these seven principles, we will break down the, quite complex task of peer-to-peer betting on the blockchain into a simple flow that will make sense to our testers.

Normans 7 principles for transforming difficult tasks into simple ones summarized by (Dix, 2004):

1. **Use both knowledge in the world and knowledge in the head**. People increase their efficiency when the knowledge they need to do a task is available externally. This can either be through the environment, but experts also need to internalize regular tasks to increase efficiency. This meaning systems need to provide necessary knowledge within their environment and their operation, which should then be transparent enough for the user to have the support in building a mental model of what is going on.

2. **Simplify structure of tasks**. Tasks needs to be simple, so you can avoid complex problem solving. It is possible to achieve a simplified structure of tasks in a number of ways. One is to aid a user when keeping track of stages when doing tasks that are more complex. Another is providing user with more information to solve the tasks, and give the user a better feedback. The third approach is to automate parts of the user's tasks, as long as it does not reduce the user's experience. The last and final approach is to completely change the nature of the task itself, and by extend creating something simpler for the user. While all of this, is concerned about simplifying it for the user, it is important not to take any control away from the user.

3. **Make things visible.** The interface should make it clear to the user what the system can do and how to do this, and it needs to be transparent to the user the effect of their actions on the system.

4. **Get mappings right.** The intentions of the user needs to be mapped clearly into the system. It need to be clear, what does what and by how much. All controls needs to be reflected within the system, a small movement has a small affect and a large movement has a large effect.

5. **Exploit the power of constraints, both natural and artifical.** Constraints are things in the world that makes it impossible to do anything, but to do it in the correct way. It is like a puzzle, it can only fit correctly together in one way. This is how the user should perceive the solution; the physical constraints should guide the user to complete the task.

6. **Design for error.** It is human to make errors, so the solution needs to anticipate the errors and make design recovery into the system.

7. **When all else fails, standardize.** If there is no natural way to map then it should be standardized, so that the users only need to learn it once. It is like riding a bike, the key controls are standardized, sometimes the

bike has a back-break, and sometimes it only has breaks on the handles, but the critical components remains the same, such as the frame, wheel and steering (Dix, 2004).

### *Development method*

To develop our artifact we will adopt agile concepts. The agile concept will bring flexibility an enable us to respond to change fast (Sull, 2009 Vol. 87).

The agile approach will support us to meet the requirements from our relevance and rigor cycles. While it will complement our iterative design cycles very well. We expect each iteration to bring new requirements, which we will implement to our artifact in a timely manner. Due to our limited timeframe for this thesis, flexibility and fast respond to change will be crucial in our development process.

### *Evaluation methods*

The evaluation of the artifact is a crucial part of a Design Science research process. The right evaluation methods are vital to prove the quality, utility and efficacy of the artifact (Alan R. Hevner, 2004).

As described earlier a central part of the artifact development process is to improve the artifact through iterations. Choosing the right evaluation methods for different stages of our thesis is essential to generate the feedback we will use for the next iteration.

According to Hevner et al. (2004), there are five types of evaluation design, which is usually applicable to evaluating when using design science research as a methodology framework. The five types are as follows:

- Observational – this is focused on case and field studies
- Analytical – examining the artifacts architecture and it's qualities
- Experimental – controlled experiment, and executing artifact with artificial data
- Testing – functional (black box), and structural (white box) testing
- Descriptive – informed argument or a constructed scenarios evaluations

To evaluate our artifact we will use several of (Alan R. Hevner, 2004) different methods. We will mainly focus on constructing detailed descriptive scenarios around the artifact.
As (Alan R. Hevner, 2004) states: *"Descriptive methods of evaluation should only be used for especially innovative artifacts for which other forms of evaluation may not be feasible."*
Before doing, the descriptive testing we will however test the artifact for defects or poorly designed flows, which could potentially interrupt our constructed scenarios.

Because the artifact is a clickable mock-up prototype that demonstrates our business model. We will only evaluate on visual interfaces of the artifact. Therefore, some of the methods will not fit our context and support us in fulfilling our research objectives.

To evaluate our first development iteration we will do an internal evaluation. Meaning that we, ourselves will be the only evaluators of the artifact. To do this evaluation we will use two methods.
First, we will make a '"Functional black box testing'; here we will click through the mock-ups to identify any defects in the interface e.g. a button not directing the user to the correct page.
Second, we will make a descriptive informed argument using info from knowledge to assess the utility of the artifact. Here we look at the complexity of the flows and tasks to ensure appropriate usability for our external evaluators in our next iteration.

The aim of the internal evaluation is to remove any undesirable disruptions when we do the external evaluation. Where the focal point of the feedback should concern the usability and utility of the artifact and the business model.

In our second and third iteration, we also made a short internal black box testing to identify and fix bugs. However, our primary focus was on our external evaluation in the form of field-testing the solution. Here we have our evaluators run through our artifact to perform different constructed scenarios such as take and create a bet. Our aim with this approach was to prove the utility of our artifact as well as gather feedback, which we would use to create the requirement for the next iteration.

## Design cycle

In the design cycle, we will be developing the prototype, based on the inputs gained from the relevance and the rigor cycle. We will as previously mentioned, go through the design cycle three times to develop the final solution.

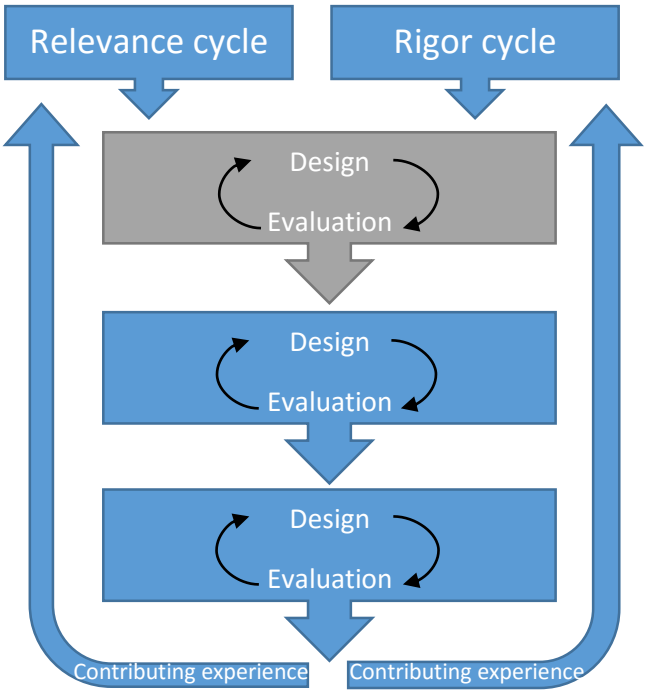


FIGURE 17 - FLOW THROUGH THE DESIGN CYCLES

### First iteration

The first iteration we will mainly develop through the requirements set in the relevance cycle, and designed through the seven steps of design, and the evaluation methods, which we went through in the rigor cycle. In the relevance cycle, we established that we will be using Axure as the developing tool for producing the prototype.

#### *First phase – the designing the artifact*

**THE REQUIREMENTS SPECIFIED IN THE RELEVANCE SECTION, TO ACCOMMODATE THE NEEDS OF THE BUSINESS MODEL, WE NEEDED TO SPECIFY FURTHER TO ESTABLISH A USE-CASE DIAGRAM, OR FLOWCHART OF THE PROTOTYPE. FOR OUR INITIAL LAYOUT, WE CREATED THE FOLLOWING FLOWCHART, TO ESTABLISH AN OVERVIEW OF THE FLOW THROUGH PROTOTYPE.**

Essentially this flow shows the functionality of the business model on a blockchain. We will in the evaluation phase assess, if the proposed idea is novel and feasible, if the requirements from the relevance cycle are met, and what to focus on in the next iteration cycle.

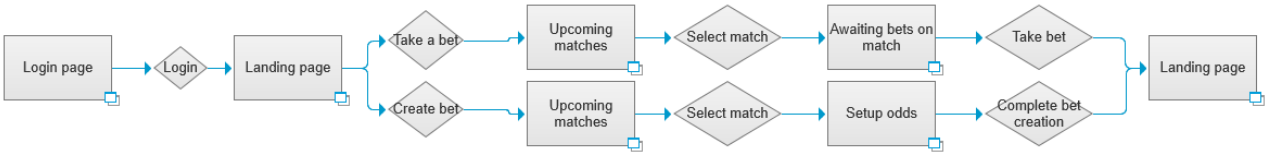


FIGURE 18 - SUGGESTED FLOWCHART THE PROTOTYPE

The first initial page that the user will face, is the login page, however, for this test there is no sign-up flow, but a functioning button, which leads the user to the next step in the flow. This is to illustrate how the login flow initially would need to be there, even though the business models aim is to decentralize existing

betting business model, this login and identification of a user is needed, for the solution to identify the wallet of the user.

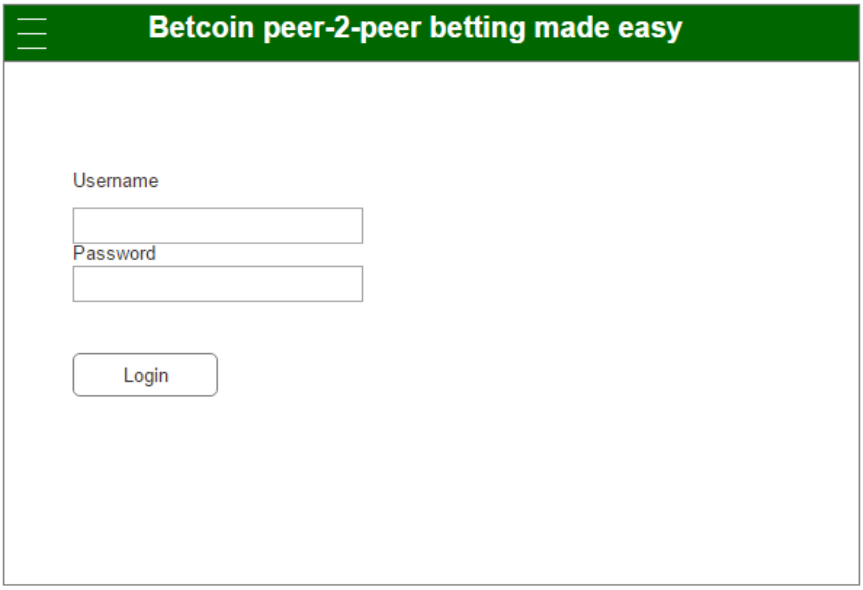


FIGURE 19 - LOGIN PAGE - FIRST ITERATION

Next in the flow, resulted in a landing page, which serves as the overview page when a user access the site. From the landing page, it is possible to either take a bet, or initiate the process of creating a bet.

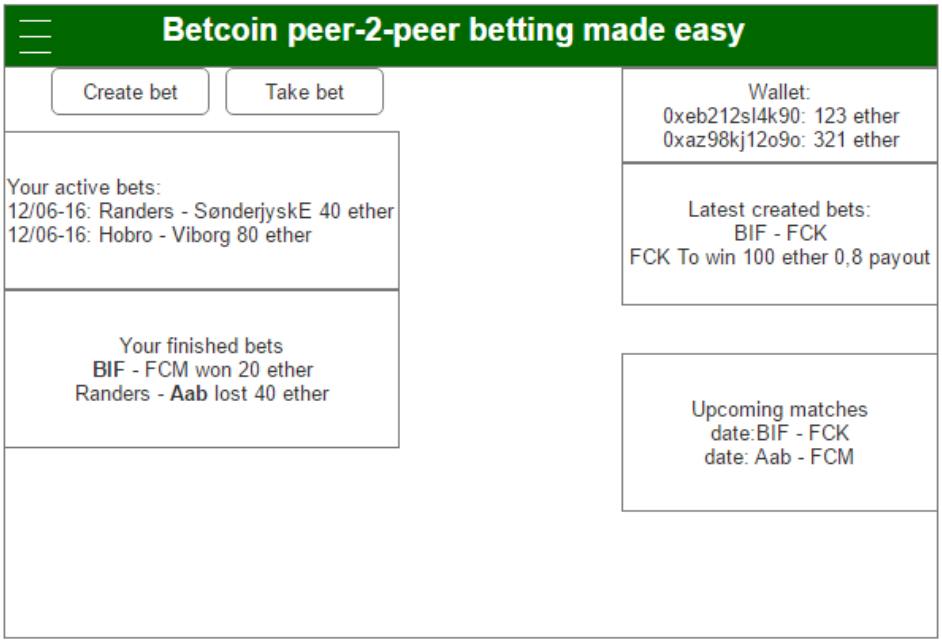


FIGURE 20 - LANDING PAGE - FIRST ITERATION

The landing page consists of several elements; some of them relies on the blockchain technology.

It is required to have a wallet address to use the system. When a user creates an account, the wallet address and user profile is connected. You could potentially have more wallets, which we have illustrated here. When a user logs in the system will fetch the current wallet balance by scanning the Ethereum blockchain.

The wallet address is the essential part for most of the elements on the landing page to work. After a user, logs in the system will scan the Ethereum blockchain for all actions the users wallet address have been involved in. The system will then sort the findings into the “Your Finished bet” and “Your active bets” containers. For this to work all bets created through the system will be provided with some sort unique identifier so the system knows what should be shown here and what should not. For example, a complete scan of the blockchain will result in some normal ether transactions from and to the user’s wallet address; such activities shall not end up on the landing page.

The container that shows “Latest created bets” could get info from two sources. The blockchain or from the system itself since it is created by another user. The idea is here to show that there is activity around certain games.

The upcoming matches is dependent on the blockchain oracle that we explained in our literature review. The oracle will have to feed the system with the different matches that our users can place bets on. Each match will have a unique match id; since the teams will play, each other several times each season in different tournaments. The oracle will also be responsible for pointing out the winners so the smart contracts knows how should get the payout after each match.

The focus on this page, is providing an overview and to help the user of the gain an easy understanding of how to initiate betting.

After choosing either to go with taking a bet or creating it, the flow sends you to another page, where the user can see the various upcoming matches. As on the landing page, all these matches comes from the blockchain oracle.

By clicking on any of the games, another pop-up comes up, where the user can decide to go with the creation flow of the bet, or see the bets which has already been established on this match.

Axure generates this popup when there are several outcomes connected with one action. Here our users select a match to bet on, which could potentially take them to the “create bet page” or show them what bets are created by others on the match.


FIGURE 21 - CREATE / TAKE BET - FIRST ITERATION

If the users continues with the creating bet option, the next step in the flow is the page where the odds are set. This meaning, this is the page where the users understanding of the business model is crucial, here the user set their own odds and establish the bet that they would like to agree with other users of the solution.

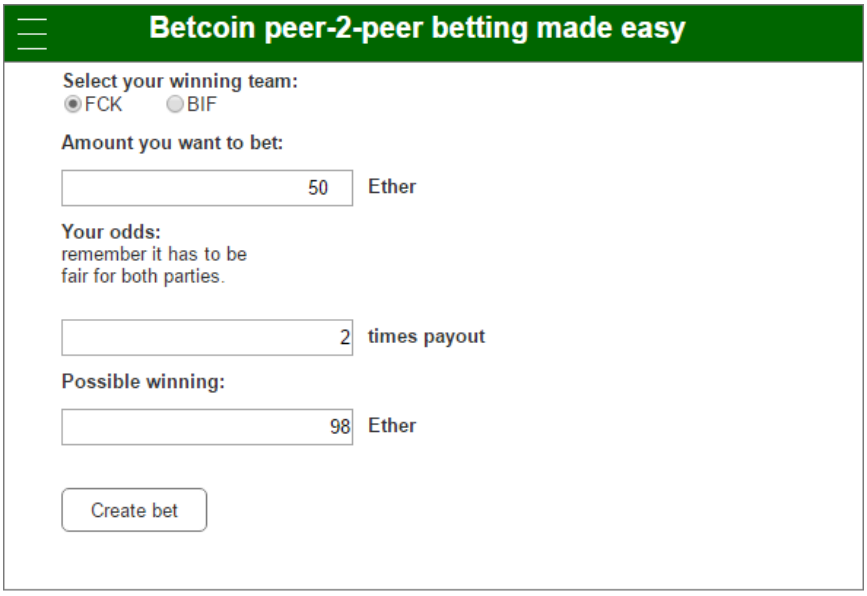


FIGURE 22 - CREATE BET - FIRST ITERATION

The user is here able to experiment with setting odds, and are able to see the outcome of the odds set; this is to help the user with seeing how the odds they are offering to other users will look in the end.

When the user creates a bet, the system will execute a smart contract on the blockchain. The contract will escrow the amount of ether the user bets. It will store the odds that where set and which team the user picked as the winner. The contract will then wait for another user to take the bet. If the case is that no one takes the bet, then contract will terminate and refund the ethers.

If the user however, chose to go with the other part of the flow of taking a bet, the page they would end up in seeing is an overview page, containing the current bets on a game available for the taking.

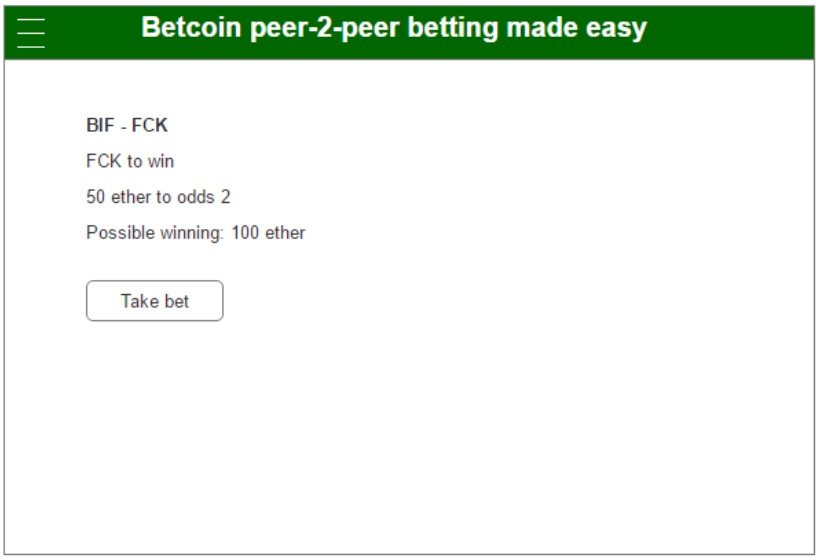


FIGURE 23 - TAKE BET - FIRST ITERATION

Although this view is rather simplistic because there is, only one active bet on this game available for the user. This should make it quite easy for the evaluators to go through the flow the constructed scenario of taking a bet.

When a user takes a bets it becomes active. Other users create all the bets that a user can take. To activate a bet certain criteria's have to be met. The smart contracts that control the bet will need the correct amount transferred. In the illustrated example a user have created a bet on the game between BIF and FCK. The odds are set to 2 and the amount 50 ether. These values are unchangeable. To take the bet, which will activate the contract, 50 ethers are send to the contract.
Then the contract will escrow 50 ethers from each of the betters until the oracle pushes the result of the match. When this happens, the smart contract will execute the payout to the winner.

After either creating or taking a bet, the user will end up in a page, which tells the user if the bet have been taken or created successfully. This design phase emphasize the simplification for the user, as the understanding of the solution is necessary to be able to use the solution as it is meant to be used.

### *Second phase – the evaluation*

As stated in the rigor cycle, the first iterations evaluation phase we apply two internal evaluation methods, a functional black box testing followed by a descriptive evaluation, where we examine the prototype for its complexity.

Functional black box testing main usability is to sort out bugs, and sort out initial design issues, as black box testing does not put any focus on the internal mechanism, but focus solely on the output (williams, 2006).

The construction of descriptive evaluation methods is by a series of questions and sub-questions to establish an argument for the artifacts usability (Alan R. Hevner, 2004). However, for this internal evaluation we will be examining the usability of the prototypes complexity, to establish if the initial artifact would be too complicated for the evaluators in the upcoming development iteration.

Our findings in the internal black box testing were as follows:

1. The 'confirmed' button coming after the bet created and the bet taken did not disappear correctly. Instead, it was not possible to 'click it away', we implemented a function, which made it possible for the user to get rid of this, and by that ending the flow of either taking or creating a bet.
2. The calculation field when creating odds did not calculate the potential winnings, for the user to understand the flow of facilitating the bet. This functionality was implemented, both for the users benefit, but also to simplify the understanding and the actions taken in the prototype.
3. When choosing to create a bet, the 'confirmed button' came out with a notice saying that the bet 'have now been taken'. This would create an unnecessary misunderstanding for the user; this is a minor fix, but certainly help in the understanding of the flow for the user.
4. The confirmed button was only able to close when being clicked, in the field 'ok', this we changed so that the entire pop-up field can be clicked to close.

Through the functional testing of the prototype, we discussed various factors of the initial prototype such as:

1. Does it make sense to use football as a solution or would another sport with less outcomes be better for the understanding of the idea?
2. Is the prototypes flow simple enough?
3. Does two wallets bring any value or complicate perception?
4. Is the current color theme a good way to go?
5. Do we need more information?
6. Is this idea feasible, and should we continue the development?

This first development cycle ended out in a prototype with facilitation of football bets. This means that a match has a potential of three outcomes. For our prototype and for the users of this prototype, means that they can only choose one of three results, ending in the outcome that if two users bet on each their team to win, in case of a draw the amount they put in to the bet should then be transferred back to each of the betters. This does not really benefit our business model idea of taking two percent for facilitating the bet. This would result in a user bet 100Eth, and then getting 98Eth back, for a bet that they did not lose on.

For the understanding and for simplifying this result issue for the users of the prototype, we decide to go with a sport where they potential outcome can only be a win for either better. Our choice for the next iteration is to go with tennis, as the sport, as it is the third most popular sport and it is the most popular sport were the outcome only has one winner and no chances for draw[17]. This would make the prototype easy to understand for the user.

The flow of the prototype was the second thing we discussed. Our finding on this, is that the prototypes flow is very much based on the fact, that we wanted to make the take/create bet as transparent as possible. However, having a functionality of a flow start, where the user know that here the betting starts, was missing. When implementing this, it would give the prototype more of a 'feel' of and actual betting site, and the flow to begin betting will be very transparent. This resulting in the finding that we have to adjust the flow of the prototype, by implementing minor changes, the entire 'feel' of the betting site will be better, and more simple for the user to understand.

The third point of evaluation is something we already established should not take the entire focus of the development cycle, but the UI more exact the color theme used in the prototype we evaluated on as well, as we predict this is something the evaluators will be commenting on as well. For the initial prototype, we use green headings with a grey background, this however, seem very blend to us, and so we decided to switch the color theme, to a darker background color and a dark blue header.

The fourth thing we discussed was the feasibility. The feasibility of this business model is a crucial component, because if no one likes the idea it is not sustainable. The solution needs to reflect the best of every world. This meaning that we want to illustrate how you can create an innovative business model using the blockchain and smart contracts. This however, we believe that we achieve as the technology is as new as it is, and the facilitation of betting is so in line with the emerging sharing economies, which people adopt to in a large degree. Both this fact, and the beneficial of the transparency on the blockchain, leads us to a conclusion that the future of betting could lie within the blockchain technology, using smart contracts to execute the bets.

Our following development iterations will see if this hypothesis is correct, and if the evaluators see potential in this idea as well.

To sum up the findings, this resulted in a set of new requirements, which is as follows:

[17] http://www.biggestglobalsports.com/

| Req # | Requirement | Comments | Reasoning |
|---|---|---|---|
| #1 | Fixing bug found in the black-box testing. | The findings that we touched upon in the functional requirements testing needs to be implemented to make sure the flow does not have the 'children diseases' that the prototype initially had. | The functional testing is necessary before field-testing, as we can sort out lots of the bugs, and by that being able to focus on the main things with our evaluators. |
| #2 | Change sport from football to tennis. | To implement this, we applied changes in the entire prototype, to make this work. | Instead of having three outcomes, having the two-outcome approach would simplify the flow from the user's perspective. |
| #3 | Simplify the flow through the prototype. | Adding the start betting functions to the flow of the prototype will increase the simplicity for the user, hence making it easier to understand. | When adding the start betting function, we avoid questions and misunderstandings from users to start their betting. |
| #4 | Change the color theme. | UI is something we mainly limit us from, but we can however, not impact how the evaluators respond to our prototype, so changing the color might help us in avoiding comments visuals | Through our internal evaluation, we found that a change in color would make the site stand out more and by that make it more memorable to the user. |
| #5 | Go from two wallets to one | A user in our system could potentially link as many wallets to their account as they wish. | To standardize our solution towards other betting sites, we choose to go with just one wallet.<br>We foresee that having 2 different wallets to bet from would create unnecessary complications when evaluating on the forthcoming iterations. |
| #6 | Remove the Axure element from the flow and make explicit buttons for the different scenarios. | When there are, two outcomes from the same action Axure have a default element that handles this. | When an evaluator clicks through our flow, there should not be different outcomes on the same element.<br>This will disrupt the flow and are not in accordance with Norman's usability principle of get mappings right. |
| #7 | Provide more information to help users understand the flow | Users should not be in doubt of the idea behind our artifact. | We estimate that to fulfill Normans principle of "Use both knowledge in the world and knowledge in the head" there is a need for more information embedded in the system. |

TABLE 6 - REQUIREMENTS TABLE 2. ITERATION

To sum up this first iteration, we have now gone through the main components of constructing the artifact, based on the requirements of the relevance cycle, and evaluating it based on the inputs from the rigor cycle.

This has resulted in a set of new requirements, which we will be implementing in the next cycle, before field-testing the prototype on a group of evaluators.

## Second iteration

Based on the findings from the first iteration, new requirements was established. These requirements is applied in the second iteration. This second iteration is building on our internal evaluation and this is the first iteration where we will field-test the solution on a group of evaluators.

### *First phase – developing the prototype*

Based on the first evaluation phase in the first iteration, a new set of requirements was established, among these one of the requirements is the one to implement a more simplistic flow through the prototype. This we need to enable, because of what the previous flow lack for it to be easier for the user to understand.

In the below figure we have established an updated version of the flowchart, which we believe leads to a simplified version and is easier to understand by the different users.

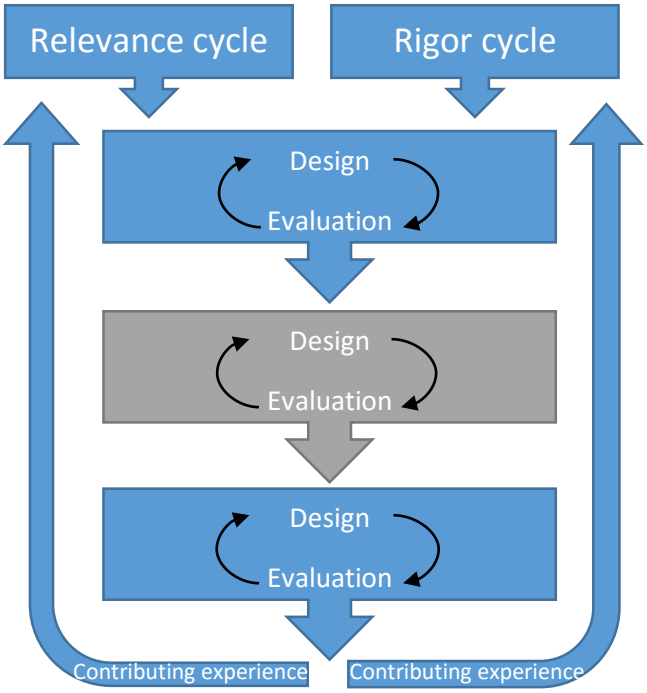


FIGURE 24 - FLOW THROUGH THE DESIGN CYCLES

In this flowchart the flow from the previous iteration, where the users choices would send them through two separate paths of either a take bet or a create bet flow, which now has a different approach. The users will go through a flow, where they at the end land at a setup odds page, where they can either take the bet or create the bet. This creates a more simplistic flow, and by adding the 'start bet' to actually send the user into a page of upcoming matches, where the user can then select a match, before choosing to either take a bet or create a bet on the selected match.

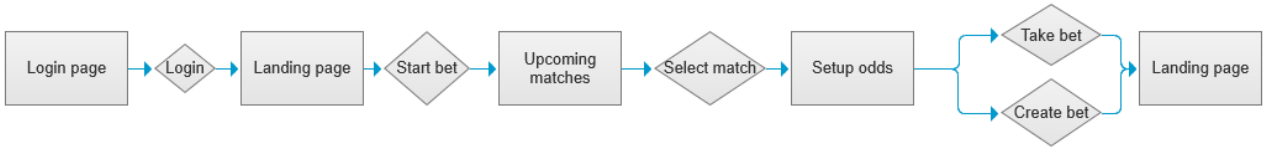


FIGURE 25 - FLOWCHART - SECOND ITERATION

With the new flow in mind, we implemented a new color theme as well, this is a darker theme, and the text were changed from black to white, as the black text would come out very blend with a dark blue background. At the login page, a small introduction section was added, which should explain the system, and the peer-to-peer betting concept. The login page also entitle a few of the upcoming games, for the users benefit, to facilitate the thinking about which bets to either create or take, even before logging in. The below figure shows the aforementioned login page, and the new color theme. The introduction of the implementation of another requirement is visible at the login page, requirement #2 regarding the switch of sports from football to tennis.


FIGURE 26 - LOGIN PAGE - SECOND ITERATION

The landing page is updated with the start betting as the central part of the page. Besides the start betting, the user can see active bets, and upcoming matches in the right side, similar to our first iteration. We implemented requirement #5 so there is now only one wallet. This makes the page look more simple. On the left side of the page, we did part of Requirement #7, which was to provide more information. We have implemented the odds from other bookmakers, which has the purpose of helping the user with setting their own odds.


FIGURE 27 - LANDING PAGE - SECOND ITERATION

As described when going through the flow to get to the next step and start betting, the user has to click on 'start bet' button.

After the clicking on the start betting, the user has to choose a game to bet on, this sends the user to an 'upcoming matches' page, where the user can see all upcoming matches, and choose which match to start betting on. On the 'upcoming matches' page, the user also has an explanation on the left side, which offers guidelines on the peer-to-peer betting also part of requirement #7. There is also information to the user about the already created bets by other users, which the user can use as inspiration or take instead of creating its own.


FIGURE 28 - UPCOMING MATCHES - SECOND ITERATION

After choosing an upcoming match, the user is sent to the 'setup odds' page. Here the user has the potential of taking a bet based on another users odd setting, or going for creating their own bet, for other users to take. The page is set up, so the user has the take bet option in the left side of the page, and the create bet functionality in the right side of the page. Setting up the odds now automatically calculates the

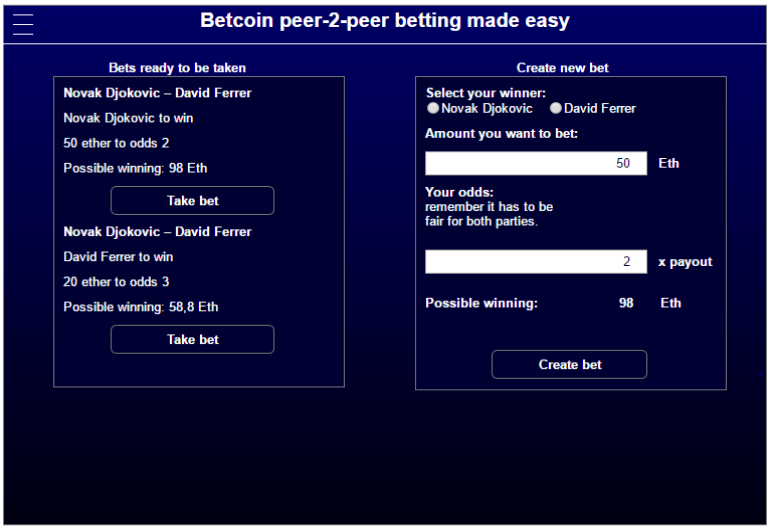


FIGURE 29 - SETUP ODDS - SECOND ITERATION

fee we take from the payouts. A fee, which is also mentioned on our upcoming matches page.

When the user has decided on an option to go with, the user will be send to the next page in the flow, however, this does not differ much from the existing pages in the initial prototype, as it is a page where the user can either choose to confirm the either taken or created bet. After the final confirmation, of the

either taken or created bet is then confirmed and the user is send back to the 'landing page' with a confirmation as seen in the first iteration.

### *Second phase – evaluation of the prototype*

For the second evaluation the prototype was field-tested, by five evaluators. We had a standardized set of questions for each of the evaluators, these were asked after the evaluators had to go through a flow of two pre-constructed scenarios, where the evaluators tried to both take and create a bet.

Prior to the interview questions, we established some ground information about our evaluators, by asking them if they have heard of blockchain technology. This is mainly unknown territory for evaluators, as only one out of five knew about this technology prior to the prototype test. On the other hand, four out of five evaluators had heard about bitcoin and cryptocurrencies prior to this exercise. We explained in brief, what the blockchain is, and where it stems from, this we did to create knowledge about the prototype functionality for the test subjects. The one evaluator, who knew about the blockchain before, was the only of our evaluators, which did not have any real experience of online betting prior to this exercise.

After getting an introduction to cryptocurrencies, blockchain and the prototypes functionality, the evaluator's next step was to go through the prototype, and test out the constructed scenario, which we would hereafter ask about through a series of standardized questions.

**Question #1**

*How was the overall experience of the prototype? What in particular was good/bad?*

This questions purpose was to establish a foundation with the evaluators, to see how they actually saw the visuals of the prototype. As we stated previously in the design cycle, we are designing the prototype based on the seven design steps by Norman, and for us it is important to demonstrate the feasibility of the business model. By doing that, the functionality of the prototype needs to work correctly, as the users outcome of their actions has be what they expect. This initial question establishes what the evaluators sees as lacking in the solution, and their initial thoughts on the concept of peer-to-peer betting:

*"Concept could be fun. If there are enough people in there, I think it would remind me a lot of gambling and poker." – Evaluator #1*

Another evaluator focus on the simplicity of the solution, and sees this as a positive thing, which was the aim of the prototype, however, feels that the design are lacking information on Ethereum/Blockchain for a new user to be confident with this betting methods:

*"Simple format that makes sense. […] I need more explanation on what an Ether is and what the exchange rate is. I would like the fundamentals of how the new technology works to be more outlined." – Evaluator #2*

Another evaluator pointed out that the functionality with transparency on users betting action, makes up for the lack in service of betting experts, which other betting sites offers, as this is now visible for the entire blockchain:

*"I like the idea, and I like the fact that you are betting against other people. It creates an alternative form of betting. If some people create wild bets, there is a good chance you can win some."* – Evaluator #4

Overall, none of the evaluators seemed to dislike the solution, however multiple improvement points was already highlighted, which we will explore more in question #9, where the evaluators have the chance to get their own improvement ideas across.

**Question #2**

*Do you primarily bet online or in a store?*

The evaluators was asked where they prefer to bet, as this gives an indication of how comfortable they are with using an online solution for their betting. As already established, one out of five evaluators did not bet often, but the rest of the evaluators said they use online betting, as they preferred way of betting.

**Question #3**

*Does the high percentage the bookmakers takes for setting odds bother you?* Why / why not?

As the introduction to the prototype, we gave the users insights in how much on an average a bookmaker set the odds on a game, and how high their rake back is. This we did, while explaining the blockchain, and providing the evaluator with an explanation of how it is possible to take a lower amount by the business model of utilizing the blockchain and smart contract.

The majority of the evaluators emphasizes that they need to be able to trust the site, where they bet, and that the sites had to make money somehow. Only one in five thought that the rake back is annoying, and actually considered this beforehand.

*"It is rather annoying every time that I bet, that the bookmakers take such a high rake back. The more I can make on an average the better."* – Evaluator #1

One of the evaluators also put forth the argument of loyalty to the site that they use, as this is something they picked based on a mix of reputation and the odds the sites provides:

*"Have not thought about it before. As long as I win then it does not matter. I choose my bookmaking site based on the reputation, but based on those I chose the one with the best odds. Although I am very loyal to the betting site I use."* – Evaluator #5

**Question #4**

*What do you think of the lower percentage the facilitator takes compared to the bookmaker?*

The basis for the questions is that we wanted to explore how the evaluators would react to this more transparent way of showing that the solution would actually 'take' a part of their betting. Instead of the centralized betting sites where they bet against the house, and have to keep track of their win and loss to know if they come out with a profit. The responses from the evaluators were mixed, as the cost per bet becomes more transparent.

One of the evaluators does not understand that the payout of the winnings is not 100%, as they are used to from the more traditional betting model.

*"Only so, it covers the cost, and will only be the provider of a system and facilitating the process"* – Evaluator #1

While other betters finds the cost fine, as long as the aim is to cover the cost for facilitating the bets, but they think the solution would have to have a reputation before they would find it attractive to take their betting here.

"*It is attractive. H*owever, *the prototype does not seem convincing at the initial look. I* w*ould need reputation to be attractive for the first time."* – Evaluator #2

**Question #5**

*Do you think it is fair to take a cut of 2% for facilitating the player vs. player betting?*

The responses on this question was very aligned from the evaluators, five out of five thought this was fair, when they compared it to the bookmakers normal rake back.

*"Yes, it is cheaper than other places. If I looked at this as a consumer, I would know it costs money to establish and maintain a system like this. When you as I do to, are investing in stocks and the like, you would always take the option where the deposit are the lowest rate."* – Evaluator #1

**Question #6**

*Do you find it attractive to set your own odds or take bets set by others? Why / why not?*

Five out of five responses on this question, resulted in positive remarks around the idea, although one of the evaluators would prefer to have the odds set by the bookmaker.

*"The idea seems interesting, but I would still prefer to have my bets created by a bookmaker."* – Evaluator #4

However, the majority of the evaluators found this to be an interesting concept, and emphasized the betting against others was an interesting aspect, three out of five felt they needed more information on how to set their own odds:

*"I think that the idea is good, and I like the idea that you have to play the market. However, it requires a different kind of thinking when betting. I would like it if I could get suggested bets and odds from the site."* – Evaluator #5

**Question #7**

*Would you trust a site like this?*

The responses to this question, there was only two out of five evaluators who thought that it would be secure enough to use. Two other evaluators were more reluctant as they would like the solution being used by a number of users, as they would prefer not to be first movers:

*"Not sure. I would like to see it has all legal remarks from authorities before I trust a site like this, and I would await the system having more users before I would adapt to a concept like this."* – Evaluator #4

**Question #8**

*Is it important for you to know exactly who you are betting against?*

The responses to this question was mixed, as three of the evaluators did not care or would prefer not to know whom they were betting against. Two out of the five evaluators suggested that betting against friends would be an interesting approach for this solution to have:

*"Either know exactly who it is or make it anonymous. Would consider using it to bet against friends."* – Evaluator #4

*"[…] Could be fun to play against friends in like the European cup, or in champions league and have like a pool of winnings."* – Evaluator 5

Based on the responses to this question it seems as the majority did not care whom they are betting against when they are choosing randomly, but knowing the country of the other better could be interesting. They were suggesting implementing a social functionality, where it would be possible to bet against friends.

**Question #9**

*Any ideas / feedback on how to improve the site?*

As our last question, we are eager to know what the evaluators think of the current solution, and what they would like to see to be improved. The layout of our prototype had not been in focus, this was told to the evaluators not to put too much focus on this, but commenting on the color theme would be appreciated.

The responses on this question, was very alike, all the evaluators want more information on the betting, they need more transparency on the different odds, as the solution is different than what they have been accustomed too.

*"More transparency with the correct information. Show other odds more."* – Evaluator #3

As the layout did not have the focus when designing the solution, all evaluators mentioned this topic, and the color theme seemed too dark. Information was set as a requirement from all five evaluators, as they need both more information on how the betting works in the prototype, but also the blockchain and smart contracts, as this is an emergent technology, the evaluators does not trust it from the beginning.

*"More division on the page layout. I would like a logo, and a little lighter colors. In addition, different colors so the columns are not alike. More contrasts. A guide to know about the system, and little more help for betting. On the betting part as well as the technical definitions of the prototype."* – Evaluator #5

**Key findings from the evaluation phase**

Throughout this evaluation phase in the design cycle, we received valuable feedback, based on this the overall findings were:

1. Transparency in the value compared to centralized betting solutions, the solution needs to have more information on each of the pages for the users, else the chances of misunderstanding will be there.

2. The social aspect of betting, the evaluators put the argument forward that it could be an interesting improvement to add the functionality of betting against friends. This could be interesting when betting throughout major sports events and tournaments where users can create groups and track their win/loss ratio against each other throughout the tournament.
3. The betting experts are unnecessary, because of how the blockchain works, it is possible to see how other users bet, and by adding in bookmakers odds from other sites, making the users avoid the need for betting expert advice.
4. The evaluators emphasized the need of legal remarks; they would not contribute to a solution where the legal aspect is not yet approved, so for this to work, these need to be in order.
5. The color theme of the prototype is too dark, and there need to be more division on the pages, to divide what relates to what.
6. The evaluators all agreed that they need more visible information on blockchain and smart contracts, as this is an emergent technology. The evaluators did not feel comfortable with the solution based on the current knowledge it offers.
7. The evaluators sought to have more information on the solutions, this meaning that they want more information on how the betting system work, and general information on how to set their own odds.
8. The prototype was simple to understand, it was easy for the evaluators to go through the two constructed scenarios.
9. The business model is valid, the evaluators all agreed that the idea of peer-to-peer betting is interesting, and they want to explore this more.

To sum up on this second evaluation, we went through the key findings, and based of these we establish a set of new requirements for the next design iteration.

| Req # | Requirement | Comments | Reasoning |
|---|---|---|---|
| #1 | A page explaining the solution | To accommodate the issues that the users brought forward, there is the need for implementation of a page explaining the solution, the blockchain and smart contracts. | Multiple of the evaluators in the second iteration mentioned that they lack information of solution, hence the reason for implementing this as a solution. |
| #2 | Bet against friends | Implementing the social aspect of betting would require changes to the flow, as there is a need for establishing a constructed scenario where this is possible. | This would create value for the user that want to bet against friends, and would create social aspect on a betting site. |
| #3 | Mark which country users are from | This would require the users to give information on their country origin, when they sign up on the page. | This would not create value as such to the idea, although the users find it interesting to track the countries of the other betters. |
| #4 | Change the color theme | The current color theme was too dark; on top of that, the layout of the pages did not improve the usability for the users. | Changing the color theme aims to put the evaluation focus on the flow and business model. |
| #5 | More information for the user on how to bet | The evaluators emphasized the need for more information on the betting structure, as the concept was unknown to the majority of the evaluators this was highlighted. | The intensive for using the solution as the preferred betting platform, would likely increase if the users had easier access to information. |
| #6 | Show what odds other people have already accepted. | A suggestion by one of the evaluators, that he would potentially replace all the betting reports that he reads if he could see what odds other people were actually accepting. | This requirement builds on top of our business model to utilize the transparency of the blockchain. We see this as an potential competitive advantage |

TABLE 7 – REQUIREMENTS TABLE 3. ITERATION

## Third iteration

Based on the result of the evaluation in the second iteration, we defined a new set of requirements. These requirements we will implement as our design for the third iteration. The new design will go through another descriptive evaluation similar to the one we used to conclude our second iteration. With the addition of some new questions and scenarios.

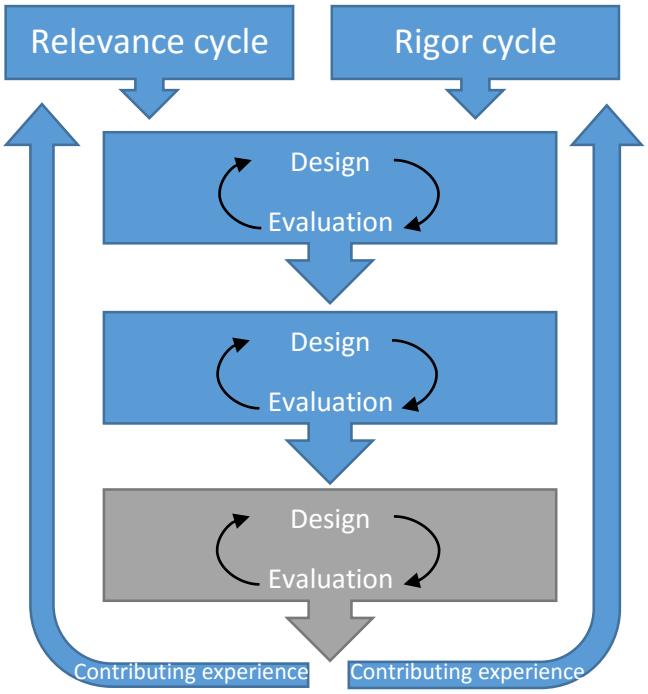


FIGURE 30 - FLOW THROUGH THE DESIGN CYCLES

### *First phase – updating of prototype based on input from previous iteration*

In our evaluation of second iteration, we got valuable feedback regarding several aspects of our product. We aim to implement the suggestions that will enhance the feasibility of our artifact and business model the most.

To respond to the requirement of added functionality and need for even more information, we had to rethink some of the solutions flow. The general feedback was that the betting flow had the desired level of usability and was intuitive. Therefore, we tried not to change that more than needed.

The updated flow chart containing all the new pages and navigation routes are below. It shows how it is now possible to navigate to more information about what a blockchain is and how our business model works both before and after login. It also reflects how we have implemented the social aspects of betting against friends into the betting flow.

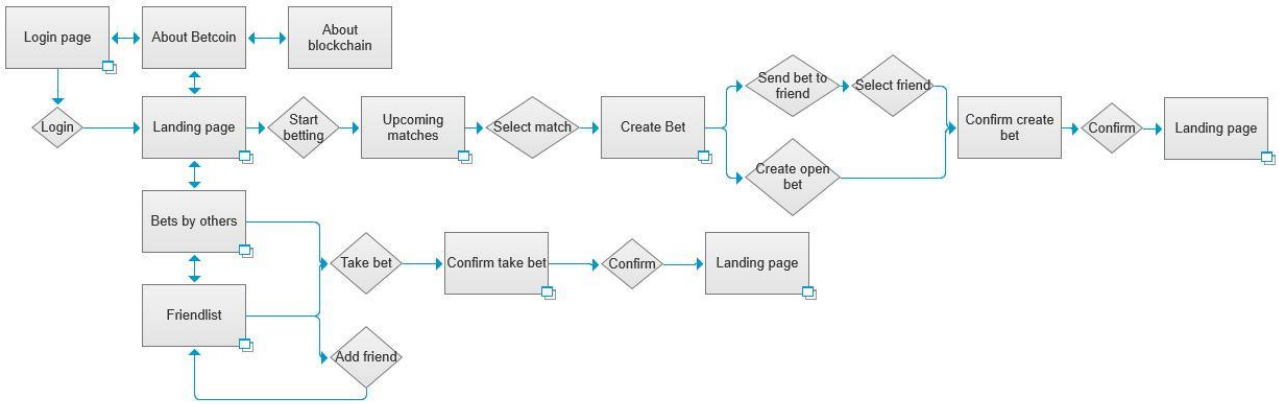


FIGURE 31 - FLOW CHART - THIRD ITERATION

When we ran through the scenarios, the evaluators had many questions on how the system would work as well as to the blockchain in general. This resulted in requirement #1: a respond to this is our pages 'About Betcoin' and 'About blockchain', which is below. These pages should also increase the amount of trust to our system, which is also an issue for some of our evaluators. These pages are available before and after login, since we see this as relevant information for both potential and existing users.

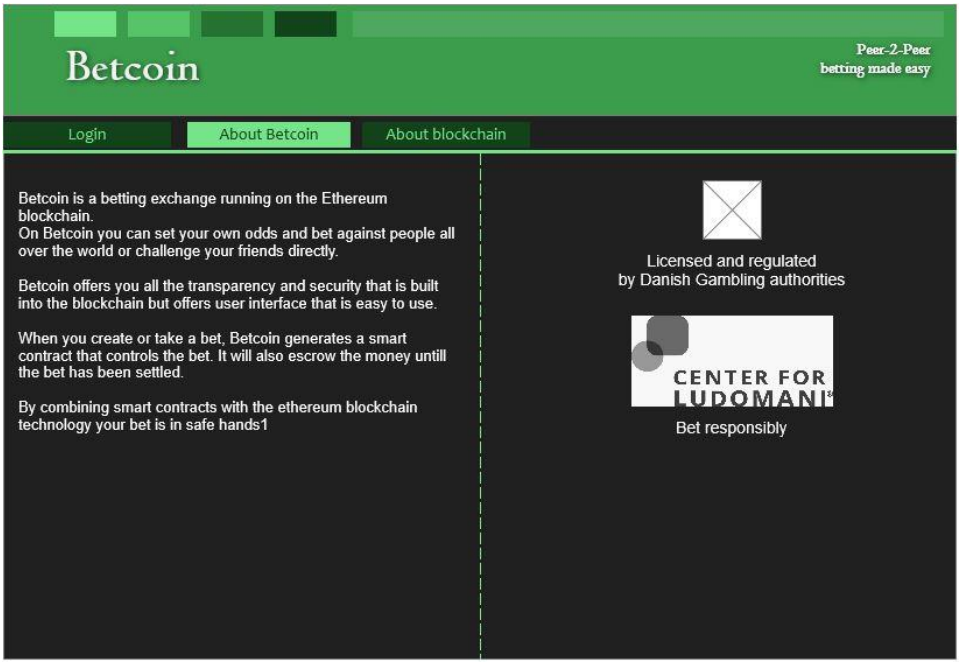


FIGURE 32 - ABOUT THE BETCOIN - THIRD ITERATION

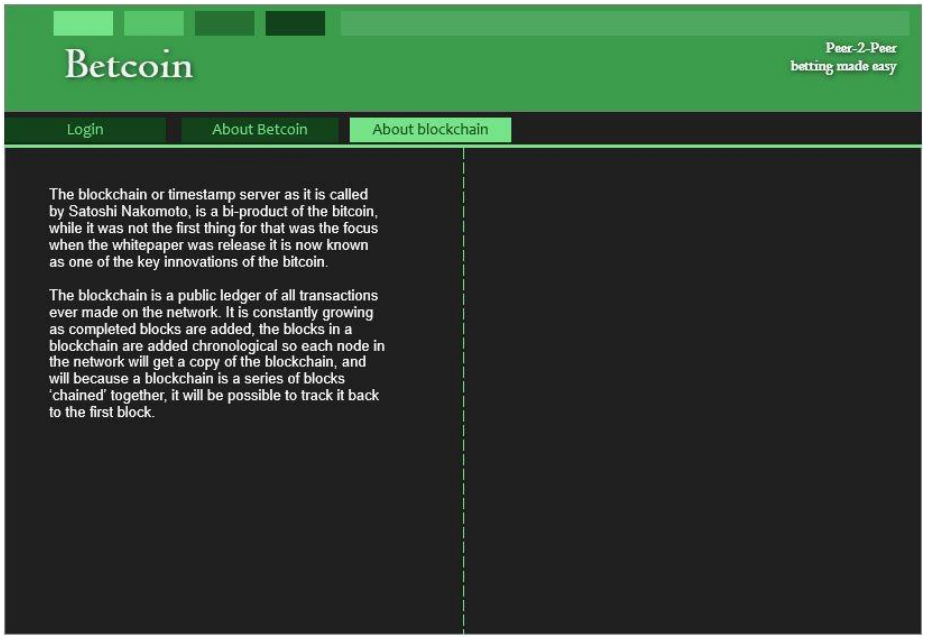


FIGURE 33 - ABOUT THE BLOCKCHAIN - THIRD ITERATION

These two screens also reveals how we responded to requirement #4 where we once again saw a need to change our visual design. Some of our feedback included our choice of colors. We felt that it took away some of the attention on the flow and idea which is our focal point of evaluation.

We decided to take some inspiration from other betting sites such as Unibet and Bet365. They also use black and green as the dominant colors. To navigate between the pages we implemented tabs. Something we got inspired by other betting sites to do. With the new layout and navigation, we follow Norman's seventh principle, "When all else fails, standardize". The aim with standardizing is to eliminate the

excessive focus on our interface and increase feedback on our flow and business model. On our landing page, we replaced the odds from other bookmakers with more information on the functionalities. As stated in requirement #5, our evaluators felt a need for more information on the screen to help understanding the flow. The odds from other bookmakers we relocated in the flow so it was closer to the actual betting task, which is where the information brings value to our users. We also increased the size of the “Start betting” button to make it even more clear what the users are supposed to do.

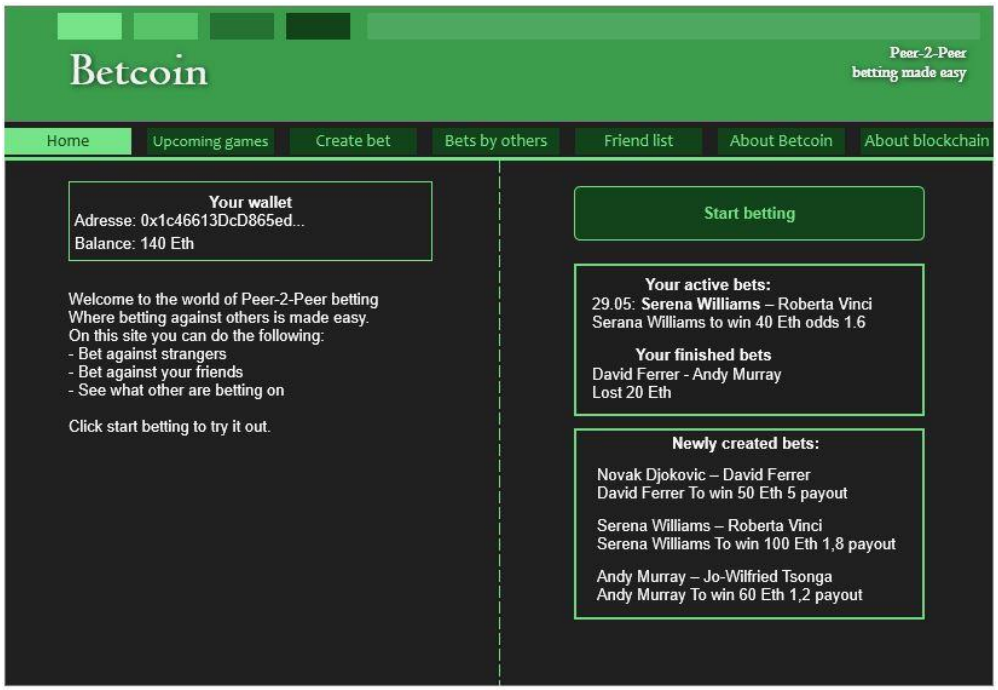


FIGURE 34 - LANDING PAGE - THIRD ITERATION

A requirement that many of our evaluators put a lot of emphasis on was requirement #2, bet against friends. In order to fulfill this requirement we had to change our betting flow slightly. We decided to split the create bet and bets by other earlier in the flow. We also added some information to explain to our users what they could do on the screen. The create bet button we split in two, the ‘Create open be’ and ‘Send bet to friend’. An open bet works similar to the create bet button.

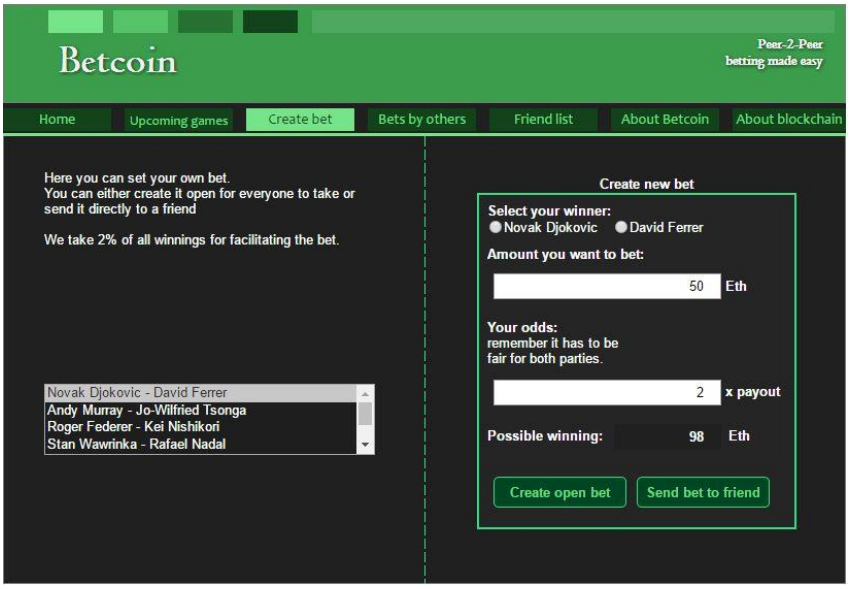


FIGURE 35 - CREATE BET - THIRD ITERATION

Send bet to a friend will open the user's friend list. Here the users is able to select which friend should receive the bet, with the possibility of taking it.

While the smart contract that controlled open bets would accept any user to take the bet. A bet send to a friend requires the wallet address of the user taking the bet, to match the wallet address of the user that the bet is send to. An added functionality could be to send it to a group of friends, but such implementation we will leave for further development.

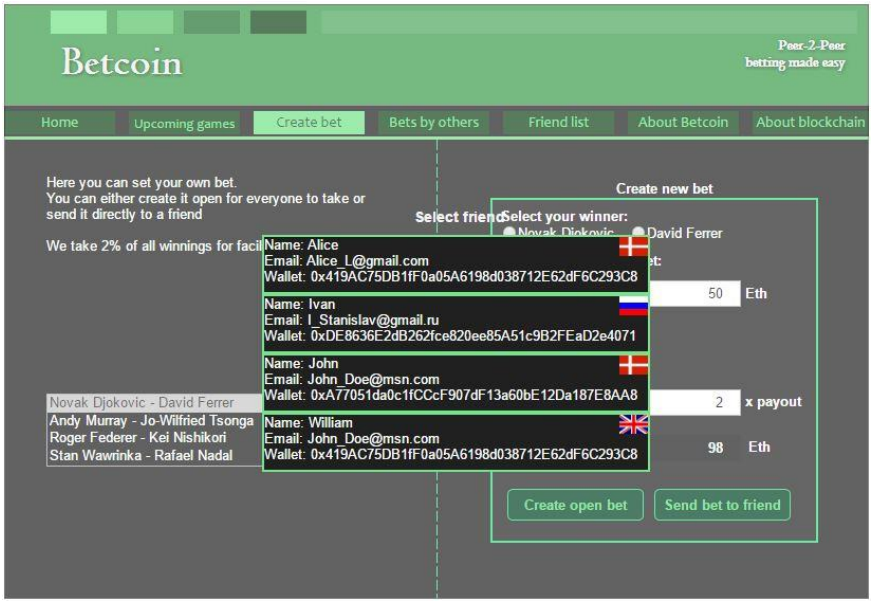


FIGURE 36 - SEND BET TO A FRIEND - THIRD ITERATION

At the bet by others page we have increased our usage of the transparency that is offered by the blockchain. One of the suggestion from our evaluators was to show what other people are actually betting on, which we outlined in requirement #6. Showing what other people are betting on should help our users to determine what favorable odds are. In addition, if they are unable to find any they are just a few clicks away from setting their own.

We also implemented the ability to see what country users are coming from as a respond to requirement #3. Something that several of our evaluators would like to have.

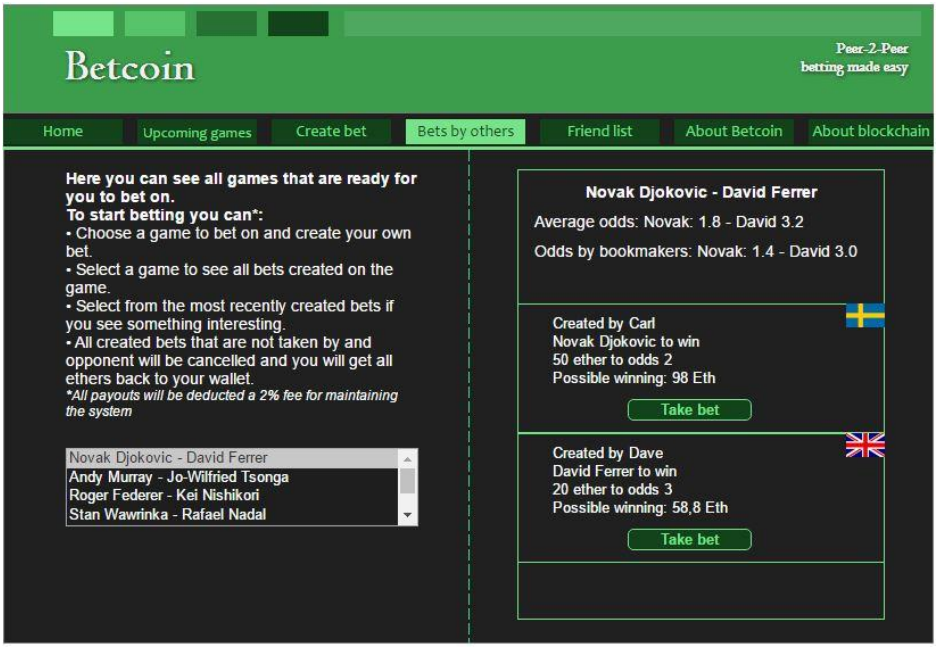


FIGURE 37 - BETS BY OTHERS - THIRD ITERATION

To finalize requirement #2 we implemented a Friend list where users can see and add friends. Here the identifier is either an email address or wallet address since those will serve as the unique identifiers.

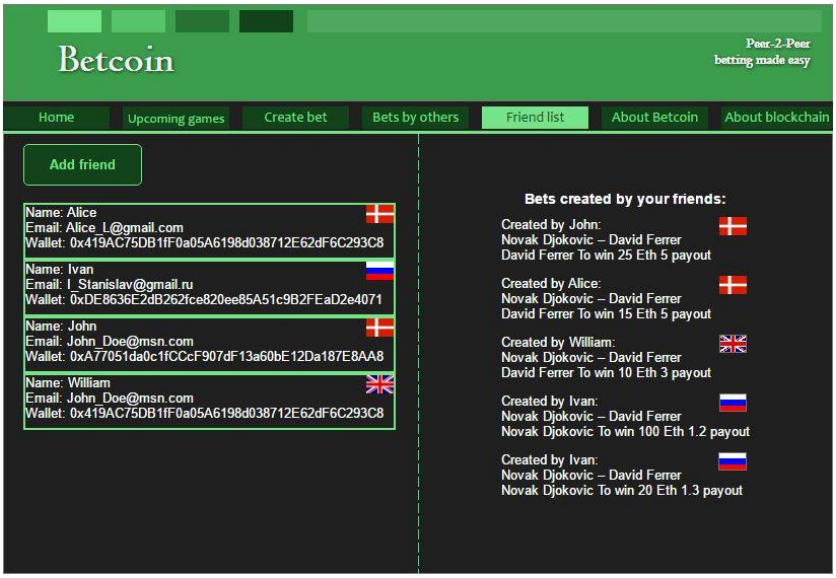


FIGURE 38 - FRIEND LIST - THIRD ITERATION

Second phase – third evaluation of prototype

For the third evaluation, there was 10 evaluators, whereas three of these evaluators are repetitive from the second evaluation. For this evaluation we have the same approach as the second iteration, we establish a foundation of knowledge of the solution for the evaluators, so they all have an understanding of the constructed scenarios they have to go through.

For this evaluation, all the evaluators have experience with betting prior to this prototype testing. For this evaluation, we established a set of standardized questions as well as in the second iteration. However, this time we will not highlight the same questions, as the second evaluation. We will highlight the questions regarding the experience of the prototype, as well as the questions regarding if the evaluators could see themselves using this solution and the suggested improvements.

**Question #1**

*How was the overall experience?*

The responses to this questions was solely positive, all the evaluators agreed that they like the concept of peer-to-peer betting. Half of the evaluators touch upon the simplicity of the prototype, which they think is very easy to understand.

*"Very smooth and clear on how to use it. Simple to interact with."* – Evaluator #6

The responses on the business model, was positive, as one evaluator mentioned the peer-to-peer systems are on the rise, and emphasized their own excitement of peer-to-peer sharing solutions as Uber and AirBnB.

*"[…] However, I like this idea, it is great, and I like the concept of peer-2-peer betting. I can't see why there should be a middleman, it annoys me when there is a middle man […]"* – Evaluator #2

**Question #2**

*Do you like the idea of peer-to-peer betting?*

All the evaluators like the concept of peer-to-peer betting, they all emphasized that this way is an interesting approach to betting. Although in this question, two of the evaluators who indicated they bet a large amount, did not find the approach of the social betting interesting. They thought this improvement would not appeal to them:

*"I like the peer-2-peer aspect. However, I do not like to bet against friends. About the aspect of losing a large amount of money to a friend, is not something I would like. Moreover, I play for a lot. I could see myself playing on this"* – Evaluator #7

However, seven out of ten mentions that they do like the idea of a social aspect in the prototype, and that they are able to engage in a bet with their friends.

*"[…] In addition, when you added a friends list, it gives a community feel to it all. It is easy to bet against your friends. I Like that."* – Evaluator #3

This again underlines the fact that the evaluators do see the value in this business model, on this matter they all agree. As we see this, the only evaluators who did not find the aspect of betting against friends interesting, was the two evaluators who indicate that they bet very heavily.

**Question #3**

*"What would you suggest for improvements?"*

The responses to this question vary from a usability point of view to minor usability improvements such as adding a back button on the page, to more comprehensive implementations such as live streaming of games. One highlight was that the first hand impression is very important to the evaluators, so the usability needs to be as simplified as possible. Five out of ten evaluators was eager to have more options in the prototype, than the simplified version of having only one sport able to bet on.

*"Nice design. A bit more bet options. You can pretty much bet on anything."* – Evaluator #10

Based on the responses on this question, the focus has changed from questioning the functionality of the solution. Instead, the evaluators focus is on the improvements that would add value for them.

*"Get some video stream on the page, to do get some information and start doing e-sports, because it would be interesting to integrate all these things."* – Evaluator #2

**Question #4**

*Would you use a solution like this?*

The responses to this question is very one sided, the majority of the evaluators could see themselves using this solution. However, the volume of customers is what would convince the evaluators to use the solution:

*"With a high volume of customers, I think I could see myself using this. I do not see the point if I am alone."* – Evaluator #7

As another evaluator agrees, the volume customer using the solution is crucial. This make sense in the way the business model is set up as well, there would not be a market for facilitating betting, if the volume of users is on a very low scale.

*"Yes. It gives some abilities that other sites does not. But with more sports and friends on it would be even better."* – Evaluator #6

**Question #5**

*Comments to usability, etc*?

The responses to this question revolved around establishing more information for the user, one evaluator suggested adding in a tutorial of how to bet.

*"However, the fact of seeing the wallet might be a game changer. A tutorial could be nice."* – Evaluator #2

Five out of the ten evaluators highlights the fact that the flow is simple, which it needs to be. The flow from initiating the betting site to actually starting to bet, has to be very intuitive, else this would not work for the user.

*"[…] the betting flow is intuitive and have the right level of complexity for users […]."* – Evaluator #6

### *Key findings from the third evaluation*

Throughout the third evaluation, we got following several suggestions on how to improve the business model as well as valuable feedback on the utility and efficacy of the artifact. We have identified following key findings to support our research in fulfilling our aims:

- Business model endorsed. Majority of our evaluators found the idea of peer-2-peer betting appealing. Something we also conclude by the fact that many of our evaluators would like more functionality that supports our main idea.
- Social aspect of betting was appealing. The option of challenging friends directly was a functionality they could see themselves use. Especially if you could expand it we private betting pools on sport events like the upcoming UEFA euro 2016.
- More sports. We chose to limit ourselves to only one sport to keep the artifact simple. Nevertheless, several evaluators requested different kind of sports to bet on and different type of bets than just picking winners. The fact that evaluators want more options is something that we interpret as an approval of the concept. In addition, that they would like to utilize the artifact to perform more activities is something, which we see as positive feedback.
- More connectivity to social media such as Facebook, Twitter, Google+ and Youtube. Similar to the request for more sports, the fact that people would like to connect to their social media platforms and share their betting activities, reassure that we are realizing our research goals.
- Live video of the matches. Another request for more functionality. We can see that we through our iteration have improved the artifact, which have increased the amount of positive feedback.
- If you gamble a lot, you prefer to be anonymous. While a lot of the evaluators appraised the social aspect. The evaluators who gambled the most preferred to be anonymous. You do not want everyone to see if you win or lose big sums on gambling. If we did another iteration on our artifact, a new requirement should be to control whether or not the user wants to be anonymous for other users of the system. The business model is generating higher revenue if more people bet in the system.
- The highlighted need for information. Even though we have given our users, a lot more information throughout the artifact some evaluators still needed more. Something, which would be catered for in further iterations.
- We sorted out the main issues from the second evaluation, the focus shifted from being as the functionality of the solution, more to the usage of the solution, and how to improve the solution to add value for the users. This convinces us that our key learnings from other iterations have benefitted our artifact and we can claim that the iterative approach applied from our framework have enhanced our solution.

## Evaluation

This section serves the purpose of evaluating on the artifact in order to rationalize its validity and utility to aid our research and illustrate our proposed business model. This is achieved by evaluating on the result of each of the design cycles. However, our primary focus will be on the third evaluation of our final artifact. Accordingly, this final evaluation will serve the purpose of identifying our contributions to the relevance and rigor cycle.

To evaluate the artifact, we must first validate that the artifact is useful. To prove the usefulness, we will assess the artifact's validity and utility, which are the two criterion outlined by Gregor et al. (2013). Examining the validity allows us to consider whether the artifact has the intended functionality (Shirley Gregor, 2013). At the same time, the utility clarifies if the artifact offers significance outside of the design cycles (Shirley Gregor, 2013).

To validate the artifact's usefulness within the research setting, it must clearly illustrate the ideas behind the proposed business model. To simplify, this alludes to the facilitation of betting against others. Throughout our design cycles, one of our focal objectives was to have an artifact that the evaluators of the prototype found useful. This is achieved through the continual evaluation following each iteration.

To assess the utility outside the development environment, we look at how the artifact and business model offer findings that are relevant to the environment. The evaluators in general felt the betting fee was fair and found the business model to be interesting and attractive, which ultimately provides value towards the environment. Additionally, the evaluators could envision themselves using the peer-to-peer functionality offered by the solution. When considering the business model presented to them, the evaluators were able to contribute with valuable feedback, which shed light on additional innovative functionalities of the business model. These added insights helped to expand the original business model by adding additional layers to the solution's functionalities and features. Overall, the contributions proved immensely helpful in fulfilling the requirements needed to further progress the research at hand.

## Contributions to relevance

According to Hevner et al. (2004), a pivotal element of conducting research, including within the design science research methodology, is to highlight the novelty and key contributions. In the initial phase of the relevance cycle, we established the foundations for our business model and set the requirements for the artifact to illustrate the business model.

In light of this, Hevner et al. (2004) states that the main contribution of design science research is often the instantiation of the artifact. However, we recognize that the business model also adds novel contributions to our environment. As a result, we include the proposed business model as a part of our relevance cycle.

Overall, the solution proves that it is technologically feasible to launch a business model of this nature. Additionally, despite some evaluators' reservations towards the funding method, the business model appears to offer the potential to be financially sustainable. As such, evaluators that held this sentiment felt that paying a percentage of their winnings to the system differed too much from the existing model used by bookmakers to collect fees. The vast majority of the evaluators, however, thought it was fair to take a fee for facilitating the process even though they set the odds themselves. Evaluators within this group particularly valued the transparency of the fee. Ultimately, this sentiment amounts to the finding that users are willing to pay a fee if a seamless transaction on the blockchain and smart contracts can be executed and a certain level of usability can be achieved. Even though our predictions on the funding potential are

limited, we can make initial predictions that it is possible to run a profitable business model on the blockchain. However, this estimation is largely correlated with the volume of users and thus, assumes a base level of users.

The novelty of being able to set one's odds and challenge other users directly with bets was something our evaluators generally found exciting. When we combine this with the finding that our evaluators were willing to pay a transparent fee, we can conclude that our evaluators are open to the idea of using an innovative way of online betting.

Our artifact currently is limited to a series of interfaces, but we have validated how it can build on top of the existing blockchain technology and how it could potentially function. We see the positive feedback on our artifact as a clear contribution to the environment that blockchain applications should start to shift from being used solely by people that are already familiar with the technology to being used by a broader audience. Adaption by a wider following is a necessary step for the technology to be able to realize the untapped potential associated with it.

The key findings to the relevance cycle emphasize that the research has made several contributions to develop the environment and to identify novel business opportunities.

## Contributions to rigor

As stated earlier, over emphasis on the rigor cycle takes away focus from the relevance cycle. The key objectives of this thesis are to provide novel information to our problem space, prove the usefulness of our artifact, and the feasibility of the business model. These objectives are all part of our evaluation, relevance and design cycles. Thus, tangible additions to the knowledge base are not provided.

We can verify, however, that our rigorous approach has aided our research and enabled us to achieve our research goals. The iterative approach helped to continually improve our artifact. Additionally, the design, development, and evaluation methods have ensured a high level of artifact value. Our contribution to the existing knowledge base is, therefore, limited to the extent that we can solely confirm the usability of the methods and framework.

## Discussion

As outlined previously, this research was conducted with the intention of developing a new business model for the online betting industry by combining the blockchain and smart contract technologies. To achieve this, a series of research objectives were outlined. As such, the first objective was directed at merging existing literature to explore the topics of smart contracts, blockchain technology and the online betting industry business model. However, given the relative newness of the blockchain and smart contract technologies, limited academic research currently exists on these topics. A lack in scholarly attention has largely limited our literature review to a scattering of books, articles and websites. Despite these restrictions, we were able to garner a foundational understanding of the existing environment. From this, it became evident that limited large-scale exploration of combining the blockchain and smart contract technologies exists. This is particularly true within the area of facilitating peer-to-peer betting. Up to this point, betting using cryptocurrencies exists but initiatives have yet to exploit the peer-to-peer betting functionality that the blockchain technology has the potential to foster.

Given this current gap in research, we have directed our thesis at developing a novel way to use the blockchain combined with the use of smart contracts to serve as a facilitator for online betting. To bridge this void in knowledge, we addressed the second research objective by merging existing literature with a practical assessment of the blockchain's current level of functionality. By combining existing knowledge with a test of the blockchain's level of development, we determined that the technology remains in its infancy. This understanding helped to shed light on the conditions faced in looking to further develop on the blockchain. As a result, we were able to have an initial grasp of the how the blockchain could be as the underlying technology for an alternative online betting business model. Through a SWOT Analysis in the relevance cycle, we determined that it would both attractive and possible to develop an alternative business model incorporating both the blockchain and smart contracts. Based on this, we outlined the requirements for the proposed artifact in an effort to visualize the proposed business model. Using the relevance cycle parameters to set the requirements for the artifact, the initial prototype must illustrate the functionality of how people can be enabled to bet directly with each other using the blockchain and smart contracts.

Having the artifact requirements established, we proceeded to address the final research objective by using the design science research framework to evolve the design of the prototype. This was accomplished by conducting three rounds of evaluations and iterations of the artifact.

During the first iteration, we conducted an internal analysis of the artifact. This revealed that using football, which has the potential outcomes (i.e. win, lose, draw), would likely prove to be too complex for evaluators to grasp the concept of the proposed business model. We preferred that evaluator's attention be directed at the capabilities of the technology rather than on the finer details of how the winnings would be distributed. Given this, we adjusted the prototype to allow bets to be placed on a sport, such as tennis, which is limited to two potential outcomes (i.e. win or lose).

Moving to the second iteration, we conducted a series of in-depth interviews to obtain external feedback on the artifact. From this, evaluators largely indicated that they were interested in the concept of peer-to-peer online betting. However, they were unfamiliar with the technologies utilized and thus, lacked trust in the security of the technology and validity of the business model. This was amplified by the fact that they felt as though they were missing necessary information to get acquainted with both the technology, the

execution of the bets, and the general business model. Furthermore, the lack of familiarity with the technology and concept led many evaluators to focus solely on the design of the artifact.

To lessen these concerns, we updated the artifact in the third design cycle. We thus added more information to the artifact surrounding the technology and business model concept. For example, we outlined what the blockchain technology is and also helped guide users on each tab to guide how to execute bets. Additionally, we adjusted the color theme and overall look and feel of the solution to resemble already established online betting sites. This helped to create a sense of familiarity with the evaluators. We also incorporated a social aspect to the business model concept by visualizing how evaluators could potential connect to both friends and strangers. This was captured by showing the opportunity to create a friends list. The large majority of the evaluators found this capability particularly attractive. Ultimately, completing these steps caused the focus of the evaluators in the third iteration to shift from the design and layout to the betting functionalities of the artifact.

Completing this series of iterations allowed us to further evolve the artifact to arrive at a more optimal business model concept overall. Additionally, key findings from the iterative process provide implications of the requirements that must be achieved for the proposed artifact to be transformed into a fully functioning business model. A main insight being that the business model must provide adequate information on how the betting process is to be completed, what the technology is, and how the fees are structured in order to gain trust with users. In addition, the flow upon entering the site must be easily understood by users. This alludes to the fact that users must be able to effortlessly navigate through the solution to execute bets and find the information they are seeking. Furthermore, to entice a larger base of users to the solution, additional sports will need to be available to place bets on. This will add a layer of complexity to the concept. However, the foundational information and flow will be in place to accommodate more sports. Finally, the social aspect of the solution should be incorporated and also given significant focus and functionality. As the social dimension is not currently associated with online betting, enabling this capability helps to bolster the novelty associated with the solution. Ultimately, the iterative process sheds light on the foundational requirements (i.e. the need for information, a clear flow, a variety of sports and social opportunities) that users feel are necessary to be fulfilled by the solution.

Overall, the combination of secondary and primary research reveals that it is feasible to use the blockchain paired with smart contracts to develop an alternative business model for the online betting industry. This has been accomplished by applying the design science research approach to address the current gap in the facilitation of peer-to-peer betting on the blockchain. Adapting this approach has allowed us to arrive at a series of the necessary requirements needed to launch a functional business model. Our research sets the stage for further exploration into the potential that the combination of blockchain and smart contract technologies offers.

## Limitations

Throughout this thesis, we have written several limitations amongst these are the following. As the timespan of this thesis, is limited we have restricted the research to span over three iterations of the design cycle. The legally binding aspect of smart contracts. We will not go into the discussion of 'know your customer' and anti-money laundry transparency, which the blockchain offers to establish.

### *Full functional front end*

In this thesis, we will not develop a fully functional frontend to interact with the blockchain and the smart contracts. This is due to several reasons:

In order to deploy and interact with a smart contract the users will have to use the command line. To interact with the command line would require a frontend to be able to execute bash scripts locally.

If the frontend were, a web application written in HTML this would be impossible to use in practice. Imagine if a webpage were able to run a 'format c:' command on your local machine. The security risks of visiting an unknown webpage would undermine the way we use the internet today.

We could develop the frontend as an application running on the user's machine locally and executing bash scripts to interact with the blockchain. However, the amount of programming needed for this would not be feasible with the timeframe of this thesis.

### *Crypto-currencies as a valid currency*

How interesting it might seem to investigate how the bitcoin and other crypto-currencies have the potential to disrupt our current monetary system and create a new world without the banks being in control (Vigna, 2015). In addition, we will not be looking at the way bitcoins value fluctuates, and the risk of investing in bitcoins.

In this thesis, we will only look at the Bitcoin network and the underlying blockchain from a technical perspective in order to describe how our smart contract framework will function.

## Further research

### *How to realize the artifact*

We have justified our artifacts underlying functionality with the Ethereum blockchain intends to work. We have also clarified how the smart contracts would enable our users to bet against each other. The apparent next step, for further research would be how to develop and implement our artifact on the Ethereum blockchain. The process of creating a browser-based solution that can execute smart contracts on behalf of the user could lead to some interesting findings.

In writing moment, the Ethereum foundation is working on a project called 'Mist' that aims to easy the use and accessibility of smart contract applications. This project could be a vigorous element in the process of realizing our artifact[18].

### *Network controlled betting*

A suggestion we got from several of the evaluators was more sports and different types of bets. An interesting way to implement this could be utilizing the autonomous way, a blockchain works. We could

[18] https://github.com/ethereum/mist/

implement this if we give full control to the network. By replacing the blockchain oracle with a voting system, users could add whatever bet they would like to gamble on. To settle a bet the network would simply vote on a winner, the same way as miners vote on a new block. The result with the highest volume of votes will be the result that the smart contract, uses to determine a winner. This perspective could however, be seen as complicated, if one untrustworthy user (or group of users) would control the majority of the network. However, the idea is in alignment of how a blockchain normally operates and the potential of eliminating intermediaries.

### *Using a private blockchain instead of Ethereum*

We have designed our artifact to run on the Ethereum blockchain. This comes with certain benefits but also the condition that all transactions comes with a fee to the miners. If we built the system on our own private blockchain, we could be the only one mining and thus collect all fees. This also gives the possibility to use our own currency instead of ethers. A currency we then would issue to our users with a rate we see fit. Doing this will expand the business model to also be a cryptocurrency exchange. Where we would be the sole operators. The increase in revenue is hard to estimate, but it definitely brings potential. This would though require some extensive marketing to around the product as well as an added need of trust to the company. The reason why we did not go with this approach for this thesis is also the fact that it does not align with our aim of decentralization.

### *The benefits of transparency*

The blockchain offers a high level of transparency. This we also highlights and utilizes in our research. While our use is limited, the transparency contains a yet to be explored potential. The increasing necessity for banks to comply with regulations that aims to increase the information about their customers and to prevent money laundering. Both regulations that requires extensive knowledge regarding the transaction their customers perform. Utilizing the blockchain technology to do bank transaction, will build all this information into the system. When the system runs on a distributed ledger, it is possible to track all transactions and identify the exact origin of a person's wealth.

This research could possible lead to immense cost-savings for banks worldwide. Investigating how to build a bank on a blockchain could potentially revolutionize the way we do online banking today.

### *Other industries*

In our research, we have mainly been focusing on how to evolve the online betting industry, but as we highlighted in our SWOT analysis, combining the blockchain technology with smart contracts creates a vast amount of possibilities. An example could be to run interest rate swaps on a blockchain. Swapping the interest rate from a fixed value in a smart contract to a variable one provided by a blockchain oracle or visa-versa for a certain period, is possible to program in a smart contract. Another example could be to pay rent over the blockchain, something people do every month. A smart contract would be able to take care of the payment and eventual changes that could occur over time.

However, the most potent area to extend our research to is 'the internet of things'. More and more appliances are connecting to the internet. Having an autonomous system that can control all these items can be potent. Imagine having a smart contract controlled refrigerator that automatically orders a new bottle of milk for you whenever you open the last one.

## Conclusion

This master thesis contributes several findings to the research gap by combining existing literature on the topics of smart contracts, blockchain technology, and the online betting industry's business model. Firstly, we contributed a large amount of knowledge to how smart contracts and the blockchain technology ties and functions together.

Secondly, we reviewed the online betting industry's business model. Based on this assessment, we outlined the criterion for an alternative business model. By taken this into consideration we had laid the groundwork for applying design science research to establish requirements for designing a solution.

Thirdly, through three iterations of the design cycle, we managed to develop and improve the alternative business model. The evaluations was used to prove the result of the design phase to be justifiable. Overall, the evaluators was excited about the solution, from which we can conclude that it is feasible to launch a full-scale business model.

This thesis was able to illustrate and clearly present a useful artifact and communicate findings through the evaluations of the design cycles. The alternative business model, which was established by design science research, offers a novel approach to the entire online betting industry. The nature of the design science research's iterative process sheds light on the foundational requirements, the key findings from the evaluations of these was discussed in the previous section. The evaluators emphasized having a clear flow and social opportunities. These we incorporated throughout the iterations of the design cycles, which led to the contribution to the relevance cycle. Through the contributions to the relevance cycle, we outlined a proposed approach for utilizing smart contracts and blockchain technology to build a business model. Nevertheless, the key improvements that the evaluators suggested needs to be implemented in a fully functional solution for this to idea to be feasible on a large scale.

Based on the findings presented through the discussion and this section, we can conclude that we fulfill the research goals and objectives that we sought to achieve in the introduction of this thesis.

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# Table of figures

# Appendix

## *Links to github*

Code for prototype:

https://github.com/Gilbro/Master-Thesis-Appendix-Stefan-Vind-and-Mark-Gilbro

Interviews:

https://github.com/Gilbro/Master-Thesis-Appendix-Stefan-Vind-and-Mark-Gilbro/tree/master/Interviews

## *Evaluation questions – Second iteration (First field test)*

Gender?

| Testperson | Answer |
|---|---|
| Tester #1 Anders Vind | Male |
| Tester #2 Kristin Pierce | Female |
| Tester #3 John Jacobsen | Male |
| Tester #4 Jan Jacobsen | Male |
| Tester #5 Kenneth Frederiksen | Male |

Have you tried betting online?

| Testperson | Answer |
|---|---|
| Tester #1 | Yes |
| Tester #2 | Yes |
| Tester #3 | No |
| Tester #4 | Yes |
| Tester #5 | Yes |

Before this, have you heard about bitcoin?

| Testperson | Answer |
|---|---|
| Tester #1 | Yes, bitcoin is a virtual currency. Beyond this, I do not know much about bitcoin. |
| Tester #2 | Yes, an up and coming alternate form of currency |
| Tester #3 | Yes, crypto currency, online valuta, decentralized from banks. Semi expert |
| Tester #4 | Yes, internet currency |
| Tester #5 | No. |

Have you heard about blockchain?

| Testperson | Answer |
|---|---|
| Tester #1 | No, the blockchain is unknown to me. |
| Tester #2 | A little bit |
| Tester #3 | Yes, I am writing my own thesis about so I know a lot about the blockchain technology |
| Tester #4 | Heard some from friends. Some centralization of bitcoin perhaps |
| Tester #5 | No. (after explanation) I have heard about this technology, this is some new technical stuff. |

Question #1:

How was the overall experience of the prototype?
Did you like it?
What in particular was good / bad?

| Testperson | Answer |
|---|---|
| Tester #1 | Concept could be fun. If there are enough people in there, I think it would remind me a lot of gambling and poker.<br><br>Good / Bad?<br>It would make sense to have a group where you could bet against each other, for example for the EM Qualification.<br><br>It is very great that you can make your own bets and set the odds.<br><br>Bad that it is not possible to bet on football, because of the complexity of having three potential outcomes instead of two. Would like option of betting on a result too. |
| Tester #2 | Simple format that makes sense.<br>Great with transparency<br>Great with flexibility<br>Great with low bookmaker margin<br>I think it needs more explanation on what an Ether is and what the exchange rate is.<br>The fundamentals of how the new technology works should be more outlined.<br>The wordings is not clear. Open for misinterpretations.<br>More clear headlines and hints should be considered to help people get started.<br>Odds from other bookies should not take so much space on the front page.<br>Entice people more to take actions. |
| Tester #3 | Simple. Relevant information seems to be there. Layout could be more user-friendly |

| | |
|---|---|
| Tester #4 | Good idea, I like how you are able to see what other people bet. This could potentially make betting experts irrelevant. I like the transparency this solution provides. I think this could make for a separate business idea. |
| Tester #5 | I like the idea, and I like the fact that you are betting against other people. It creates an alternative form of betting. If some people create wild bets, there is a good chance you can win some. |

Question #2

Do you primarily bet on sports online or in a store?

| Testperson | Answer |
|---|---|
| Tester #1 | Online. However, I have done it in stores too. |
| Tester #2 | Online when I do. |
| Tester #3 | Don't bet often |
| Tester #4 | Online |
| Tester #5 | Online, mainly on my phone using apps |

Question #3

Does the high percentage the bookmaker takes for setting odds, bother you? Why/why not?

| Testperson | Answer |
|---|---|
| Tester #1 | It is rather annoying every time that I bet, that the bookmakers take such a high rakeback. The more I can make on an average the better. |
| Tester #2 | As long as the site is secure then it is okay that they take a bigger percentage. |
| Tester #3 | It makes sense that they have to make money some way |
| Tester #4 | As long as I win, then it is fine. |
| Tester #5 | Have not thought about it before. Therefore, as long as I win then it does not matter. I choose my bookmaking site based on the reputation, but based on those I chose the one with the best odds. Although I am very loyal to the betting site I use. |

Question #4

What do you think of the lower percentage the facilitator takes compared to the bookmaker?

| Testperson | Answer |
|---|---|
| Tester #1 | Only so, it covers the cost, and will only be the provider of a system and facilitating the process. Commercials could pay the entire fee, and pay for facilities, risk and workers. |
| Tester #2 | It is attractive. However, the prototype does not seem convincing. Would need reputation to be attractive for the first time. |
| Tester #3 | The more I get the better. |
| Tester #4 | It seems weird that I do not get a 100% payout when I win. |
| Tester #5 | If I knew about it, I would like this. I would think it would appeal more to the customer. |

Question #5

Do you think it is fair to take a cut of 2% for facilitating the player vs. player betting?

| Testperson | Answer |
|---|---|
| Tester #1 | Yes, it is cheaper than other places. If I looked at this as a consumer, I would know it costs money to establish and maintain a system like this.<br><br>When you as I do to, are investing in stocks and the like, you would always take the option where the deposit are the lowest rate. |
| Tester #2 | Yeah, it is fair to take something. It would be odd to think it is free. If it was free then it would be more suspicious |
| Tester #3 | Yes |
| Tester #4 | Yes |
| Tester #5 | Yes, I do think this. Because I do not dislike that I pay this much now. |

Question #6

Do you find it attractive to set your own odds or take bets set by others? Why / why not?

| Testperson | Answer |
|---|---|
| Tester #1 | Yes, this could especially be interesting setting odds and bets that I think is fair. It is annoying when you are betting, and you feel like you do not get enough value for money. |
| Tester #2 | It is a really cool concept. Good with input from other bookies as a reference point. Good with odds from others to show trends. Fun to set own odds |
| Tester #3 | If I had the knowledge to do set the odds I would |
| Tester #4 | The idea seems interesting, but I would still prefer to have my bets created by a bookmaker. |
| Tester #5 | I think that the idea is good, and I like the idea that you have to play the market. However, it requires a different kind of thinking when betting.<br><br>I would like it if I could get suggested bets and odds from the site. |

Question #7

Would you trust a site like this?

| Testperson | Answer |
|---|---|
| Tester #1 | Yes, from what I have been told about the blockchain it sounds rather secure. I like the fact that you as a company are holding the money, for the bet to be executed correctly, so you do not have to trust that the persons is holding up his end of the deal. |
| Tester #2 | Not at first. However, if I got more clarity on the security and saw the site getting some traffic. |
| Tester #3 | Knows how the technology works, so would trust something like this as long as I could see the contracts that my bet is based on. |
| Tester #4 | Not sure. I would like to see it has all legal remarks from authorities before I trust a site like this, and I would await the system having more users before I would adapt to a concept like this. |
| Tester #5 | Yes, I think I would like a system like this. However, I would probably like to see other people using it before I would jump into it. |

Question #8

Is it important for you to know exactly whom you are betting against?

| Testperson | Answer |
|---|---|
| Tester #1 | I do not care. I would however feel it would be interesting to know which country the other person are from. This could be interesting as I find differences on where person are from, to how they would behave when betting. |
| Tester #2 | No. But it would be cool to see the nationality of who you are betting against |
| Tester #3 | Anonymity would be best. To keep an even ground all the way through. |
| Tester #4 | Either know exactly who it is or make it anonymous. Would consider using it to bet against friends. |
| Tester #5 | No, I do not care. It could be a problem for some, but I do not care.<br><br>Could be fun to play against friends in like the European cup, or in the champions league and have like a pool of winnings. |

Question #9

Any ideas / feedback on how to improve the site?

| Testperson | Answer |
|---|---|
| Tester #1 | 1. Layout<br>2. Rather simple layout, very simple system.<br>3. I did not doubt how this worked, very simple to maneuver.<br>4. Very customer friendly.<br>5. Betting against friends could be cool to do.<br>6. It is nice that you are not able to back out of a bet while using this system. |
| Tester #2 | More focus on the part that the user can control.<br>Different colors to separate what is info and what there should be focused on and call of actions.<br>More information on how it works and that you are betting against others and can set your own odds.<br>Twitter feed to update users on what others are thinking about the game. |
| Tester #3 | More transparency with the correct information. Show other odds more. |
| Tester #4 | Needs some technical and visual improvements. More transparency on the odds. |
| Tester #5 | More division on the page layout. I would like a logo, and a little lighter colors. In addition, different colors so the columns are not alike. More contrasts.<br><br>A guide to know about the system, and little more help for betting. On the betting part as well as the technical definitions of the prototype. |

### *Evaluation questions – for third iteration – second field test*

Question #1

*Do you have any experience prior to betting?*

| Testperson | Answer |
|---|---|
| Tester #1 Kristian | Huge. I have used it a lot. |
| Tester #2 Eski | Not a lot, but I have betted some on E-sport, and a little bit on football. However, not overly extensive the experience. |
| Tester #3 Kg | Everything, I tried a large amount of betting site. However, I mainly online sport, and in the kiosk, betting on everything of football and E-sport. |
| Tester #4 Tobias | CS:GO E-sport betting, and Dota E-sport betting, I do not really bet on football or anything. |
| Tester #5 Anders | I bet a lot, on sites like bet365. Primarily sportsbetting. |
| Tester #6 Kristin | Yes, some |
| Tester #7 Casper | I bet primarily on football, and tennis, hockey, basket. I bet on pretty much everything that I know about. I bet a lot, both online and in stores. Mainly online though. |
| Tester #8 Omid | A little store betting. Tried online once or tice |
| Tester #9 Kim | A lot of experience. Only on football and American football. |
| Tester #10 Jakob | Relatively good experience. I bet around a couple of times a month, very periodical. I bet on football, tennis and handball. |

Question #2

*Do you understand this concept? Regarding blockchain and smart contracts?*

| Testperson | Answer |
|---|---|
| Tester #1 | Yes |
| Tester #2 | Yes. |
| Tester #3 | Yes. |
| Tester #4 | Introduction given and now understand concept. |
| Tester #5 | Yes, I was part of the previous iteration |
| Tester #6 | Yes, I was part of the previous iteration |
| Tester #7 | Introduction given, and now understand concept fully. |
| Tester #8 | No |
| Tester #9 | Yes |
| Tester #10 | I understand it after the explanation. |

Question #3

*How was the experience?*

| Testperson | Answer |
|---|---|
| Tester #1 | I like the idea. Reminds me a bit of dota 2 lounge. It seems quite fun, that you can bet directly against your friends. It is a brilliant idea. You will get to go without bookmakers. |
| Tester #2 | I like the new stuff. When the bitcoin came, I read about a lot about it. I like newcomers like Uber and stuff. In addition, the entire deal about Peer-2-peer is great, and I like this idea where things can be automated a lot more. I like the fact that you can now facilitate it. I think many people, inclusive myself; can be a little afraid about these crypto currencies. There goes a lot of work into this. I would like this to be with normal money, then this in my mind would be better.<br>I have trouble about understanding where this goes, but I am seeing the volumes going up. But I like this idea, it is great, I like the concept of peer-2-peer betting. I can't see why there should be a middleman, it annoys me when there is a middle man. I think people are tired of the bookmakers, also I do think about people who gambles a lot, would easily transition to this. They would be reluctant to change their betting style, because this would change their ecosystem. |
| Tester #3 | Tutorial, like a youtube video would be a good idea, to explain the concept.<br>Step-by-step explanation with pictures maybe?<br><br>It is nicer colors, and I like the green part. I like the design way more, and the smoothness this provides.<br><br>It is hard to misinterpret what you are supposed to do in the different sections of the site. That way I think it is user friendly. |
| Tester #4 | It is nice overview when you come into the site. You might need some information, on the players.<br><br>*Sees the bets by other site*<br><br>Sees the average odds by others, so now it looks simple to what to do.<br><br>I like the idea, that it the same idea of betting against others like ingame of CS:GO (Counter Strike: Go).<br><br>I like the idea, because it gives the feel that you are betting against others, and not through a 3rd party. |
| Tester #5 | It has gotten a lot better, there is multiple things, and even so it has a better overview. |

| | |
|---|---|
| | I think it is a bit weird you have a separate page for the "about blockchain", it should just go under "about betcoin".<br><br>I like the friend's part. Would enjoy having a text function or maybe a full functional chat with friends. Could make the entire platform a social project. |
| Tester #6 | Very smooth, and clear on how to use it. Simple to interact with. |
| Tester #7 | It is exciting, because it is a different form of betting than you are used to. I like the fact that you have to make your own odds. I like the peer-2-peer aspect. |
| Tester #8 | It is fun. I think it should have been here already. |
| Tester #9 | Fun Idea. I like the fact you can play against your friends.<br>Betfair offers something like this, where you can play other, where you buy odds and stuff. |
| Tester #10 | I like the idea. It is a little the same from as the Unibet solution from a user's perspective. It is a bit like concept. I think it is good with the time, all the money laundering. In addition, the fact that you do not provide the odds and just facilitate it. |

Question #4

*Do you like the idea of peer-2-peer betting?*

| Testperson | Answer |
|---|---|
| Tester #1 | I do not know how it works in practice. I just saw the bets by others; I like the fact that you can see others.<br>Q: Would this even be possible though?<br>A: Yes, you can see an example of it on bold.dk, they show the top 5 odds.<br><br>You could put this into the part where you create bets. |
| Tester #2 | Yes, I like the idea. I love the idea of peer-to-peer betting, and I think it is brilliant how you can facilitate the process on the internet. |
| Tester #3 | Yes, I really like the idea. In addition, when you added a friendslist, it gives a community feel to it all. It is easy to bet against your friends. I Like that. |
| Tester #4 | |
| Tester #5 | I like it, it is a little bit like the last time, I would repeat my answer, I like this from the consumer point of view. I think it is a great and fun improvement to bet against friends on this.<br><br>It is important to know that it is legally allowed to use this page. |
| Tester #6 | Yeah definitely. Especially with the implementation of the friends list to make it more social.<br>Peer-2-peer and the notion settings is great |
| Tester #7 | I like the peer-2-peer aspect. However, I do not like to bet against friends. About the aspect of losing a large amount of money to a friend, is not something I would like. In addition, I play for a lot. I could see myself playing on this |
| Tester #8 | I do not care so much about betting. However, I think this could be fun, and people who don't like the central. I like the social aspect, maybe you could make it more social and competitive |
| Tester #9 | I like this; I want to beat Sebastian |
| Tester #10 | I like the idea.<br>I do like the idea about the friends betting, but the question is that there should be something about the average bookie odds. |

Question #5

*What would you suggest for improvements?*

| Testperson | Answer |
|---|---|
| Tester #1 | I would at least give it a chance. Just to see how it was. First hand, impression is very important, so everything has to work from the beginning. As user-friendly as possible.<br>Bet365 is very good on this. I like that. |
| Tester #2 | Improvements must be something like the colors. It is very easy to understand the site. The usability is very good, no questions. I do think you would have to be able to filtrate the games and such when more games come in.<br><br>Get some video stream on the page, to do get some information and start doing e-sports, because it would be interesting to integrate all these things.<br><br>Add links to Facebook profiles, google users, and so on. People like to connect everything, and would make you more apparent.<br><br>I like the part where you can see others bets and this would be cool to see.<br><br>I have very easy with myself going in and taking a bet, but I do have trouble with me setting a bet.<br><br>I like that you have little points, about bets made by others. |
| Tester #3 | Overall – there should be some customer service, support function on the site.<br>I cannot really think of something, that the solution needs. |
| Tester #4 | Do so you have live-updates of the match, so you can follow the match process. It would make sense if you play on a match, I would like to get the information on the site.<br><br>I do not see what else is missing. Could you bet on a bookie? – Yes if the bookmaker makes a user on the site.<br><br>Does not necessarily needs to be on the solution, but a link to the league or a place where you can see the game, just to help people create bets. |

| | |
|---|---|
| Tester #5 | Possibilities of interaction with other users would be great.<br><br>It would not make me nervous for people to know who I am. I would be sitting and watching bicycling, and then be able to talk with people about the bet's we could establish with each other.<br>For me this would be like poker, you have a username there too. |
| Tester #6 | Improve the implementation of bookmaker's odds and other betters odds and make it more clear what your friends are doing. It's good that it's there but it should be more visible and more distinguished on what is what |
| Tester #7 | I think there needs more games, and more sports that are different. |
| Tester #8 | I think it would be great to see you wallet on every page. There should be an explaining about the odds system, because you are playing with money. |
| Tester #9 | Back button would be very nice. |
| Tester #10 | Nice design. A bit more bet options. You can pretty much bet on anything. |

Question #6

*Would you use a solution like this?*

| Testperson | Answer |
|---|---|
| Tester #1 | It is very green. Green writing on green background make everything a little bigger. I do not see the point in the top three. |
| Tester #2 | I could see myself using this site, easily. However, I think I would mainly use the bets created by others. I would rather do Peer-2-Peer than having a bookmaker as an intermediary. |
| Tester #3 | Yes, I could see myself using this solution. I think the idea is, I do not want to say fun, but good. You are a little more on your own. |
| Tester #4 | I link to think I would use this, but you could do it so you bet "skins" from a game.<br><br>The problem I see with Ethereum and bitcoins, it seems as something criminal.<br><br>I do not think I would use traditional betting with money, because this is. |
| Tester #5 | Yes, I would like to do this. Like my answer last time. |

| | |
|---|---|
| Tester #6 | Yeah. It gives some abilities that other sites do not. But with more sports and friends on it would be even better |
| Tester #7 | With a high volume of customers, I think I could see myself using this. I do not see the point if I am alone. |

Question #7

*Does the high percentage the bookmaker takes for setting odds, bother you? Why/why not?*

| Testperson | Answer |
|---|---|
| Tester #1 | If the page is working it would be great. However, if it is slow and such, the more establish companies will be used. |
| Tester #2 | Yea that bothers me, they are pigs, worse than the banks.<br><br>Q: How much do they take?<br>A: 5-10 percent.<br><br>Then taken 2% is very generous. |
| Tester #3 | Answered this last time |
| Tester #4 | It is a part of the game, and the way they make money. I would think that the sites which provides live-streaming of the game, would take an extra percentage, because of the extra they give it. |
| Tester #5 | -.- |
| Tester #6 | -.- |
| Tester #7 | It is not something that crosses my mind. That is just how it is. When I am in the kiosk playing on dogs. |
| Tester #8 | I think I would use this as much as anything else. If I am in a social setting, it could be interesting |
| Tester #9 | I do not think I would use it as serious betting, but as a social perspective, it would be fun. |

Question #8

*Improvements, etc?*

| Testperson | Answer |
|---|---|
| Tester #1 | -- |
| Tester #2 | Usability is fine, the layout is okay. But the fact of seeing the wallet might be a game changer. A tutorial could be nice.<br>Establish to the user why this is a good idea. |

| | |
|---|---|
| Tester #3 | It has gotten better since the last iteration. I think that is good. Design perspective, it could be more smooth looking. And I know it is a prototype, and I think it could use a nice hand. But again, you have to start somewhere and then improve. |
| Tester #4 | It is not so exciting to look at, but I get the idea of it not taking focus of the functionality.<br>I would like a smoother look and feel to it.<br><br>I like the idea to bet against my friends, that seems fun.<br><br>I like that I can see the odds of others, you want to see people make a bad odds for themselves so you can profit. |
| Tester #5 | It is great overview, but could use a professional touch on the layout. Also, it could be great to have an app. |
| Tester #6 | Good amount of information but not too much that you looses the overview. The betting flow is intuitive and have the right level of complexity for users.<br>Having additional information improves the security feeling of the site. |
| Tester #7 | Very simple, it needs to be simple, and easy to understand. It needs to be easy to navigate around bets and so forth. |
| Tester #8 | Looks poor in design. The flow and overview is very easy to understand. |
| Tester #9 | Something that doesn't look like windows 98. |
| Tester #10 | The layout could use a nice handyman. I like the flow, and the overview. |

Question #9

*Do you think it is fair to take a cut of 2% for facilitating the player vs. player betting?*

| Testperson | Answer |
|---|---|
| Tester #1 | Yea, how else should this work without adds. |
| Tester #2 | This is very generous then. |
| Tester #3 | Answered this last time. |
| Tester #4 | I like the less you can use, so that is positive in my mind. I think most would think the less the better, equals more profit for yourself. |
| Tester #5 | -.- |
| Tester #6 | -.- |
| Tester #7 | I do not think that is fair. I made the odds. |
| Tester #8 | I didn't know companies had that much profit. But I think 2% sounds fair. People who does not like the system, would think this to be fair. |
| Tester #9 | I do not think |
| Tester #10 | A fair solution with only 2%. |

Question #10

*Do you find it attractive to set your own odds or take bets set by others? Why / why not?*

| Testperson | Answer |
|---|---|
| Tester #1 | It seems fun. I haven't tried it, but you should maybe make suggestions on how much to bet. |
| Tester #2 | Yes, I like this a lot. I would like the betting to be also microbetting, and it is just a question of the volume. Make it more of a platform where you can bet on everything. In addition, maybe bet against others on a stadium around you. |
| Tester #3 | Did answer this last time |
| Tester #4 | Not personally, but I see it is a fun thing for people who bet a lot. Because you avoid the bookie, and it by that is not a pre-created bet. |
| Tester #5 | -.- |
| Tester #6 | -.- |
| Tester #7 | I like that idea. |

Question #11

*Would you trust a site like this?*

| Testperson | Answer |
|---|---|
| Tester #1 | Yes |
| Tester #2 | Yes, I think so. However, I do feel the need research about the solution first, before actually knowing what I agreed to. Because blockchain is transparency. |
| Tester #3 | Maybe a support function would help. In addition, having and showing all the law agreements is in order. |
| Tester #4 | I think the systemic functionality is good, I would like to know a bit more, and I can get some information on the site. I think it is smart that you can get information on this. |
| Tester #5 | -.- |
| Tester #6 | -.- |
| Tester #7 | Not at a first glance. I would have to have heard about from others. I am not a first mover. |
| Tester #8 | |
| Tester #9 | |

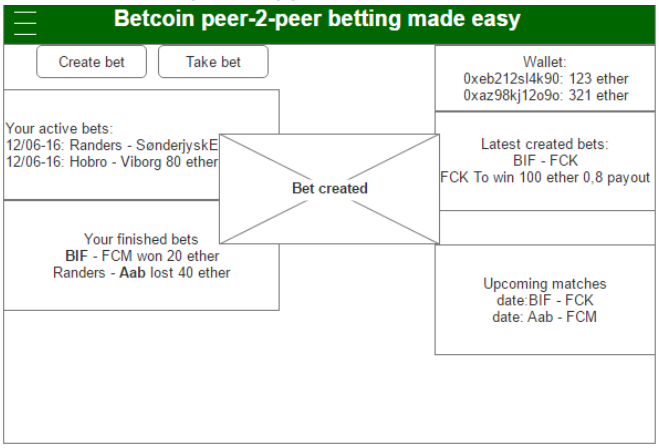
Question #12

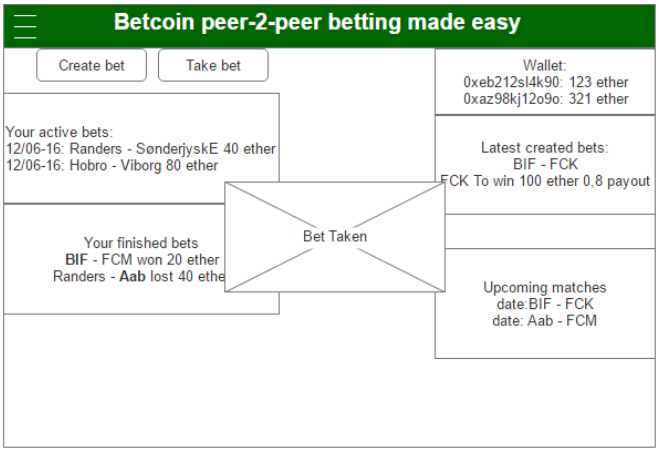
*Is it important for you to know exactly who you are betting against?*

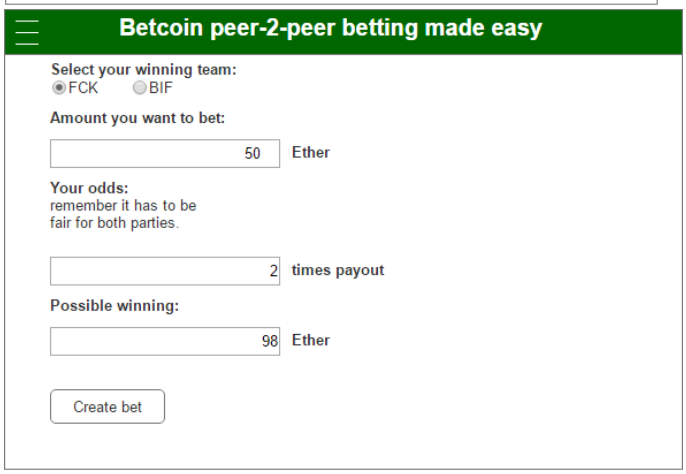
| Testperson | Answer |
|---|---|
| Tester #1 | I would like to do know if my friends takes my bets. But if it's random I do not care. Name and country is fine, then I could always go steal money from some swedes. |
| Tester #2 | No, not to know who I bet against, but a usecase could be one where you could see people near you to bet against, like on the same stadium. Because, when talking about P2P betting and betting, and making it a social event could be a great idea. |
| Tester #3 | I like this new function a lot. Then I can see average bets, I can see other people's bets, and I can see how this is, makes me know I am not getting tricked. Seeing other betting sites grouping of bets, makes it easy for me to spot if I should choose a traditional betting model. |
| Tester #4 | No, I do not think it is important to know whom I am betting. |
| Tester #5 | -.- |
| Tester #6 | -.- |
| Tester #7 | No, not on the surface. Then, it depends on the bet a bit. Let us assume it is one from Algeria, and if the |

| | |
|---|---|
| | person were not from there, I would not bet on that game. There is a large amount of match fixing. |
| Tester #8 | |
| Tester #9 | |

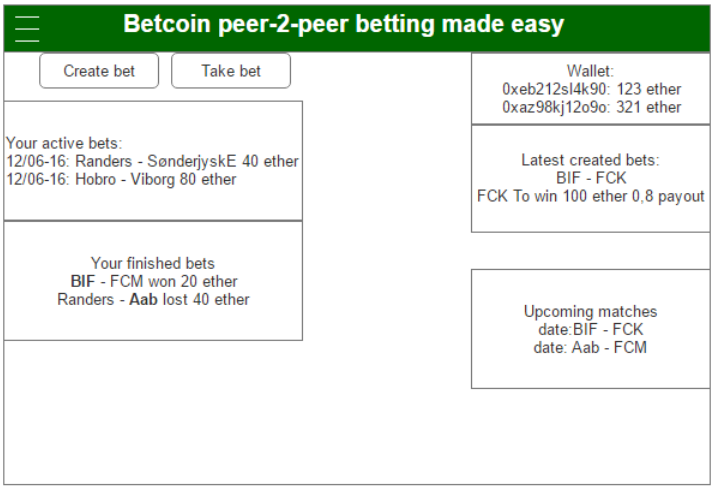
## *First iteration prototype*



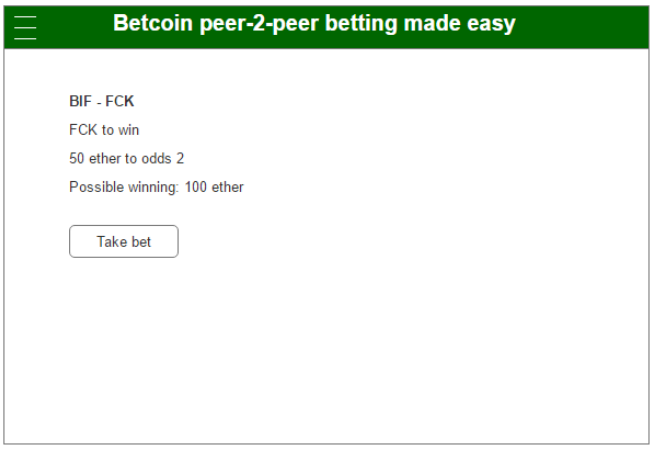




Betcoin peer-2-peer betting made easy
Today
BIF -FCK
Randers - SønderjyskE
Aab - FCM
Create bet on match
See already created bets on match
27/06-16
Hobro - Viborg
Team 3 - Team 4
Team 1 - Team 2

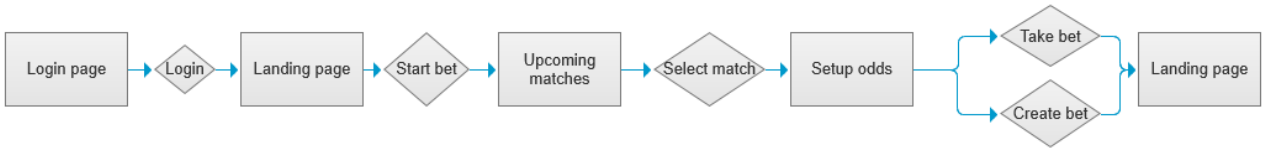

Betcoin peer-2-peer betting made easy
Create bet
Take bet
Wallet:
0xeb212sl4k90: 123 ether
0xaz98kj12o9o: 321 ether
Your active bets:
12/06-16: Randers - SønderjyskE 40 ether
12/06-16: Hobro - Viborg 80 ether
Latest created bets:
BIF - FCK
FCK To win 100 ether 0,8 payout
Your finished bets
BIF - FCM won 20 ether
Randers - Aab lost 40 ether
Upcoming matches
date:BIF - FCK
date: Aab - FCM


Betcoin peer-2-peer betting made easy
Username
Password
Login


Betcoin peer-2-peer betting made easy
BIF - FCK
FCK to win
50 ether to odds 2
Possible winning: 100 ether
Take bet

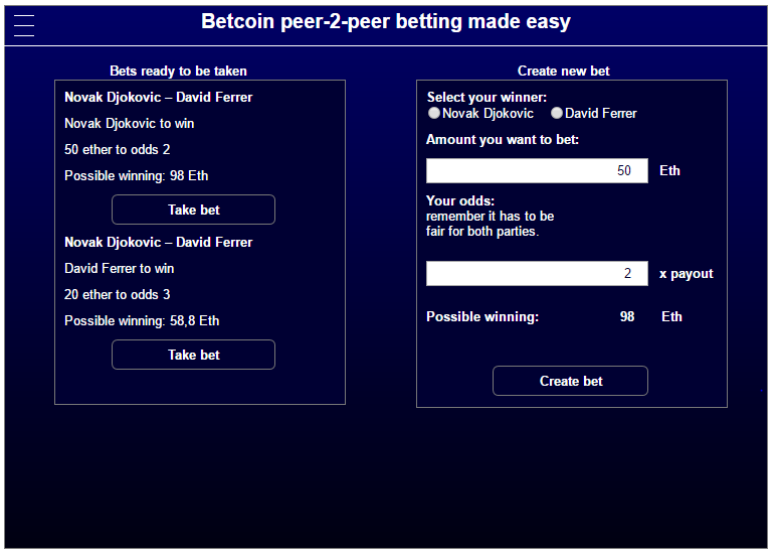

Betcoin peer-2-peer betting made easy
Today
BIF -FCK
Randers - SønderjyskE
Aab - FCM
27/06-16
Hobro - Viborg
Team 3 - Team 4
Team 1 - Team 2

## *Second Iteration prototype*

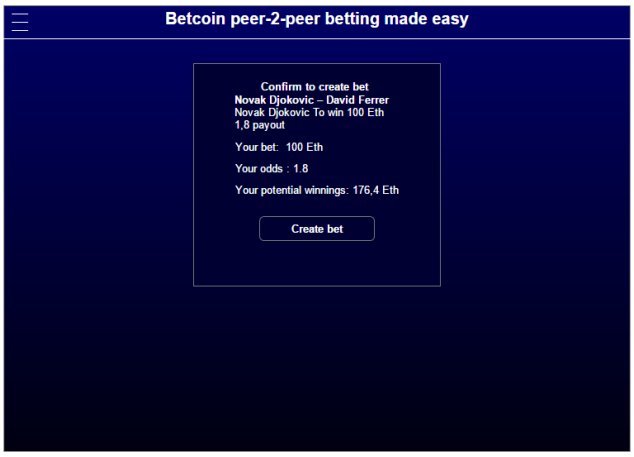




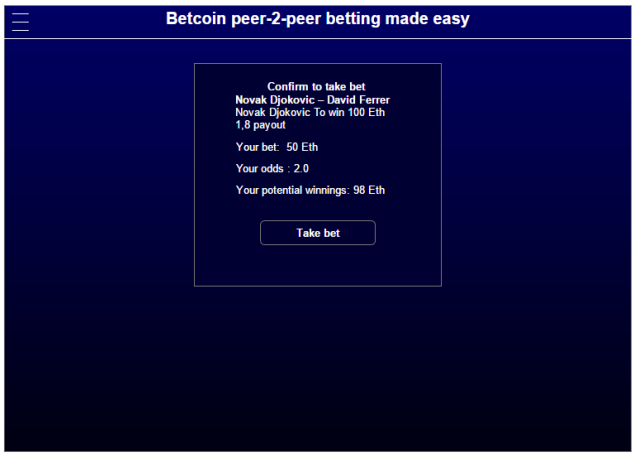

Betcoin peer-2-peer betting made easy
BIF - FCK
FCK to win
50 ether to odds 2
Possible winning: 100 ether
Take bet


Betcoin peer-2-peer betting made easy
Bets ready to be taken
Novak Djokovic – David Ferrer
Novak Djokovic to win
50 ether to odds 2
Possible winning: 98 Eth
Take bet
Novak Djokovic – David Ferrer
David Ferrer to win
20 ether to odds 3
Possible winning: 58,8 Eth
Take bet
Create new bet
Select your winner:
Novak Djokovic
David Ferrer
Amount you want to bet:
50
Eth
Your odds:
remember it has to be
fair for both parties.
2
x payout
Possible winning:
98
Eth
Create bet

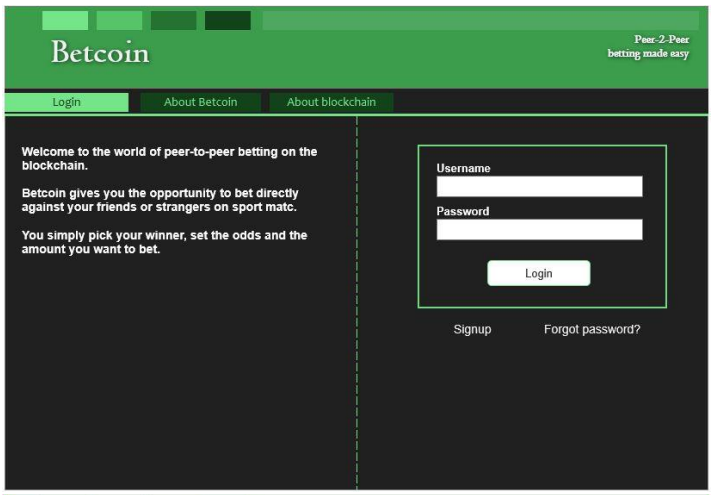

Betcoin peer-2-peer betting made easy
Click on a game to start betting on it
Here you can see all games that are ready for you to bet on.
To start betting you can*:
• Choose a game to bet on and create your own bet.
• Select a game to see all bets created on the game.
• Select from the most recently created bets if you see something interesting.
• All created bets that are not taken by and opponent will be cancelled and you will get all ethers back to your wallet.
*All payouts will be deducted a 2% fee for maintaining the system
Upcoming games
29.05: Novak Djokovic – David Ferrer
29.05: Andy Murray – Jo-Wilfried Tsonga
29.05: Roger Federer – Kei Nishikori
29.05: Stan Wawrinka – Rafael Nadal
29.05: Serena Williams – Roberta Vinci
29.05: Agnieszka Radwanska – Petra Kvitova
Bets created by others, ready to be taken or for your inspiration
Newly created bets:
Novak Djokovic – David Ferrer
David Ferrer To win 50 Eth 5 payout
Serena Williams – Roberta Vinci
Serena Williams To win 100 Eth 1,8 payout
Andy Murray – Jo-Wilfried Tsonga
Andy Murray To win 60 Eth 1,2 payout

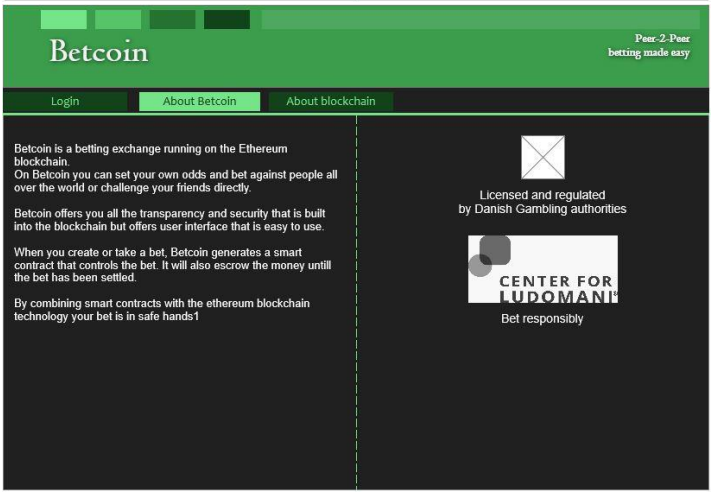

Betcoin peer-2-peer betting made easy
Confirm to create bet
Novak Djokovic – David Ferrer
Novak Djokovic To win 100 Eth
1,8 payout
Your bet: 100 Eth
Your odds : 1.8
Your potential winnings: 176,4 Eth
Create bet

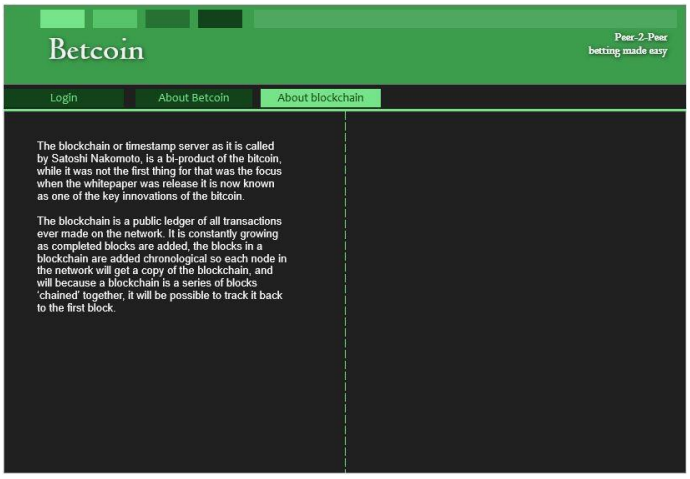

Betcoin peer-2-peer betting made easy
Confirm to take bet
Novak Djokovic – David Ferrer
David Ferrer To win 20 Eth 3
payout
Your bet: 20 Eth
Your odds : 3.0
Your potential winnings: 58,8 Eth
Take bet

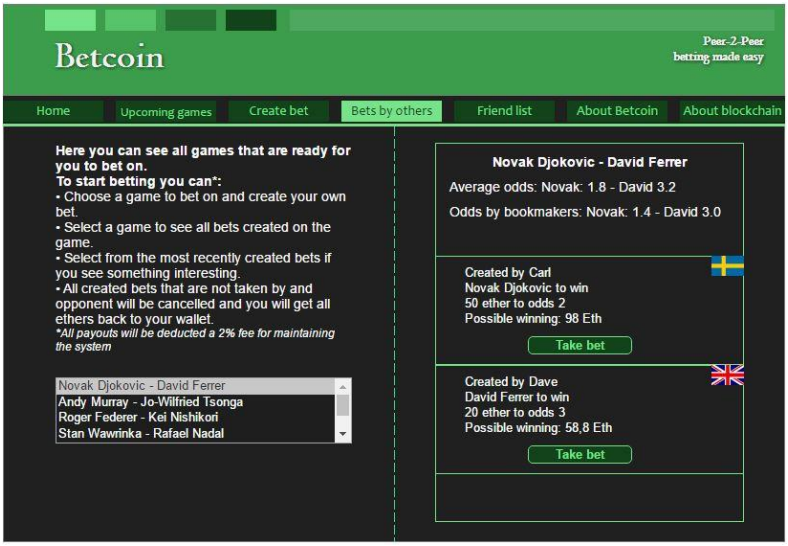

Betcoin peer-2-peer betting made easy
Confirm to take bet
Novak Djokovic – David Ferrer
Novak Djokovic To win 100 Eth
1,8 payout
Your bet: 50 Eth
Your odds : 2.0
Your potential winnings: 98 Eth
Take bet

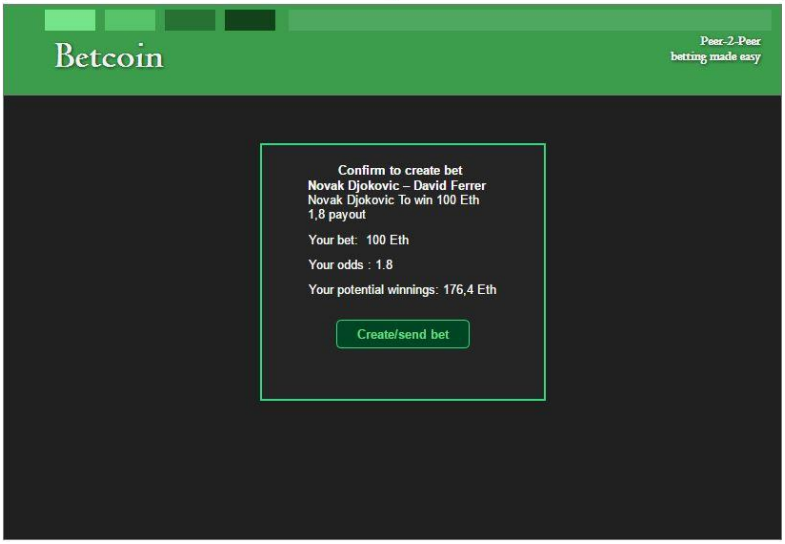
## *Third iteration prototype*

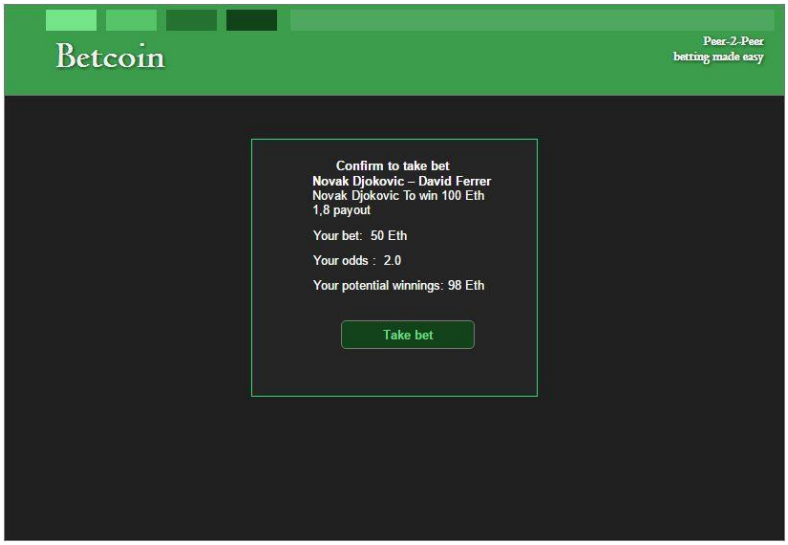


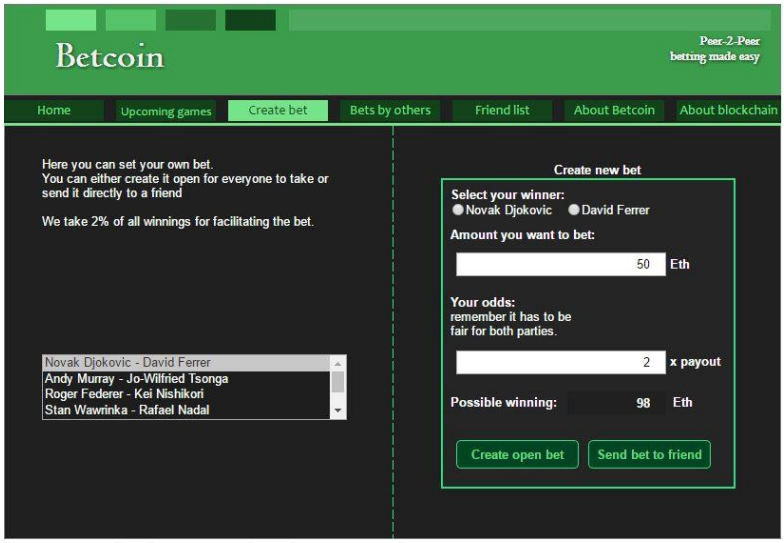



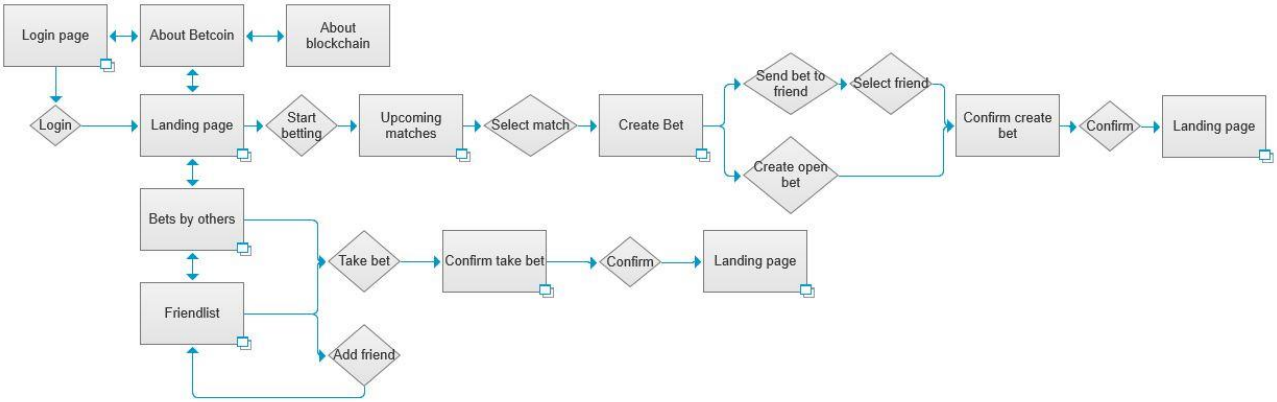



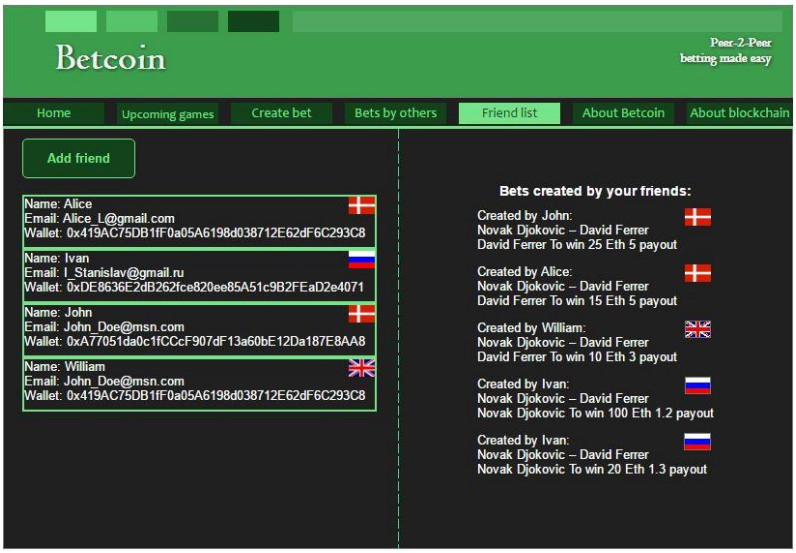

Betcoin
Peer-2-Peer
betting made easy
Home
Upcoming games
Create bet
Bets by others
Friend list
About Betcoin
About blockchain
Here you can see all games that are ready for you to bet on.
To start betting you can*:
• Choose a game to bet on and create your own bet.
• Select a game to see all bets created on the game.
• Select from the most recently created bets if you see something interesting.
• All created bets that are not taken by and opponent will be cancelled and you will get all ethers back to your wallet.
*All payouts will be deducted a 2% fee for maintaining the system
Novak Djokovic - David Ferrer
Andy Murray - Jo-Wilfried Tsonga
Roger Federer - Kei Nishikori
Stan Wawrinka - Rafael Nadal
Novak Djokovic - David Ferrer
Average odds: Novak: 1.8 - David 3.2
Odds by bookmakers: Novak: 1.4 - David 3.0
Created by Carl
Novak Djokovic to win
50 ether to odds 2
Possible winning: 98 Eth
Take bet
Created by Dave
David Ferrer to win
20 ether to odds 3
Possible winning: 58,8 Eth
Take bet

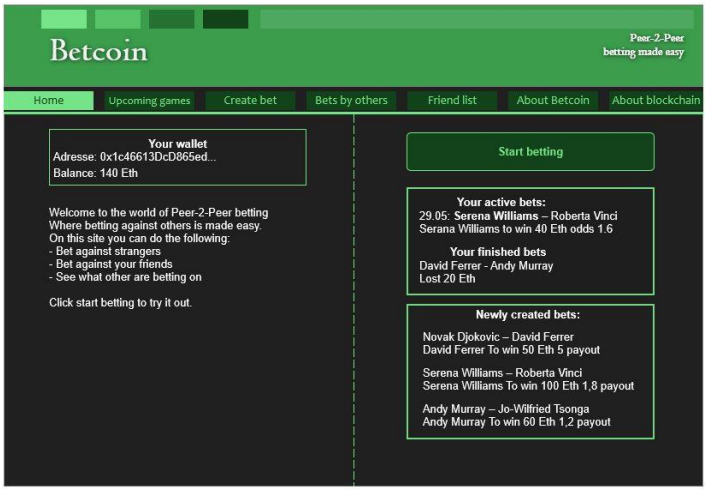

Betcoin
Peer-2-Peer
betting made easy
Confirm to create bet
Novak Djokovic – David Ferrer
Novak Djokovic To win 100 Eth
1,8 payout
Your bet: 100 Eth
Your odds : 1.8
Your potential winnings: 176,4 Eth
Create/send bet

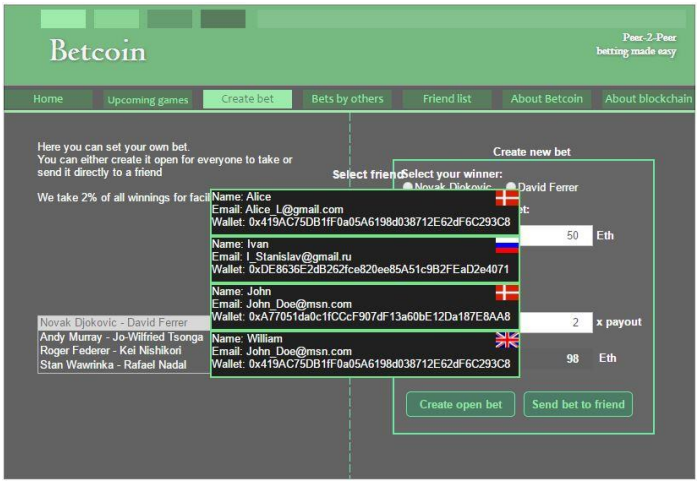

Betcoin
Peer-2-Peer
betting made easy
Confirm to take bet
Novak Djokovic – David Ferrer
Novak Djokovic To win 100 Eth
1,8 payout
Your bet: 50 Eth
Your odds : 2.0
Your potential winnings: 98 Eth
Take bet


Betcoin
Peer-2-Peer
betting made easy
Home
Upcoming games
Create bet
Bets by others
Friend list
About Betcoin
About blockchain
Here you can set your own bet.
You can either create it open for everyone to take or send it directly to a friend
We take 2% of all winnings for facilitating the bet.
Novak Djokovic - David Ferrer
Andy Murray - Jo-Wilfried Tsonga
Roger Federer - Kei Nishikori
Stan Wawrinka - Rafael Nadal
Create new bet
Select your winner:
Novak Djokovic
David Ferrer
Amount you want to bet:
50
Eth
Your odds:
remember it has to be fair for both parties.
2
x payout
Possible winning:
98
Eth
Create open bet
Send bet to friend


Login page
About Betcoin
About blockchain
Login
Landing page
Start betting
Upcoming matches
Select match
Create Bet
Send bet to friend
Select friend
Create open bet
Confirm create bet
Confirm
Landing page
Bets by others
Take bet
Confirm take bet
Confirm
Landing page
Friendlist
Add friend


Betcoin
Peer-2-Peer
betting made easy
Home
Upcoming games
Create bet
Bets by others
Friend list
About Betcoin
About blockchain
Add friend
Name: Alice
Email: Alice_L@gmail.com
Wallet: 0x419AC75DB1fF0a05A6198d038712E62dF6C293C8
Name: Ivan
Email: I_Stanislav@gmail.ru
Wallet: 0xDE8636E2dB262fce820ee85A51c9B2FEaD2e4071
Name: John
Email: John_Doe@msn.com
Wallet: 0xA77051da0c1fCCcF907dF13a60bE12Da187E8AA8
Name: William
Email: John_Doe@msn.com
Wallet: 0x419AC75DB1fF0a05A6198d038712E62dF6C293C8
Bets created by your friends:
Created by John:
Novak Djokovic – David Ferrer
David Ferrer To win 25 Eth 5 payout
Created by Alice:
Novak Djokovic – David Ferrer
David Ferrer To win 15 Eth 5 payout
Created by William:
Novak Djokovic – David Ferrer
David Ferrer To win 10 Eth 3 payout
Created by Ivan:
Novak Djokovic – David Ferrer
Novak Djokovic To win 100 Eth 1.2 payout
Created by Ivan:
Novak Djokovic – David Ferrer
Novak Djokovic To win 20 Eth 1.3 payout


Betcoin
Peer-2-Peer
betting made easy
Home
Upcoming games
Create bet
Bets by others
Friend list
About Betcoin
About blockchain
Your wallet
Adresse: 0x1c46613DcD865ed...
Balance: 140 Eth
Welcome to the world of Peer-2-Peer betting
Where betting against others is made easy.
On this site you can do the following:
- Bet against strangers
- Bet against your friends
- See what other are betting on
Click start betting to try it out.
Start betting
Your active bets:
29.05: Serena Williams – Roberta Vinci
Serana Williams to win 40 Eth odds 1.6
Your finished bets
David Ferrer - Andy Murray
Lost 20 Eth
Newly created bets:
Novak Djokovic – David Ferrer
David Ferrer To win 50 Eth 5 payout
Serena Williams – Roberta Vinci
Serena Williams To win 100 Eth 1,8 payout
Andy Murray – Jo-Wilfried Tsonga
Andy Murray To win 60 Eth 1,2 payout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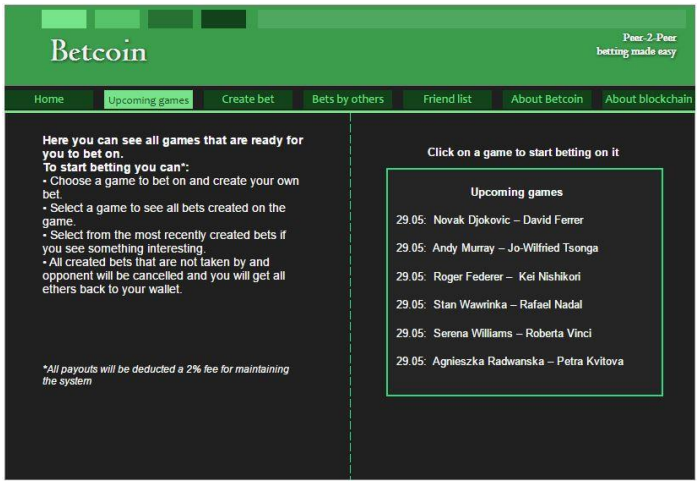
Create bet
Bets by others
Friend list
About Betcoin
About blockchain
Here you can set your own bet.
You can either create it open for everyone to take or
send it directly to a friend
We take 2% of all winnings for facil
Select friend
Name: Alice
Email: Alice_L@gmail.com
Wallet: 0x419AC75DB1fF0a05A6198d038712E62dF6C293C8
Name: Ivan
Email: I_Stanislav@gmail.ru
Wallet: 0xDE8636E2dB262fce820ee85A51c9B2FEaD2e4071
Name: John
Email: John_Doe@msn.com
Wallet: 0xA77051da0c1fCCcF907dF13a60bE12Da187E8AA8
Name: William
Email: John_Doe@msn.com
Wallet: 0x419AC75DB1fF0a05A6198d038712E62dF6C293C8
Create new bet
Select your winner:
David Ferrer
50
Eth
Novak Djokovic - David Ferrer
Andy Murray - Jo-Wilfried Tsonga
Roger Federer - Kei Nishikori
Stan Wawrinka - Rafael Nadal
2
x payout
98
Eth
Create open bet
Send bet to friend


Betcoin
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betting made easy
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Upcoming games
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Friend list
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you to bet on.
To start betting you can*:
• Choose a game to bet on and create your own
bet.
• Select a game to see all bets created on the
game.
• Select from the most recently created bets if
you see something interesting.
• All created bets that are not taken by and
opponent will be cancelled and you will get all
ethers back to your wallet.
*All payouts will be deducted a 2% fee for maintaining
the system
Click on a game to start betting on it
Upcoming games
29.05: Novak Djokovic – David Ferrer
29.05: Andy Murray – Jo-Wilfried Tsonga
29.05: Roger Federer – Kei Nishikori
29.05: Stan Wawrinka – Rafael Nadal
29.05: Serena Williams – Roberta Vinci
29.05: Agnieszka Radwanska – Petra Kvitova

### *Idi contract*

Idi contract written in Solidity taken from a template by Eris Industries (ErisIndustries, Eris Industries, 2016):

Idi.sol

```
contract IdiSmartContract{
  uint storedData;

  function set(uint x) {
    storedData = x;
  }

  function get() constant returns (uint retVal) {
    return storedData;
  }
}
```

### *App.JS*

App.JS JavaScript used to interact with the Idi smart contract on the blockchain. Taken from template by Eris Industries (ErisIndustries, Eris Industries, 2016):

```
// requires

var fs = require ('fs');

var prompt = require('prompt');

var erisC = require('eris-contracts');


// NOTE. On Windows/OSX do not use localhost. find the

// url of your chain with:

// docer-machine ls

// and find the docker machine name you are using (usually default or eris).

var erisdbURL = "http://localhost:1337/rpc";


// get the abi and deployed data squared away

var contractData = require('./epm.json');

var idisContractAddress = contractData["deployStorageK"];

var idisAbi = JSON.parse(fs.readFileSync("./abi/" + idisContractAddress));


// properly instantiate the contract objects manager using the erisdb URL

// and the account data (which is a temporary hack)

var accountData = require('./account.json');

var contractsManager = erisC.newContractManagerDev(erisdbURL, accountData);


// properly instantiate the contract objects using the abi and address

var idisContract = contractsManager.newContractFactory(idisAbi).at(idisContractAddress);


// display the current value of idi's contract by calling

// the `get` function of idi's contract

function getValue(callback) {
```

```
  idisContract.get(function(error, result){
    if (error) { throw error }
    console.log("Idi's number is:\t\t\t" + result['c'][0]);
    callback();
  });
}

// prompt the user to change the value of idi's contract
function changeValue() {
  prompt.message = "What number should Idi make it?";
  prompt.delimiter = "\t";
  prompt.start();
  prompt.get(['value'], function (error, result) {
    if (error) { throw error }
    setValue(result.value)
  });
}

// using eris-contracts call the `set` function of idi's
// contract using the value which was recieved from the
// changeValue prompt
function setValue(value) {
  idisContract.set(value, function(error, result){
    if (error) { throw error }
    getValue(function(){});
  });
}

// run
getValue(changeValue);
```