MASTER

Successfully launching a Blockchain SSI application for career credentials

the insights for the development of an SSI employee onboarding application for the financial sector identified by assessing the value of the application from a customer-centred and service dominant perspective

Pašalić, S.

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TU/e faculty:	Industrial Engineering & Innovation Sciences
University Supervisors:	Murat Firat (1st) & Baris Ozkan (2nd)
Third Assessor:	Alexia Athanasopoulou
Graduate program:	M. Sc. Innovation Management
Track:	Managing Innovation Processes
Bank department:	Blockchain Team
Author:	Sanir Pašalić (Student number: 0820961)

Preface

Thank you for reading this report. I wrote this in cooperating with the Rabobank, at the Blockchain team, for which I am grateful. The choices we make in life, truly decide our path. And my path has had some interesting and sometimes weird jumps. For me, this thesis is the final chapter of a long, educational and very interesting period in my life.

I started this phase wanting to do "something technical", without having that defined for myself all that much. Throughout my years doing industrial engineering in Eindhoven I gradually learned about technology, innovation and business and the possibilities they offer to have a positive impact in the world. It's a path that I decided to follow throughout many projects, side-businesses and jobs.

My decision that my educational journey wouldn't be over after my bachelors' degree, my decision to go back after two years of working and doing business, changed the course of my path. Somehow, through chance, I ended up working at the Rabobank, while enrolled in my masters Innovation Management, which I wasn't even sure I would go back to enrol in. I am happy that I did, because I met amazing people along the way, got in contact with many companies, corporates, SME's and start-ups and worked with them in various ways. I met many people that helped me to learn and to grow, and to seize amazing opportunities I wouldn't have had, had I followed the standard and familiar route through university and early employment.

My time in the Rabobank has been an exceptionally valuable one. I got the chance to experience the internal processes, the way-of-working and the culture at one of the largest corporates of the Netherlands and apply my knowledge and earlier experiences to positive outcomes. And through my time there I had the opportunity to meet the amazing people of the Blockchain Acceleration Lab, where I would end up doing my master's thesis research. The cutting-edge developments that this team works on have been interesting and educational in many ways. And I am grateful that I had the opportunity to do my research on Self-Sovereign Identity, innovation adoption and business models in this department, as I feel I somehow contributed to the development of a new field of business and technology. Maybe the effect won't be seen right away, but maybe in a little while, or maybe not at all. Either way, it's been a valuable experience that I look fondly back on.

The process of writing this thesis has arguably been long, intense and challenging at times, with even a pivot on the topic at one point. But with the support of the people around me, I have brought this thesis to its' end successfully and I look forward to the opportunities that lay in the future.

Enjoy the read!

Acknowledgements

There are many people that helped me during my time at the Rabobank, during the writing of this thesis.

I would like to thank my wife, Nerma, for supporting me, for always having my back, and for generally being awesome.

I would like to thank my supervisors Murat Firat and Baris Ozkan for advising me and giving me the critical feedback and ideas to move my research forward. I would also like to thank Alexia Athanasopoulou for acting as my third assessor and taking time to critically read this work.

I would like to thank the entire Blockchain Acceleration Lab team at the Rabobank for their help in my research, comradery, department drinks and general good time. And especially my bank mentor Djuri Baars, for his advice, feedback and friendship.

And finally, I would like to thank all the other professionals who offered their help, input and support in any way, shape or form.

Management summary

This report was done with the goal to research the adoption of the relatively young field of SSI applications, so as to create a better understanding of what would make it a commercial success, and what would deter from that success. The incentive for this research manifested after a literature review on the self-sovereign identity. It became clear during the search for sources that literature on self-sovereign identity as a concept was limited in general, and research pertaining to self-sovereign identity in a business context, or adoption context, even more so.

The performed research was primarily qualitative in nature. Due to the newness of the topics and concepts surrounding SSI, there isn't much quantitative data to collect. Therefore, interviews were used as one of the main methods to gather information. The interviews were done specifically with industry experts who were in some way involved in digital identity or self-sovereign identity projects. The goal of the interviews was to measure the industry's views on adoption of SSI, market readiness, demand and other aspects which may be relevant. The interviews were intentionally semi-structured, so as to steer the conversation somewhat, yet allow for free flow of speech. The transcripts of the interviews were then labelled and coded.

These labels for the interviews were based on elements identified in literature as being relevant or playing a role in SSI adoption (commercial) success or failure. Therefore, the labels were made based on an academic literature review on the topics of innovation adoption, diffusion, acceptance, market readiness, user interface design, business models and service dominant business models. By basing the labels on literature, the elements could be validated and quantified in the interviews to see what aspects the industry holds as most important.

The labels are seen in the Table M.1 below.

Concept/construct/factor	Label	Source theory
Optimism	*OPT*	DIT
Innovativeness	*INN*	DIT
Discomfort	*DIS*	DIT
Insecurity	*INS*	DIT
Technology Readiness	*TR*	DIT
Task Characteristics	*TKC*	TTF
Technology Characteristics	*THC*	TTF
Task-Technology Fit	*TTF*	TTF
Performance Impacts	*PI*	TTF
Utilization	*UTI*	TTF
Attitude (Towards Use of Object))	*ATT*	TRA / TAM / TAM2 / TAM3
Belief	*BEL*	TRA
Behaviour	*BEH*	TRA
Subjective Norms	*SN*	TPB / DTPB
Perceived Behavioural Control	*PBC*	TPB / DTPB
Perceived Usefulness	*PCU*	TPB / DTPB / TAM / TAM2 / TAM 3
Perceived Ease of Use	*PEU*	TPB / DTPB / TAM / TAM2 / TAM 3
Compatibility	*COM*	DTPB
Intention to Use	*IU*	TAM / TAM2 / TAM3
Actual Usage	*AU*	TAM / TAM2 / TAM3
Image	*IMG*	TAM2 / TAM3
Job Relevance	*JR*	TAM2 / TAM3
Output Quality	*OQ*	TAM2 / TAM3
Result Demonstrability	*RD*	TAM2 / TAM3
Computer Self-efficacy	*CSE*	TAM3
Perceptions of External Control	*PEC*	TAM3
Computer Anxiety	*CA*	TAM3
Computer Playfulness	*CP*	TAM3
Perceived Enjoyment	*PE*	TAM3
Objective Usability	*OU*	TAM3
Performance Expectancy	*PE*	UTAUT
Effort Expectancy	*EE*	UTAUT
Social Influence	*SI*	UTAUT
Facilitation Conditions	*FC*	UTAUT
Voluntariness	*VOL*	UTAUT
Perceived Risk	*PR*	n/a
User Interface Design	*UID*	n/a
Market Readiness	*MR*	n/a

Technology Readiness	*TR*	n/a
Demand Readiness	*DR*	n/a
Technology push	*TP*	n/a
Market pull	*MP*	n/a

Table M.1

The transcripts were then coded using these labels. The labels were scored, and a weight was added to some of them, depending on the reported importance of a certain element by an expert. The final scores can be seen in the Table M.2 below.

Labels	Final Score
PR	**22**
DRL	**21**
PEU	**21**
TP	**19**
FC	**18**
INS	**16**
MR	**13**
MP	**12**
COM	**11**
PU	**9**
RD	**9**
SI	**9**
SN	**9**
ATT	**9**
TR	**6**
THC	**6**
DIS	**6**
EE	**6**
INN	**5**
VOL	**5**
TRL	**4**
PBC	**4**
UID	**4**
BEL	**3**
PEC	**3**
OQ	**3**
GL	**2**
IU	**2**
OPT	**2**
TTF	**2**
IMG	**1**
NE	**1**
OU	**1**
TKC	**1**
AU	**0**
BEH	**0**
CA	**0**
CP	**0**
CSE	**0**
JR	**0**
PCU	**0**
PI	**0**
UTI	**0**

Table M.2.

Using a common cut-off method of using the mean of all the scores, and adding and subtracting 2x the standard deviation, the top scores were isolated, which left the four highest scoring elements. These were:

- **PR**: *Perceived Risk* (Score: 22)
- **DRL**: *Demand Readiness Level* (Score: 21)
- **PEU**: *Perceived Ease of Use* (Score: 21)
- **TP**: *Technology Push* (Score: 19)

Perceived Risk is understood as the potential risk a person perceives for use of a product, service or provider. *Demand Readiness Level* is the degree of expression of need by a customer on a given market. *Perceived Ease of Use* is defined as the degree to which a person believes an innovation is easy to use. And *Technology Push* is defined as the case of a producer or service provider first creating a product without an explicit need by the market beforehand.

Technology Push and Demand Readiness Level are related in that there was a broad consensus among industry experts that there is no knowledge, and therefore almost no demand for SSI among consumers, and thus the Demand Readiness Level is low. The general answer of the industry experts was to use a technology push approach. I.e. develop the technology, present it into the market and buyers will follow. Perceived ease of use on the other hand, although an important aspect in product design, may be considered a given nowadays for commercial success of any product or service. Therefore, it was chosen that it wouldn't be relevant in this research report.

The results of the cross-reference analysis showed that Perceived Risk was the most important one element. Topics that were often mentioned by the experts with regards to risk as playing a large role for SSI were privacy, security, control over one's own data and consent. Also, the question of who a trusted third party would be in an SSI ecosystem, i.e. who would be trusted with data and credentials. The literature study and additional desk research yielded a model which would fit into the self-sovereign identity context well, as well as offer a possible solution to some of the problems described by the experts.

The model that was found is the Service Dominant Business Model Radar, or SDBM/R. The SDBM/R template shows promise of being a good fit with self-sovereign identity applications due to its foundation in Service Dominant thinking. The SDBM/R acts as a non-instantiated template, which, when filled in, becomes a blueprint for a business model. Some of the tenants of Service Dominant logic focus on value co-creation in actor ecosystems and the payment for services instead of products. Due to the inherent ecosystem dependent aspects of blockchain based applications and the proven ecosystem dependent SSI innovation projects at the organisation, the model lends itself quite well to the situation. It is meant to give an initial high-level overview of all actors, their added value to the ecosystem, their cost and benefits and high-level activities they would need to perform. This gets all actors on the same page early in the process, and creates buy-in, an synchronizes communication before moving on to a more detailed working out of the cooperation and business models. It generates a business model blueprint for some co-created value-in-use for a specific customer segment. The original model is shown in Figure M.1.

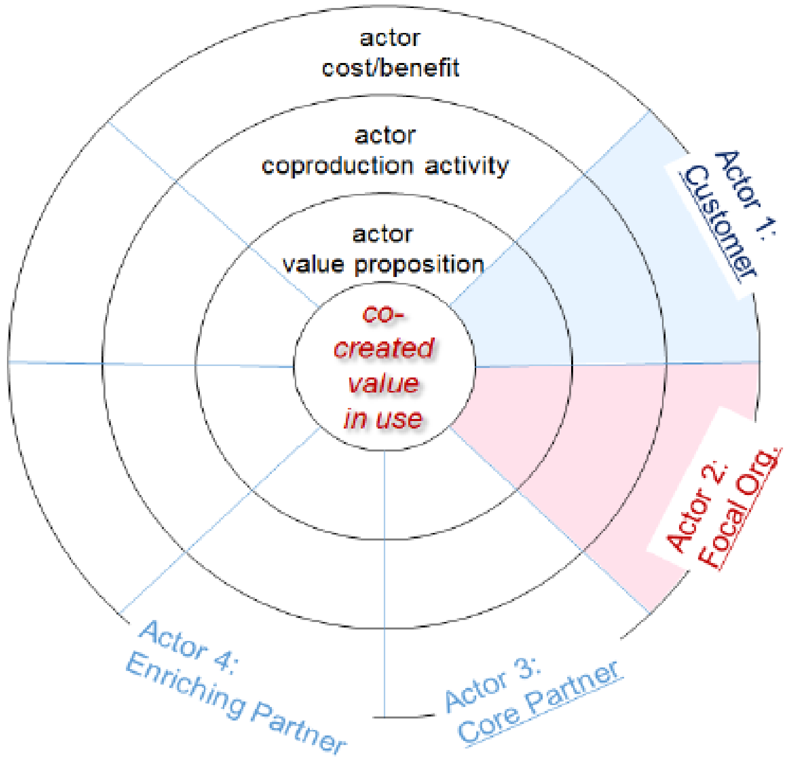

Figure M.1.

An additional special function of SDBM/R is the fact that it invites the customer at the table at the same initial moment, early in the process. This pre-empts potentially working on something that the customer doesn't need or want, and instead requires them to actively take part in the mapping of the SDBM/R. The treatment of the customer as involved in value co-creation in this manner is another cornerstone of the Service Dominant logic.

Even though the model shows promise in its original form, the research showed that perceived risk was paramount in the context of self-sovereign identity. Risk was isn't incorporated into the original SDBM/R template yet. So, before the model was to be applied into a bank example, the template was extended with a risk ring as to include relevant aspects of risk, hence include risk concerns in model development.

Based on literature on the topic or risk, the term Perceived Risk Event (PRE) and Risk Response Action (RRA) are defined. Firstly, actors in the early stages of cooperation see risks, or perceived risk events (PRE). It is valuable to generate early awareness of these risk and share this in the ecosystem with other actors, so as to make others aware. In addition, actors can start thinking of ways to counter these risks when they come up, or risk response actions (RRA). PRE and RRA can be mapped at micro, meso and macro levels, which is something which is done after the PRE is written down. This can aid in better understanding the scale, and thus implications of a PRE. Furthermore, the PRE can be held by individual actors, or by the collective of all actors. And an RRA can be performed by one individual actor or by the collective of actors together. This understanding yielded the PRE/RRA matrix, shown in Figure M.2. below.

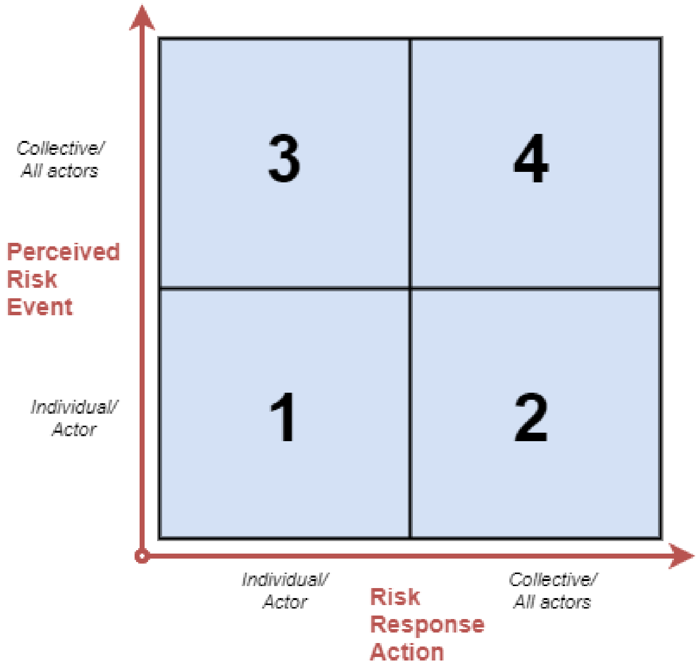

Figure M.2.

The PRE/RRA matrix was used to generate model variants for the mSDBM/R. The four main variants were based on the four field sin the PRE/RRA matrix. Because the SDBM/R is mapped in a group with multiple actors, thede mSDBM/R is proposed as a modification to the original SDMB/R, with the incorporation of PRE and RRA. The variants were validated with experts at organisation, who were asked to evaluate and score the models based on their usefulness and usability for the context of blockchain SSI applications. The winning model could be placed in the bottom left corner of the matrix, with Individual/Actor PRE and Individual/Actor RRA. This allowed for more granularity, e.g. mapping of risks and response actions on an individual level. And, if then multiple or all actors had the same PRE, it could be said that it is a collective PRE. The selected mSDBM/R is seen below.

Figure M.3.

The mSDBM/R was then applied to a real-life case at organisation to test its general usability and validate the addition of risk to the original SDBM/R. A workshop was organized for a blockchain SSI career credentials application, which is a wallet application that holds CV credentials which can be used for fast onboarding, reducing onboarding times from up-to a month, to a day. This would prevent loss of talent by applicants leaving, decrease administration cost and generally optimize all processes surrounding onboarding. As such the co-created value-in-use for this workshop was chosen to be "Onboarding in 1 day", and the customer was chosen to be the applicant. The filled in model can be seen in Figure M.4. below.

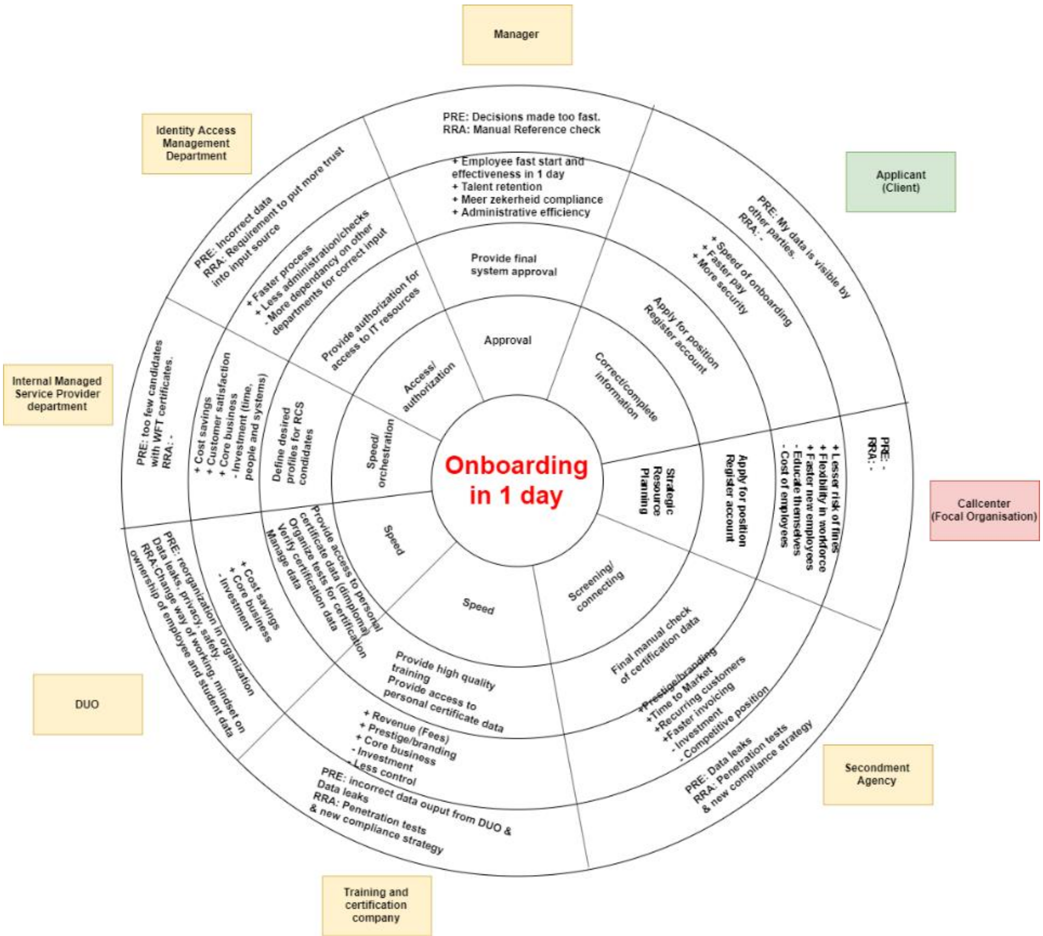

Figure M.4.

The results of the workshop showed that:

- *A lot of actors are required to make one value-in-use possible. The workshop also made attendees aware that some actors were missing and would need to ideally be added.*
- *Filling in the 'actor value proposition' and 'actor co-production activity' made clear to the participants that they all have different (but important) roles.*
- *A "technology push" approach could come with some risks for adoption, as pushing the innovation by some of the required actors, while others withhold, would not have the effect of successful and valuable implementation of the application.*
- *Early communication between departments also showed to be a useful addition.*
- *Early awareness of risks and what can be done about them was generated.*
- *Some PRE were mapped without accompanying RRA. If these risks remain present in the minds of actors, they could adversely affect adoption in the future. This however does show that the addition of risk in the model has led to early awareness of risk with actors in the*

ecosystem and can therefore positively affect adoption in the long-run, if actors communicate and act upon perceived risks in the ecosystem.

- *Instead of ad hoc, back-and-forth, unsynchronized communication between actors, where information can be missed, important expectations can be overlooked, and actor buy-in can be forgotten, The SDBM/R workshop can help to synchronize communication in the early stages of ecosystem dependent innovation, first getting all parties on board with the high-level view of the ecosystem, responsibilities, added values and risks, before moving further to detailed working out of the business models. This is shown Figure M.5.*

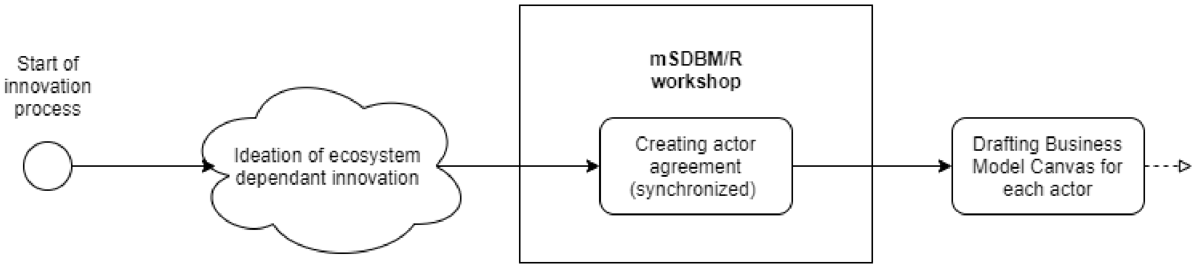

Figure M.5.

Based on all the previous information of this chapter, the following recommendations are offered:

- *For successful adoption of an innovation, time and energy should be invested as early as possible on the question of adoption.*
- *Successful business models increase adoption rate and success. Incorporate business and service-dominant thinking early in the process of innovation.*
- *Ecosystem-dependent innovations require a lot of actors to make them successful. Incorporate mechanisms to get all these actors around the table as early as possible to map their added value, risks, activities and other useful information, so they can agree on the bigger picture before moving onto detailed plans. The SDBM/R seems like useful tool for this.*
- *Perceived Risk plays an important role in the success of an innovation. Especially for blockchain SSI applications. Presumably this is the case for all heavily ecosystem dependent, and IT related innovations. Address risk as soon as possible and offer actors with worries potential solutions to their perceived risks. The mSDBM/R might useful in this regard.*

Recommendation to examine Chapters 5 through 7 detail the process which generated the output as described above.

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Abbreviations

- **BBSA** – Blockchain Based SSI Application
- **CRM** – Claim Registry Model
- **DIMS** – Decentralized Identity Management System
- **DIT** – Diffusion of Innovation
- **IRM** – Identity Registry Model
- **MSP** – Managed Service Provider
- **PUE** – Perceived Ease of Use
- **PU** – Perceived Usefulness
- **PR** – Perceived Risk
- **PRE** – Perceived Risk Event
- **RRA** – Risk Response Action
- **SSI** – Self-Sovereign Identity
- **TAM** – Technology Acceptance Model
- **TPB** – Theory of Planned Behaviour
- **TRA** – Theory of Reasonable Action
- **TR** – Technology Readiness
- **TTF** – Theory of Task-technology Fit
- **TTP** – Trusted Third Party
- **UTAUT** – Unified Theory of Acceptance and Use of Technology

1. Introduction

Developing a new innovation is one thing, however creating a sustainable business model and getting customers to actually use the product is another. Part of the development of a successful business model is achieving adoption and actual utilization. Without this the intended society-wide advantages of the new product will not fully materialize, because for any innovation, the user's acceptance is going to be a major determining factor for its success in the market (Aldhaban, Daim and Harmon, 2015). Understanding the adoption processes and potential usages of said innovation will allow for a better eventual alignment with the market.

Because of the importance of adoption, much (general) research has focused on examining different elements that are relevant. Many different theories have been developed to (try to) explain how the adoption process works (Lai, 2017). Different theories have focused on different aspects. For example, some theories focus on the characteristics of the users, the beliefs and attitudes they hold and what the role is of certain benefits and risk they might see on whether they will use the product or technology (Lai, 2017). Other theories focus more on the product itself, for example whether the technology that has been developed fits the task the user is trying to accomplish and how ready-to-use (and/or easy to use) the developed technology is (Lai, 2017). For different innovations, different elements may be important.

This thesis focusses on a new technology that is already far in development but has not been introduced to the public yet: a blockchain-based Self-Sovereign Identity (SSI). In essence, SSI is the concept in which individuals fully own and manage their digital identity (Mühle, Grüner, Gayvoronskaya and Meinel; 2018). The Sovrin Foundation grouped the underlying principles of SSI in three categories: security, controllability and portability (Mühle et al., 2018). Security being the protection of the personal data and providing only the minimum data required in application. Controllability are the functions that allow the users to control what happens to their data, and for instance provide consent for the use of said data. Finally, portability means that the identity of a user must be useable wherever they want and must be independent of identity providers (such as Google or Facebook or the government). Up until recently however, the full implementation of SSI as described has been technologically impossible or infeasible to fully implement. However, Blockchain technology for the first time offers a method to develop a technological solution to fully implement SSI with all its principles. Therefore, blockchain SSI could play an important role in the difficulties and challenges the current identification ecosystem is facing (Lim et al., 2018).

Blockchain-based SSI seems to have future potential, and businesses worldwide have started experimenting with various prototypes already (Mühle et al., 2018; Sovrin, 2016; bank, 2019). For example, a prototype that is currently being developed is a prototype for employee onboarding. This application allows a safe and fast way to check the credentials and documentation of potential new employees, saving both the employer and potential employee time as they do not have to handle all the involved paperwork themselves each time they switch jobs, as they can take their full credentials with them.

One thing that becomes clear when examining the literature is that relatively little knowledge exists on the topic of SSI, including scientific examinations of its market validation and adoption aspects. Appendix A shows that the number of sources relative to the other search topics in the table presented in the Appendix is significantly lower. This means that even though the applications of SSI are coming closer, relatively little scientific research is available. The scientific research that is available, is not related to market validation and adoption aspects. This can partially be explained by the fact that innovations in the field of SSI primarily are performed by private ventures or independent working groups, which leads to documentation not being very scientific or acting as primarily advertisement for the project (Mühle et al.,2018). The scientific usefulness of the produced documentation for the aforementioned SSI applications is therefore limited, which means that there is potentially a missing foundation on which to build further scientific research in SSI and its application.

Therefore, this thesis aims to give insights in the relevant elements with regards to adoption that need to be considered when wanting to launch a blockchain SSI application in the market. It defines success- and failure factors that need to be taken into consideration when a technology leader in this field plans on bringing a blockchain SSI application to the market and to end-users. Besides the scientific relevance, this thesis also has the aim to enlarge the knowledge of developers of SSI prototypes.

1.1. Research questions

The research question of this thesis is:

"Which success factors, failure factors, or other relevant elements for market and business success should be emphasized when developing an SSI application from a customer-centred and service dominant perspective?"

To answer the above main research question, several sub-questions have been constructed:

1. What aspects and dimensions of innovation adoption, diffusion and acceptance are revealed to be relevant for an SSI application based on a scientific literature review?
2. What believes about adoption of an SSI application do experts from the industry hold, based on their coded answers from an in-depth semi-structured interview?
3. What elements can be corroborated between the scientific literature review and the semi-structured expert interviews by performing a cross-reference analysis?
4. What insights can be derived from the application of a service dominant business model in a workshop setting, modified based on the input from the cross-reference analysis, to develop a blueprint for a business model for SSI applications?

Chapter two will describe the methods that will be used to answer the research questions. Following this, chapter three will provide some relevant technical background information with regards to Blockchain and SSI. This will help to gain better understanding of the technology itself for reference later in the document. In chapter four an academic literature review will be performed to describe the different existing theories on innovation adoption, diffusion and acceptance, as well as business models, market readiness and risk. This will result in a table in chapter five with different elements that are relevant to adoption, diffusion and acceptance according to current scientific literature and an answer to research question number one. In chapter five the expert interviews will be described and the results from the interviews will be coded and reported to provide an answer to research question number two. To answer research question number 3, chapter seven describes a modified service dominant model that can help create a business model for the blockchain SSI career credentials. This model will be derived from the results from the literature review and experts). In chapter seven this model will be applied to the case of the blockchain SSI application for career credentials, answering question number 4. Finally, chapters eight and nine will report the overall conclusions and recommendations for future research.

1.2. Goal of this document

This document serves several purposes. First, it acts as a proof of the required level of knowledge and skill of the author to receive a master's degree in Innovation Management. As such, it presents the method and research done at the bank in researching a relatively new field, Self-Sovereign Identity (SSI), and the application of the same into a real-life environment.

Furthermore, due to the newness of the topic of SSI, the work performed to make this document possible adds to the, as of yet, limited knowledge of the topic of SSI.

Next, it should help to add some additional perspective for industry in general, and the bank specifically on the topic of ecosystem dependent innovations, such as blockchain SSI applications. As such, this document also aims to offer some value as documentation and proof for business model generation in the case of ecosystem dependent, service dominant business propositions. That is, innovations that require many actors to cooperate to establish some value for an end-user.

This chapter provided an overarching introduction to this document, and presented the research questions to be answered, tied to the research protocol. The goal of this document was also briefly discussed. In the following chapter, the research methods that will be used to obtain the information required to answer the described research questions are described in more detail.

2. Methods used for research and answering of the research questions

This chapter describes the methods that have been used to answer the main research question and sub-questions. It will describe in more detail the literature review, the way in which the expert interviews were prepared and done, the different analyses, and how the case study was conducted. The outline research protocol can be found in Appendix B.

2.1. Literature review

First, the literature review was performed to obtain insights on the topics of Self-Sovereign Identity, blockchain, innovation adoption and diffusion, market readiness and user experience. In Appendix A the initial Literature Keyword Search Table can be found.

From the literature review, several characteristics, dimensions, types, called "elements" in an overarching fashion in this document, were extracted. These elements were relevant for the general field of SSI, and SSI software applications pertaining to technology acceptance, innovation adoption, perceived risk and market readiness. The elements were summarized in a table, this table will be presented and explained in chapter five, the Synthesis.

2.2. Expert interviews

Because little research focusses on the application of the characteristics from the first paragraph to specifically SSI applications, a number of experts from the industry were interviewed to determine which factors and characteristics are considered important for the adoption of specifically SSI applications.

The experts were chosen in cooperation with the organisation. All experts are currently involved with projects related to digital identity or SSI. Experts from five different organisations were selected, with each organisation focusing on a different digital identity application or project. The organisations include financial institutions, a research institution and a governmental organisation. This was done to ensure that expertise from different fields could be combined.

The interview protocol was developed based on the results from the literature review (the table as described in section 2.1). The protocol was constructed to be a semi-structured interview. All questions were 'open' questions to ensure that the answers given were as elaborate as possible, so that valuable or latent information could be extracted from the answers later in the process through coding and labelling the transcripts. An example of a question is: 'What do you think would be the main reasons for somebody to use, and not use, an SSI solution?'. The full interview protocol can be found in Appendix C.

For all experts, the same interview protocol was used to ensure that the data from the interviews could be compared. As mentioned before, to ensure that the interviews could be analysed appropriately, all the interviews were recorded and transcribed verbatim. After this, the interviews were coded, to assess which elements mentioned in the literature are also seen as most relevant by the experts when it comes to the development of an SSI application. The coding involved the labelling of pieces of text which were related to the table of relevant elements from the literature review. The number of mentions of certain elements in the transcripts of the interviews were then recorded. I.e., if an element from literature is "Perceived Ease of Use", then the label might be "PEU", and a mention of this in the transcripts results in one additional point for the label "PEU" towards its final score. Furthermore, a *weight designation* is assigned to each mention of a label. The weight designation is based on perceived importance. The weight designations are: **--**, **-**, **+-**, **+** and **++**. This weight is assigned according to a qualitative assessment and interpretation of the experts' words. The weight designations modify occurrence, and thus final score, of a label upwards or downwards.

One drawback of this methodology is the fact that the mention of certain aspects as being important, or the occurrence of certain aspects at all, is fully self-reported by the experts, whose words are labelled and weighed according to the interpretation of the researcher. This potentially leaves room for error and for different individuals labelling and weighing the same transcripts differently. However, such qualitative research methods of recording, transcribing, coding, labelling and weighing are well-established among researchers (Gorden, 1992; Keller, 2017; Nijkamp and Van Delft, 1977; Scriven and Davidson, 2000; Voogd, 1983), so they will suffice for this document as well.

Following the establishment of the final scores per element, several high-scoring labelled elements are selected to further examine for the application in the context of SSI adoption. For this, a cut-off score is necessary as it is not feasible to examine all elements further in this thesis, the method used here is the Mean + 2SD method (Singh, 2006). In addition, it adds much needed focus, which is necessary for the following step, the case study.

2.3. Case study

In cooperation with the organisation, a blockchain SSI career credentials application which is now in pilot phase, was chosen as case to examine. This is an SSI prototype that the bank is currently developing. It is an application on the mobile phone with which users can collect and store identity information. This is done in such a way to adhere to the principles of self-sovereign identity, a concept which will be explained later in this document. The user then has control of his full identity, only retrieving parts of his identity from issuing parties, and allowing verifying parties to see their information when given explicit consent. In this manner, no other party owns or stores the identity of the user, but it is uniquely stored on the user's mobile device. The case study is performed to investigate the potentially valuable information in an applied setting, by testing the elements that have been identified (through literature and expert interviews) in a specific real-life case. The goal of the bank is to obtain a blueprint of an innovative business model for the blockchain SSI career credentials application. So as to maximize the commercial chances of the innovation, and thus the adoption.

For this case study, an existing Service Dominant model is modified based on the synthesis from the literature review and the analysis of the expert interviews, so that it can be used for the case study. This model will be presented and further explained in chapter six. A workshop is organized to apply the model to the chosen case study to gain insights on developing a successful business model for an SSI application. The results of the workshop will be interpreted and reported.

This chapter described the main three methods of research that were performed for this thesis in more detail, the literature review, expert interviews and the case study. Before elaborating on the first method, the literature review, the following chapter will first present some theoretical background. The theoretical background is intended to provide a basis of understanding to the reader about the technologies and concepts on which the bank and other organizations are work on, blockchain technology, digital identity and self-sovereign identity (SSI).

3. Theoretical background

This chapter will discuss the topics of blockchain, digital identity, and SSI in more detail. This is done to provide a foundation of understanding for the technological topics this thesis is grounded in. First blockchain will be discussed, followed by digital identity, and then finishing the chapter off with SSI.

3.1. Blockchain

Blockchain has emerged as a technology that is able to drastically change the way that organisations and individuals share information (Reyna, Martin, Chen, Soler and Diaz, 2018). Blockchain technology is characterized by its immutability, transparency and trustworthiness (Chen, Xu, Lu and Chen, 2018). It allows participants to, at a low cost, secure the settlement of transactions, conclude the transactions and transfer assets without the need for a trusted third party (TTP) to guarantee trust between all parties involved.

Reyna et al. (2018) have described how blockchain technology works. A blockchain uses a decentralized network of "nodes", hardware such as a PC, that have a piece of software installed which allows it to be part of the network for that specific blockchain. Bashir (2017, pp. 10) described nodes in a distributed system as follows: "A node can be defined as an individual player in a distributed system. All nodes can send and receiving messages to and from each other. Nodes can be honest, faulty, or malicious and have their own memory and processor." He continues to state that nodes, due to their semi-autonomy in the distributed system, can show arbitrary behaviour, and that it is therefore the main challenge of distributed system design to implement sound coordination between nodes (Bashir, 2017). Unlike "the internet", which is usually a term used to unitarily describe the whole world-wide network we daily use, there isn't *one* blockchain. There can be many blockchains, or distributed ledger systems, each with their own type, goals and functions. One can for instance have a blockchain specifically made to facilitate monetary trade, and another blockchain to allow for ownership rights transfer.

Information in a blockchain is structured in a chain of multiple "blocks''. In every "block a set of information is stored, usually the most recent transaction information at the time of the block's creation. Each block is timestamped and refers to the previous one trough cryptographic pointers or references. Blocks are added as more transactions are performed within the network, each being added at the end and once again referring to the previous one. Since the reference pointers are cryptographically secured, the references are astronomically difficult to crack. This chain of blocks is where the name "blockchain" originates. These blocks are validated by the network of nodes by using their computing power to solve cryptographically hard puzzles, or hashes, which are only feasibly solvable by trial-and-error. Due to the nature of hash functions, they can only be solved in one direction. Thus, blocks using cryptographic hashes to reference each other, form a one-way chain. This means that there is a chain of blocks from the first ever block all the way to modern day. This "blockchain" makes it computationally infeasible to edit transactions in the past, as it would require that all subsequent transactions need to be redone with enough computer power to overtake the longest chain produced collectively by all the nodes combined. The network of nodes follows the longest, or "heaviest", blockchain (heaviest meaning the blockchain that has the most computing power invested, or "proof of work"). Any attacker would need to invest unrealistic amounts of computing power into the network. This is the way in which the protocol knows which blockchain is the "right" one. With every new transaction, nodes need to verify a block of transactions to reach a consensus as to whether the block is permanently added to the blockchain. This is how blockchain or distributed ledger technology eliminates the need for a TTP for verification of - and trust in - transactions. Figure 3.1.1. shows a representation of a blockchain (Crosby, Nachiappan, Pattanayak, Verma and Kalyanaraman; 2016).

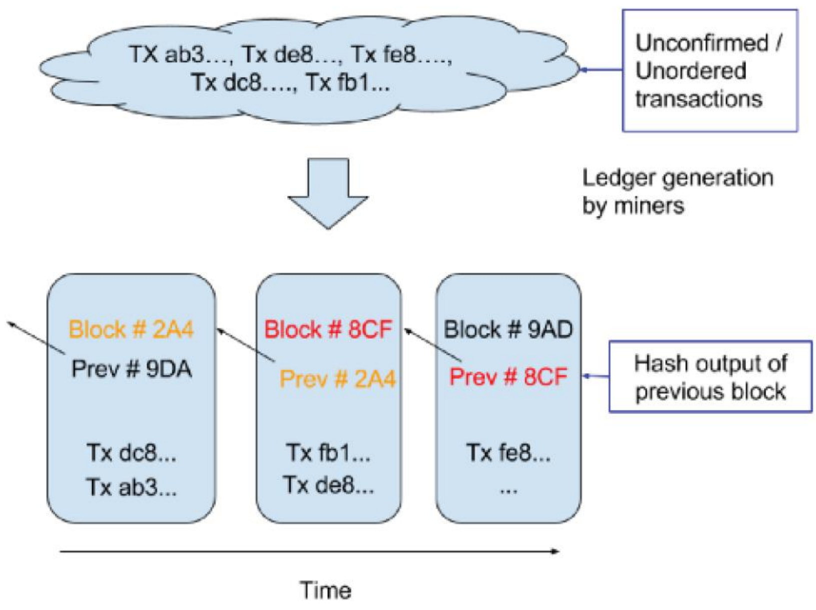

Figure 3.1.1. A model representation of a Blockchain

For describing the system in more detail, we use the work of Baars (2016), in which he describes the working of a blockchain, SSI and more generally decentralized identity management systems (DIMS).

One counterargument that might be laid out against the distributed ledger format is incentive. Why would any node be willing to provide computer power to solve others' transactions? Incentive for the nodes to provide computing power is provided by rewarding the node that first solves a new block hash puzzle with several tokens as a reward (for instance, bitcoins). Tokens are chain-specific currency that can be traded with on the same blockchain. Not all blockchains have tokens by default, but the most popular ones do (for example, Bitcoin and Ethereum). In addition, incentive to validate blocks after they've been found is provided to all nodes in that if a block is *invalidated*. This means that nodes will try their hardest to check whether the solution provided by the initial winning node is correct, for if it isn't, all other nodes once again get the chance to finish their own hash puzzle and receive the reward. When nodes invest their computer power to solve hash puzzles to validate other transactions, this is called "mining".

Once a block is found (the hash puzzle is solved) and validated by all other nodes, the transactions of that block are added to the ledger of all nodes, which now once again hold the entire history of transactions, including the latest one. Thus, in this way they're expanding the shared transaction history.

Bitcoin was the first blockchain, and the first to truly popularize the technology and conquer the world stage in the years after its introduction. However, the possible use of blockchain is much broader than 'just' a cryptocurrency such as Bitcoin. In her book "Blockchain: Blueprint for a new economy", Swan (2015) has divided the possible development of the blockchain technology in three stages: 1.0, 2.0 and 3.0. Blockchain 1.0 involves the deployment of cryptocurrencies as a cash payment system (peer-to-peer). Blockchain 2.0 is a more extensive application of blockchain that is more than a simple cash transaction and that includes for example bonds, stocks or loans. Finally, in blockchain 3.0, the application of blockchain goes beyond finance and currency and applies to areas as for example government, science, health or culture.

In their article on blockchain technology as an identity management and authentication disruptor, Lim et al. (2018) state that blockchain has the following advantages:

- *Immutability*; confirmed transactions in the past cannot be altered.
- *Permanence*; a public blockchain is accessible by everybody for reference, as long as the network remains operational.
- *Removal of intermediaries*; due to the decentralized nature of the blockchain, there is no need for TTPs.
- *Speed*; transactions are much faster than in a centrally controlled network or manual system.
- *Security*; only the sender and receiver of a transaction can access the data that they sent between one another.

Catalini and Gans (2018) furthermore describe a few business advantages of blockchain technology. According to them, in an ideal situation where blockchain is used in place of conventional databases and networks, costs for networking and verification are reduced drastically. Due to the verification that is built into the blockchain protocol. For example, there is no need to manually verify transactions and run teams or departments for these purposes.

3.2. Digital identity

To understand how blockchain technology can help in better constructing digital identity solutions, we must first get a better understanding of digital identity and identity in general.

In their conference paper on the institutional economics of identity Berg, Berg, Davidson and Potts (2018) propose that identity in actuality acts as an input for *economic*, *social* and *economic* exchange. It acts as some sort of security for the truth of who the counterparty truly is, as well as for that which is being traded. This knowledge of the identity of counterparties during various exchanges is vital for a trade, as without it, all trading would seize (Akerlof and Kranton, 2000). Berg et al. (2018) additionally make the distinction between two main types of identity, *evolutionary identity* and *legal-centric identity*.

The evolutionary theory of identity states that identity management is a consequence of market dynamics, and therefore considers it an exchange between buyers and sellers. The assumption in this theory is that buyers and sellers only perform relatively simple transactions where the goods or services have easy to judge quality and all transactions are definite. That is to say, there is no possibility of reversing a transaction. This also means that buying on credit is never a possibility and neither are refunds. The trading parties would not be too worried about the identity of their counterparty, mostly only for the value of that which is being traded. For instance, Demsetz (1964, 1967) provides the example of property rights (also a type of identification) that only arise due to the need for economic interaction between buyers and sellers of real estate. Berg et al. (2018) reaffirms this example by stating that, like property rights, identity is a concept that requires universal recognition, acceptance and affirmation by all parties involved, and is only of valuable in the moment of some sort of exchange.

By contrast, *the legal-centric view of identity* says that the state (or law-makers) provide the identity for individuals and other parties. Even in this instance, identity is mainly answering a need for a mechanism for exchange, however the legal-centric view emphasizes political exchange, instead of economic. For example, core identities are created at important moments in the lifetime of a person or other entity, such as birth certificates, marriage registrations and death certificates or registrations at the chamber of commerce (Berg et al., 2018). These registrations are important for all kinds of different identity documents such as voting passes, driver licenses, passports, contracts and bank accounts. Thus, according to the legal-centric view of identity, a person's identity is permanently tied to a person or object, regardless of transactions made, and before any potential transactions made in life. For the purpose of a general-purpose digital identity that can be accepted and adopted by a governing body, the legal-centric view of identity would be preferred, as a comprehensive solution would be required that could replace conventional ID cards and passwords. Both of which are similarly operating on the legal-centric view of identity.

On a more technical note, Marthews and Tucker (2019) present a number of elements for *digital* identity that are vital for its normal functioning, regardless of underlying assumptions and principles (for example, SSI). These elements are *registration information*, *transactional identity*, *transaction history* and *digital history*. Registration information comprising of the aforementioned officially issued documents given at the moment of registration for a service. Transactional identity is the set of facts vital to be able to authenticate a user before a transaction will be permitted in a system at a particular time. Transaction history is simply the list of transactions in a system over time. And finally, digital history is the combination of all registered transactions and information retained within a system, by each user in the system. Based on the above described elements Marthews and Tucker (2019, p. 7) define a person's digital identity as "the set of digital histories across systems relating to a single legal identity".

Legal identity is the official record a government holds about one of its citizens. On a higher level, these records present an image of the person, and often contain inaccuracies. Records may paint a picture that is outdated or simply incorrect, and which may give observers a wrongful impression of the person. One such example could be a crime record that was proven afterwards to be false. Even though such inaccuracies do exist, they are relatively fewer than in any conventional digital identity or narrative identity of a person (Marthews & Tucker, 2019), which is why they are still mainly relied upon for the purpose of identification. They are tried and tested. An additional type of identity classification is called "narrative identity". Narrative identity is the story a person tells about themselves to form a coherent personal, internalized story and image of themselves, of who they are. It is the evolving life story they hold, integrating the past and imagined future to give their life more structure and meaning (McAdams & McLean, 2013). Narrative identity is considered to be a deeper notion that either legal or digital identity, and deeply personal. A key difference between narrative and legal identity though, is that narrative identity is much more subject to change over time than legal identity is. A potential difference between digital identity and narrative identity is that your narrative identity might not be congruent with any or all the details held within your digital identity.

3.3. Self-Sovereign Identity (SSI)

An SSI specifically has a few aspects that make it differ from "regular" (digital) identity. Although he admitted himself that the concept of SSI is still very much in its infancy, Christopher Allen (2016) laid out several principles that serve as an attempt to define SSI and to start a discussion. These principles will be the basis of our understanding of SSI. The principles are (Allen, 2016):

1. Users must have independent existence.
2. Users must fully control their existence.
3. Users must always have access to their own data.
4. All systems and algorithms must be fully transparent, in how they function and how they're managed.
5. Identities must be long-term (persistence), ideally for ever.
6. All information and services must be portable.
7. Identities should be as widely usable as possible.

8. Users must always be asked consent to the use of their identity.
9. Disclosure of data must be minimized. Only the least required amount of data necessary should be shared for the task at hand.
10. User's rights must be protected. That is to say, if conflict arises between the network and the rights of the individual user, then the network should always choose the freedoms and rights of the user.

One organisation that is involved in the development of a true SSI solution for the market is the Sovrin Foundation. In essence, SSI would be an identity management system in which individuals would, as described in Allen's (2016) ten principles, fully own and manage their digital identity. (Mühle, Grüner, Gayvoronskaya and Meinel; 2018). The Sovrin Foundation further grouped these principles in three categories, being security, controllability and portability (Mühle et al., 2018). Security being the protection of the personal data and providing only the minimum data required in application. Controllability are the functions that allow the users to control what happens to their data, and for example provide consent for the use of said data. Finally, portability means that the identity of a user must be useable wherever they want and must be independent of identity providers (such as Google or Facebook). The Sovrin Foundation summarized the principles of Allen in Table 3.3.1., as seen:

Security	Controllability	Portability
Protection	Existence	Interoperability
Persistance	Control	Transparency
Minimisation	Consent	Access
		Portability

Table 3.3.1 Christopher Allen's principles as summarized by the Sovrin Foundation (Mühle et al., 2018)

SSI is currently being developed by multiple parties worldwide (Mühle et al., 2018; Sovrin, 2016; bank, 2019), however the understanding of what it is still varies among the various parties. This implies that, even though the principles of Allen exist, there is still no consensus on terminology and architectures of all these different applications. This is not automatically a problem per se, but it does highlight the lack of standardization and the ambiguity in the field of development of SSI, which may contribute to confusion about the innovation. And in turn, this may also affect the short- and long-term success of the innovation. Furthermore, Mühle et al. (2018) state that innovations in the field of SSI primarily are performed by private ventures or independent working groups, which leads to documentation not being very scientific or acting as primarily advertisement for the project. The scientific usefulness of the produced documentation for the aforementioned SSI applications is therefore limited, which means that there is potentially a missing foundation on which to build further scientific research in SSI and its application.

As mentioned before, SSI is user-centric. There is no central identity provider such as Google or Facebook. One party on the network puts forward attestations through the same network which are aimed at attesting to certain parts of the identity of a user as being true. That is to say, they "guarantee" that this part of the presented identity of the user is truthful and correct. This identity is fully in control of the user. When the user needs to identify himself or herself, they present *only* those parts of their digital identity that are relevant for the identification at hand. The trust in this transaction needs to come from a trustful relationship between the issuer of the claim and the party that is requesting the user to identify themselves (the relying party). This can be done either through giving certain nodes in the network special status, such as banks or government bodies or specially vetted "stewards" such as the

Sovrin Foundation (2016) uses. A second option is the use of "off-chain" trust. The prior option is not entirely compliant to the principles of Allen (2016). Some would argue that this is because giving nodes on the blockchain special status, somewhat defeats the purpose of decentralizing the identification process, as there would be some nodes that could be considered central identity providers in a sense, or at least holding more authority than other nodes. In contrast, the latter option of trust being derived by off-chain real-world recognition, entails that a node in the network is recognized and identified as a real-world party that holds some authority on the matter of identifying the user and can therefore reliably only attest to the truth of the attributes of the identity of said user over the blockchain. For instance, a government body on the network is recognized as such and because of its off-chain and real-world status, they are trusted to provide high quality attestations on-chain, however, they do not have any special status on-chain whatsoever.

To examine SSI in more detail, we will dive into the components that generally speaking all SSI applications must contain. *Identification*, *authentication*, *verifiable claims* and *attribute storage*.

Identification: With identification is meant the way in which nodes, users, claim-issuers and claim-verifiers are recognized in a blockchain network. To comply with the SSI principles of Allen (2016), identification should not require a centralized third party to verify the truth of an ID. Therefore, the use of classic blockchain public and private key pairs is preferred, as well as the use of self-authenticating key-value pairs. There exists more in-depth information on types of identification for an SSI solution using blockchain, but this is out of scope of this literature review.

Authentication: Authentication on a blockchain is typically done using Decentralised Public Key Infrastructure (Fromknecht, Velicanu and Yakoubov, 2014). This method is also congruent with the principles of SSI. Zero knowledge proofs (ZKP) allow for the relying party to know that an identity or an attribute of said identity is truly correct without actually perceiving the information directly. ZKP is explained in more detail further down in this section. Furthermore, authentication is important because it is a very visible part of the identification process and as such impacts perceptions of trust among users of the network in relatively direct way (Lim, Fotsing, Almasri, Musa, Kiah, Ang, and Ismail, 2018)

Verifiable claims: Verifiable claims, or verifiable credentials, are paramount for the SSI concept. Verifiable claims are collected signatures from attestation issuers through which identities, or part of identities (attributes) are attested to ("guaranteed"), by other nodes on the network. It can be seen as another person in the network cryptographically signing that a piece of data is correct and truthful. Or how Marthews & Tucker put it (2019, p.23) "…each attesting to a fact without containing that fact within itself.".

Storage: Storing data can be done either publicly or privately. The data in this case consists of the claims, keys and personal information about the user. In both public and private methods, the user decides what information is to be publicly revealed, assuming all is complying with SSI principles. Public storage means that the public key is typically stored on public profiles. Private storage means that the same data is stored on some user-controlled location, such as a smartphone. Private storage does however increase the risk of losing data in the case that hardware is lost. That is why it is important to allow for key recovery and replacement (Mühle et al. 2018), which is already a staple of most popular blockchain SSI solutions.

There are two main methods of SSI architecture that have to do with storage. One of the methods focuses on identifiers and the other on claims. Fittingly, they are named Identifier Registry Model (IRM) and

Claim Registry Model (CRM) respectively. The difference between IRM and CRM is that in the case of IRM, an identity information is stored in a user-controlled off-chain location. The party requesting identification (the same one that will verify the claim), the relying party, can then identify the user by comparing the publicly availably identifier with the identifier which the user provides for him or her. The relying party may then either accept or reject the claim, depending on successful verification. CRM on the other hand, might be considered an extension of IRM (Mühle, 2018), where a blockchain contains the cryptographic hashes (identifiers) of all claims of an identity. No additional user information needs to be stored using this method, effectively making this a more privacy compliant method. In most recent developments of SSI applications, the latter method seems to be predominant. Using these principles as the fundamental aspects of an SSI application, blockchain technology seems to be a good fit, as explained in the following paragraphs.

The concept of a blockchain-based digital identity is not new, and in recent years has been popularized as "blockchain-based SSI" (Baars, 2016). Up until recently however, the full implementation of SSI as described by the ten principles of Allen (2016) has been technologically impossible or infeasible to fully implement. However, Blockchain technology for the first time offers a method to develop a technological solution to fully implement SSI with all its principles. Therefore, blockchain SSI could play an important role in the difficulties and challenges the current identification ecosystem is facing (Lim et al., 2018). The current systems of digital identification do not seem to suffice as they are very inefficient (different service providers build their own costly databases), difficult to secure (as shown by personal data breaches in scandals of companies such as Facebook and Google) and difficult to use by end-users as they have to remember different credentials for different services (Baars, 2016). Furthermore, users do not have control over the way in which their data is being used and they do not, by rule, have full control and (physical) ownership of their data (Lim et al, 2018). A blockchain may act as a replacement for an identity registration authority as it exists in conventional identity management (Mühle et al., 2018), where the user manages their identifier on the blockchain and the verifiable claims personally and directly.

Thus, using blockchain SSI applications, a consumer could identify themselves to banks, governments, institutions and other third parties digitally, without the use of additional official paperwork to confirm their identity. In addition, there would be no need for TTP verification and validation of paperwork when submitting an identity or other personal information to some other party. For instance, if a user wishes to open a new bank account for a business, the bank they apply at may ask for information concerning their business registration at the EGB 1over a blockchain application and receive attested confirmation from the EGB 1about their business.

Another advantage of blockchain SSI is allowing for the aforementioned selective sharing of only the information that is required for the specific identification need at hand. Note that the software application does need to be made to allow for this functionality specifically. To explain this, consider the following example. An entrepreneur could request a loan from a credit provider. However, the credit provider, as the lending party, might want guarantee that the entrepreneur, as lendee, has a regular income flow to their bank account or that there are sufficient funds on the bank account to begin with. In this situation, if the bank of the lendee could guarantee both these requirements to the lending party, and attest this cryptographically using blockchain, the lending party could be almost fully certain that both these requirements are met, without actually needing to see into the bank account of the lendee. Thus, instead of having full access and insight into the bank account or some exported lists, and in the process maybe seeing other information that may not be relevant for the task at hand, the lending party would receive attested guarantee from the bank that their requirements for providing a loan to the lendee are fully met. This means they could receive an answer to their requests in the form of a “yes” or “no” answer, with the bank guaranteeing the truth of the statement. As this example illustrates, it would be possible to increase privacy using blockchain technology, as there would be no insight into the detailed information of either node in the network, only a “yes” or “no” answer to a check. The described concept is called an “attestation” and is widely used for blockchain applications.

Blockchain-based SSI truly has future potential, and businesses have started experimenting with various prototypes already (Baars, 2016). Success with blockchain SSI is not guaranteed however. An innovation possessing many possibilities does not automatically mean that it will be accepted by the market and its end-users, partner organisations or other stakeholders. Acceptance and adoption of an innovation is crucial for its prolonged use and success (Teece, 2010). The way in which an innovation is eventually accepted by possible adopters heavily relies on the characteristics of the innovation and of the possible adopters themselves (Rogers, 2002). For possible innovators with regards to blockchain-based SSI, it is important to be aware of the possible success (and failure) factors when trying to introduce this type of product to the market. For any innovation, the user’s acceptance is going to be a major determining factor for its success in the market, as understanding the adoption processes and potential usages of said innovation will allow for a better eventual alignment with the market (Aldhaban, Daim and Harmon, 2015).

This chapter presented a theoretical foundation on the topics on blockchain, digital identity and SSI. The research on these topics was a limited literature review. Understanding these topics gives the reader the basics on the technology examined later in this document. However, before examining the technologies in context further, the next chapter will be a detailed literature review on the topics of innovation adoption, risk, UI, market readiness, business models and service dominant business models, which play a crucial role in the chapters that follow thereafter.

3.4. Service dominant business models

Service dominant (S-D) logic builds on the notion that value from business is mainly generated by a network of individuals and organisations who come together in an ecosystem, so to speak, to exchange their competencies for others’ competencies that they themselves require (Lusch, Vargo, & O’Brien, 2007). S-D logic rose after an era of goods dominant (G-D) logic, which was the classic way of thinking about business value. G-D logic proposes that value propositions are supplier-centric inherently (Anderson, Narus & Van Rossum, 2006). That is to say, they are created by suppliers internally and presented outwards in an attempt to convince potential consumers that the propositions are better than those of the competition (Anderson et al., 2006). They are thus developed in isolation by the suppliers without involving any potential consumers in its creation or development (Ballantyne, Williams & Aitken, 2011). In contrast, S-D logic emphasizes value propositions as factors that connect actors in an ecosystem in which they can better formulate opportunities for value co-creation (Vargo & Lusch, 2008).

Vargo and Lusch (2016) furthermore provide the S-D based viewpoint that businesses should always involve customers and other actors in the design, creation and completion of the main output of the business. i.e. co-production. They add that value can never be created by a company. A company can only facilitate the creation of value, but the customer is the actor who plays the main role in value creation through use. Value is thus always co-created, and always needs multiple actors to achieve, including the main beneficiary (Vargo and Lusch, 2016)

To summarize, the key differences between G-D and S-D logic are explained in this paragraph. First, the initiating creator and communicator of the value proposition is different. In G-D logic, this is the supplier alone. In S-D logic, this can be done both individually by each actor, as well as by multiple actors, to be advantageous by all. Value is thus co-created and specific to a context in an ecosystem where each actor participates.

Turetken and Grefen (2017) designed a service dominant business model in which the co-created *value-in-use* constitutes the central point. Value-in-use refers to the emphasis of the value of the use of the products and services in an integrated customer focuses context (Turetken and Grefen, 2017). To be able to generate innovative business models in a way that includes all actors in an ecosystem, while being advantages and adding value for all those actors. Turetken and Grefen (2017) presented their Service Dominant Business Model Radar (SDBM/R). The SDBM/R will be described in more detail in chapter 6 of this document. Suffice to say, the model is predicated on S-D logic.

This literature review chapter presented a number of theories and concepts relevant when examining innovation adoption and eventual market success. This theory will serve as a basis and input for the following chapter. The following chapter will be the Analysis, in which the input from expert interviews will be cross-referenced with the knowledge found in the literature pertaining to innovation acceptance, diffusion and adoption. Moreover, the cross-reference analysis will present a substantiated output which can be used for further development, as it will prove that certain aspects from literature are important for the adoption of SSI applications.

3.5. Presentation and interpretation of the SDBM/R in an adoption context

The SDBM/R model forces organisation to define – together with customers – the value-in-use they are delivering. Furthermore, the users of the model need to define the different relevant actors that need to be taken into account. This consists of the *focal organisation* (the party that initiated the set up), the *core partners* (that contribute to the essentials of the solutions), *enriching partners* (that enhance the added value-in-use of the solution) and *the customers.* After this, three different layers framing the value-in-use need to be filled in for the relevant actors. First, the actor value proposition needs to be determined. This represents the value that is being delivered by one specific actor. Second, the co-production activity needs to be defined, this relates to the value that is being delivered by different actors together. Last, the actor cost/benefit needs to be described. This can be related to concepts such as *perceived usefulness* and perceived *ease of use* that have been described before. The business model should eventually have a positive sum of costs and benefits. The service dominant business model has been used in the past to search for new business models with regards to digital innovation in smart mobility (Turetken, Grefen, Gilsing and Adali, 2019).

The addition of the customer as a separate actor is relatively unique and can be valuable in various contexts. It is grounded in S-D logic (Vargo and Lusch, 2015), and can be advantageous when used in situations when customer buy-in is difficult to achieve. For example, one additional notable piece of information from the expert interviews (Appendix N), was that a number of parties already profess that they want SSI applications. However, when pressed, or offered such an application, often times they turn out to be unwilling, or not ready for it yet. By inviting such parties to the table in early stages of a cooperating involving SSI on can optimize the process. Either they can be swiftly filtered out if they do not truly want SSI, to prevent problems in the cooperation later on, or the workshop with all the other actors proves to them the potential and value of the cooperation while minimizing their perceived worries. Thus, possibly getting these parties on board with the initiative.

The SDBM/R as described and used by Turetken et al. (2018) is mapped using a workshop method as described in the same paper. The workshop has the goal to serve as basis for developing potential business models in the case of a co-created value in use. That is to say, when a new business model needs to be developed by multiple actors in which the goal is that they all must work together to create value from the service and benefit themselves. During the workshop representatives of all associated actors are brought together to define the co-created value in use, think about their benefits, investments, costs and then the eventual service innovation. In this way, the workshop serves as a basis for developing a business model that is beneficial for all parties. This is especially useful when with innovations that are inherently dependant on an ecosystem. The result from the workshop will be a valuable tangible addition to the literature study and expert input from the interviews.

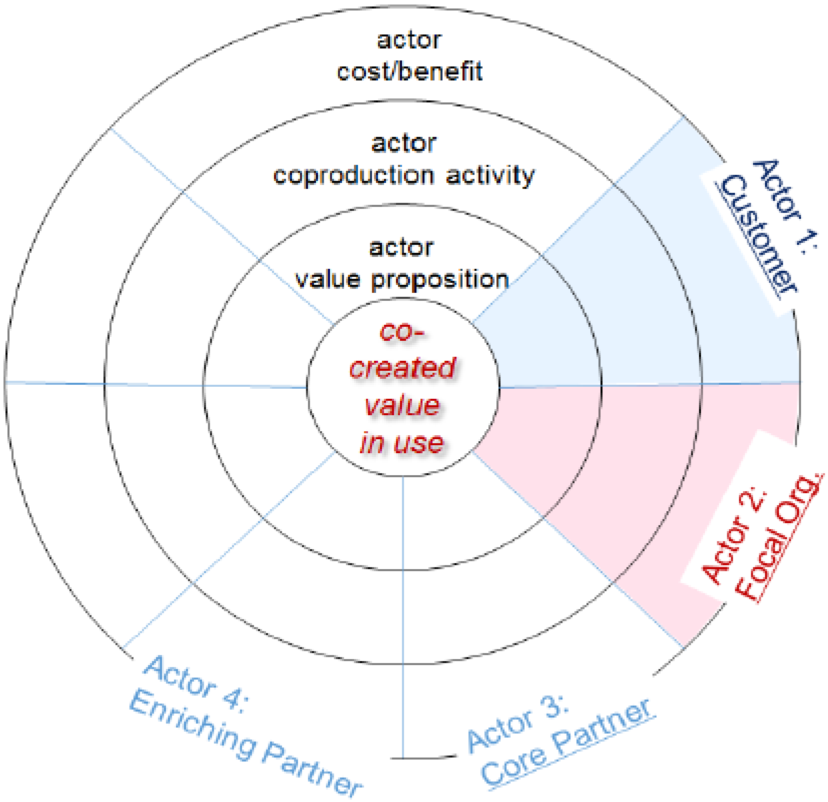

Figure 3.5.1. The Service Dominant Business Model Radar (SDBM/R) (Grefen & Turetken, 2017)

In the end, all previously mentioned results will provide the bank with insight into which of the described important elements related to market adoption are already being considered by the relevant teams and which elements need further attention and consideration.

4. Literature review

To answer the first research questions, this chapter will present various classifications, factors and attributes that could be useful when examining innovation and technology diffusion, adoption and acceptance. One of the underlying reasons these theories are examined is because they can offer a theoretical handle to research the way SSI in general and one of its applications are treated in the market. SSI and blockchain technology after all, are relatively new to the world and their application is limited, relative to more established and well-known technologies. This chapter will give an overview of previous research done on adoptions, technology acceptance, technology readiness and market readiness.

First, an introduction from the literature will be given on adoption and acceptance, and several various models that have been used to conceptualize the mechanics behind adoption and acceptance. Following this, the concepts of perceived risks will be highlighted due to its significant detrimental effects on adoption and acceptance. The chapter will then discuss the market and technology readiness. As the text will prove, these play an important role for any innovation in the market. Finally, a model will be presented and motivated from the literature that can serve as a basis for the ecosystem dependent innovation that is SSI technology.

4.1. Models of innovation diffusion, adoption and acceptance

The concept of SSI has found a home in corporate and governmental pilots and research. Nevertheless, its wide adoption and use in wider society and the development of efficient business model is still limited as of yet. Most papers and research on this topic focus on the technical aspects of the technologies required to establish SSI, standards, definitions and specific use cases or initiatives. One of the reasons might be the newness of the concept. Appendix A shows keyword search tables for a few different academic databases for searches on the term "Self-Sovereign Identity" with combinations of terms like "interview" and "questionnaire". These terms are often associated with validation studies, to test previous research and hypothesis. Examining the tables in Appendix A makes it clear that SSI is a topic that is yet to be fully researched, standing only at the beginning of its life as a topic of academic research. For instance, Google Scholar only shows 329 articles in the search results in total, whereas other fields of research frequently yield thousands of hits. The other databases presented in Appendix A, JSTOR, Scopus and ScienceDirect, show even less hits. Moreover, the oldest article on Google Scholar that mentions "Self-Sovereign Identity" is from 2013. This in itself should be sufficient testament to the newness of SSI as a topic of academic research. It is furthermore also grounds for justifying this thesis, as it would add much needed research and insights to the limited existing academic research in the field of SSI.

However, the newness of the SSI has additional aspects to it. The fact that resources are being utilized to research and develop applications based on SSI principles is proof that the bank finds it a goal valuable to pursue. In addition, internal conversations with bank experts have shown and affirmed that there is a wish that the developed solutions move past mere research and development, and that successfully fielding these various solutions a product or service in the market is a wish of the bank. Moreover, the priorities the bank has are congruent with the general trend towards SSI solutions for digital identity and KYC for financial institutions in wider society (Almasi, 2019; Verifer, 2018; Weinberg, 2019).

However, there are missing perspectives that have not been examined in detail yet regarding SSI. If SSI solutions are to be successful, the main goal is to ensure adoption of these technologies in wider society. Examination of which aspects of SSI innovation are important for higher likelihood of adoption are therefore important to research. This should be considered for both end-user adoption as well as businesses and organisations. In this regard, the end-user perspective is most important, as research has been done for SSI applications within organisations before, even though it may have been too focused on individual cases, whereas end-user perspectives have not been considered.

To be able to say anything useful on the possible adoption of a new technology by users, it is prudent to examine models or theories that have previously been formulated on this topic. Quite a few models and theories of technology adoption (and diffusion) exist, with the subject being extensively studied since halfway past the 20^{th} century.

This section will provide a short summary of each known model or theory in literature of technology adoption. Each model or theory will have its own subsection with a short description, a Figure for visual aide and an explanation of why it may be relevant for this paper.

The collection of models and theories used in this paper is based off the compiled list of said models and theories from the article by Lai (2017). The following models will be discussed in their respective order; Diffusion of Innovations (DIT) (Rogers, 1995), Theory of Task-technology fit (TTF) (Goodhue and Thompson, 1995), Theory of Reasonable Action (TRA) (Fishbein and Ajzen, 1975), Theory of Planned Behaviour (TPB) (Ajzen, 1985, 1991), Decomposed Theory of Planned Behaviour (Decomposed TPB) (Taylor and Todd, 1995), Technology Acceptance Model (TAM) (Davis, Bogozzi and Warshaw, 1989; Venkatesh and Davis, 1996), Technology Acceptance Model 2 (TAM2) (Venkatesh and Davis, 2000), Technology Acceptance Model 3 (Venkatesh and Bala, 2008), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis and Davis, 2003) and Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) (Venkatesh, Tong and Xu, 2012).

The reason the innovation diffusion and adoption models were chosen was because these are a collection of some of the most popular innovation diffusion and adoption models in the academic field of innovation, as Lai (2017) points out. Throughout the different models, various factors and variables exist that describe the cause and effect dynamics in innovation theories. All these different factors and variables allow for a starting point to examine the complexity of said innovation adoption and diffusion dynamics. The factors or variables could be rearranged into certain new models based on to-be-tested hypotheses. This is also the value of using multiple models, as some of them might be more useful than others. Later in this document certain parts of these models will be discussed in a combination and context that is relevant for the research.

Furthermore, the general importance of looking at these models is motivated by the nature of the topic examined in this document. SSI is a new field by any standard. To prove this statement, the literature keyword search table in Appendix A shows that the number of academic sources that popup when searching for “self-sovereign identity” is (relatively) extremely low compared to the other key word search terms in the table. Combining such a new topic with a technology to bring it into the realm of practical solutions means that the resulting product will be considered a radical innovation. Introducing innovations of these kind is best done through well-established innovation models such as the ones mentioned in this literature review.

Finally, a subsection of this section will be devoted to examining the concept of perceived risk. This is done on basis of Slade, Williams and Dwivdea (2013). The reason for this inclusion is because there seems to be a relevant connection between a new technological way for identification and uneasiness, or perceived risk, that individuals experience, as Sok Foon and Chan Yin Fah (2011) described in their article.

4.1.1. Diffusion of Innovation Theory

Through his work on the Diffusion of Innovation Theory (DIT) Rogers (1995) established, based on an extensive number of studies on technology diffusion, that innovations presented into a market go through five consumer acceptance stages. These stages include, in order, *understanding*, *persuasion*, *decision*, *implementation* and *confirmation*. EX3 stages each roughly correspond to Rogers' (1995) subsequent adoption curve with respective "types of adopters", *innovators*, *early adopters*, *early majority*, *late majority* and *laggards*. Through these stages and their corresponding types of adopters, DIT tries to explain in broad strokes how innovations propagate through different channels and types of users.

However, DIT did receive its fair share of critique. For instance, Lyytinen and Damsgaard (2001) state that DIT is too simplistic and fixed, as the individual adoption decisions or intentions to adopt that DIT tries to explain are aimed at very specific technologies in specific circumstances. As the technology examples used in DIT research are often well-established technologies tested in a relatively homogenous population, this does not seem to fit very well with innovative IT technologies, as Lyytinen and Damsgaard (2001) point out.

As such, it could be noted that DIT might be relevant to examine when researching possible technological innovations' adoption process. One can imagine that for a business case it might for instance be relevant to examine the time it takes to adopt a technology, the time a technology spends in certain stages or the time between stages. Or alternatively, for example, it may be useful to be able to identify exactly at what stage an innovation is currently, to be able to cater one's actions for that specific situation and target consumers or clients.

A related term is presented by Parasuraman and Colby (2001), who propose Technology Readiness (TR) as a construct to describe individuals' willingness to accept and use new technologies in their everyday life. Parasuraman and Colby (2001) present TR as having four underlying dimensions that make up the construct. These dimensions of TR are; *optimism*, which is to what extent people view technology in a positive light in general and belief that it offers control, flexibility and efficiency. *Innovativeness*, which is the propensity of users to be a pioneer. *Discomfort*, which is the perceived lack of control and a feeling of being overwhelmed. And finally, *insecurity*, which is a distrust or scepticism of technology in general. Furthermore, Parasuraman and Colby (2001) state that TR has a set of readiness segments in the general population. These coincide with the segments presented by Rogers (1995); *explorers*, *pioneers*, *sceptics*, *paranoids* and *laggards*.

Parasuraman and Colby (2001) point out that in the context of TR, and despite rapid growth of products based on technology, the customer does not always get the advantages from said technology that they expect. Moreover, Pires, da Costa Filho and da Cunha (2011) state that. "...there is growing evidence of frustration when dealing with technological systems or apparatuses mainly in auto-service.". This indicates that customers still value human interaction in their daily dealings. This is something that Souza and Luce (2005) support in their paper. Nevertheless, there still seems to be a tendency towards high-tech innovations in customer's preferences (Pires et al., 2011).

See Figure 1 for the bell curve presented by Rogers (1995).

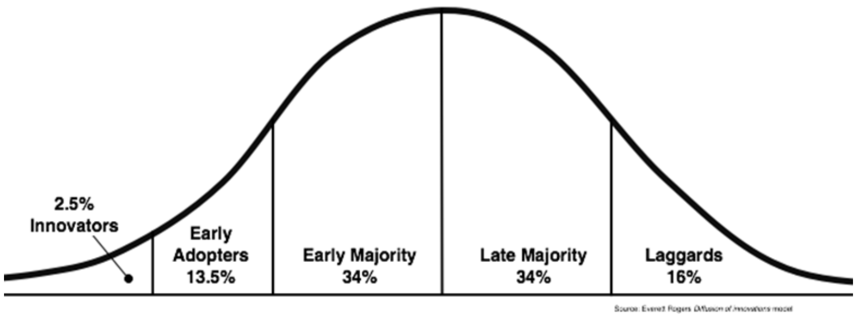

Figure 4.1.1. Adoption Curve of Rogers (1995)

4.1.2. Theory of task-technology fit

For the Theory of Task-Technology Fit (TTF) Goodhue et al. (1995) assume that a good fit between a task that needs to be performed and a technology that presumably is meant to help in performing this task, will lead to a greater chance of people eventually actually using the technology. In addition, the technology will presumably then also better fit the wishes and needs of users, which will lead to the technology having a greater impact on performance. See Figure 2 for a visual representation of TTF (Goodhue, 1995)

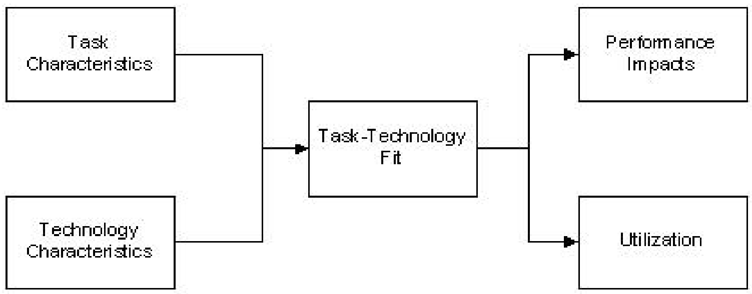

Figure 4.1.2. Visual representation of TTF by Goodhue (1995)

Due to the nature of the model, Lai (2017) states that the model is mainly useful for assessing technology already in use in the marketplace. This is mainly due to it requiring users already applying the technology and tangling with their frequent tasks, to measure its fit. Without the technology being out in the market there logically cannot be a measurement of task-technology fit outside of an experimental setting. However, evaluating the expected task-technology might be useful. In this context a fit occurs when an innovation is used precisely for its intended purpose, for example, the Roomba robot vacuum cleaner is perfectly fit for the job of automated regular vacuuming of the living space. An example of a misfit might be Viagra, which was originally intended to lower blood-pressure. Today it is best known for the side-effect it had on male users.

4.1.3. Theory of Reasoned Action

The Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) examines the effects of a person's' *attitude* and *subjective norms* on their *intention*, and then eventually *behaviour*. In TRA, *attitude*, *belief* and *behaviour* are important constructs. *Attitude* in this context is defined as a personal evaluation about (and thus stance towards) an object. *Belief* here is considered a psychological state or view between an object and an attribute of said object. Or as Lai (2017, p. 4) puts it, "… a link between an object and some attribute". Finally, *behaviour* is defined as the "acting out" of earlier formed *intention* (Fishbein and Ajzen, 1975).

In addition to the attitude, according to TRA (Fishbein and Ajzen, 1975), the second factor in the model is *subjective norms*. *Subjective norms* are attitudes derived from what an individual believes are the attitudes of the community they are embedded in. See Figure 3 for a visual representation of TRA (Fishbein and Ajzen, 1975).

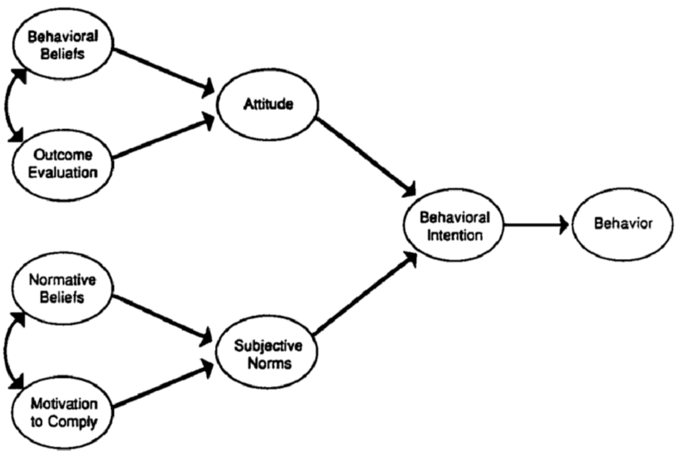

Figure 4.1.3. Visual representation of Theory of Reasoned Action by Fishbein and Ajzen (1975)

The usefulness and relevancy of TRA for this literature review is derived from the inclusion of the believes that a person has about their immediate communities' attitude on some or any behaviours.

4.1.4. Theory of Planned Behaviour

Long after the TRA was developed by Fishbein and Ajzen in 1975, Ajzen independently developed the Theory of Planned Behaviour (TPB) (Ajzen, 1991). TPB shares a few factors with TRA, as can be seen in Figure 4. These factors are *attitude* and *subjective norms*. Where it differs however, is the addition of a third factor which Ajzen (1991) deemed was necessary to complete the picture. The factor that was added is *perceived behavioural control*, which is defined as the perceived ability to perform a behaviour. In other words, to what degree does the user experience the control that a certain product or service necessitates. (Lai, 2017).

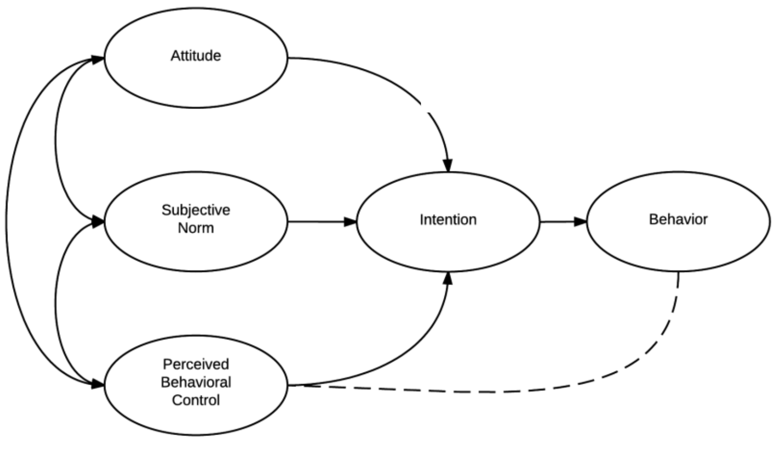

Figure 4.1.4. Visual representation of the Theory of Planned Behaviour by Ajzen (1991)

The addition of perceived behavioural control extends the TPB beyond TRA. This means that when examining novel technology introduction into a market it may be prudent to incorporate as many relevant factors as reasonably possible initially, which increases the odds for a researcher or marketer to successfully predict behaviour when examining potential user behaviour. In practice this may come down to the amount of direct inputs a user has in the new technology. For instance, a technology could possess a dashboard that can be used to control whatever it is the technology is intended to do. Or, there might be a built-in support function, in case the standard (ideal) work-flow is disturbed.

4.1.5. Decomposed Theory of Planned Behaviour

Taylor and Todd (1995) introduced a theory based on, as the name suggests, TPB. The decomposed Theory of Planned Behaviour (Taylor and Todd, 1995). According to Taylor and Todd, to acquire a better understanding of beliefs and their relation to intention, requires a more in-depth examination of the attitude and the attitudes that together form it ("decomposition" of attitude). In support of this decomposition, Shimp and Kavas (1984) earlier stated that subcomponents of belief cannot simply be grouped together into conceptual and cognitive units. Taylor and Todd (1995) showed that the Decomposed TPB had superior explanatory properties compared to TPB (Fishbein and Ajzen, 1975). According to Shih and Fang (2004), this decomposition leads to more detailed and thus satisfactory understanding of adoption attention.

In the Decomposed TPB (Taylor and Todd, 1995), *attitudinal beliefs* (from TPB) are decomposed into *relative advantage*, *compatibility* and *complexity*. These then in turn decide the *attitude* factor of the model. Furthermore, *control belief* is decomposed into *efficacy* and *facilitating conditions*, which decides on perceived *behavioural control*. Finally, the decomposition of *normative beliefs* has been researched in the past as well. However, while some studies found support for this decomposition (Burnkrant and Page, 1988), most other studies did not (Shimp and Kavas, 1984; Oliver and Bearden, 1985). The decomposition of *normative beliefs* does therefore not have the support to justify said decomposition and is left as is (*normative influences*). See Figure 5 for a visual representation of the Decomposed TPB (Taylor and Todd, 1995)

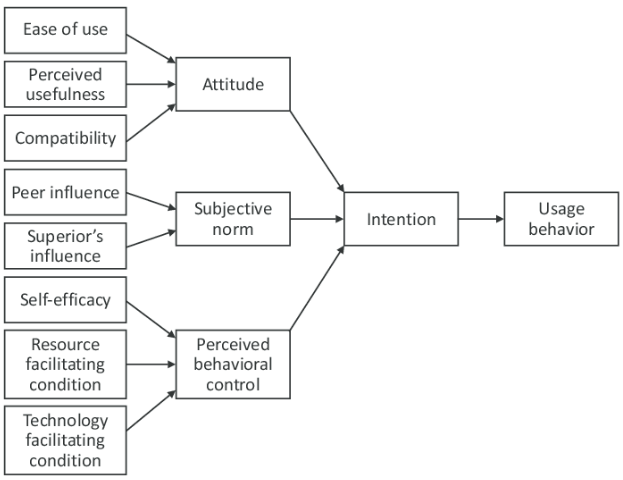

Figure 4.1.5. Visual representation of Decomposed TPB by Taylor and Todd (1995)

4.1.6. Technology Acceptance Model

In 1986, Davis presented the Technology Acceptance Model (TAM), which has garnered the reputation of being one of the most widely used models on this topic (Lai, 2017). Presented as an extension of Ajzen and Fishbein's (1975) Theory of Reasoned Action (TRA) Originally specifically created to address acceptance of information systems technologies. TAM presents *Perceived Usefulness (PU)* and *Perceived Ease of Use (PEU)* as the two relevant factors in determining *attitude* towards using (technology) (Davis, 1986).

See Figure 6 for the TAM model.

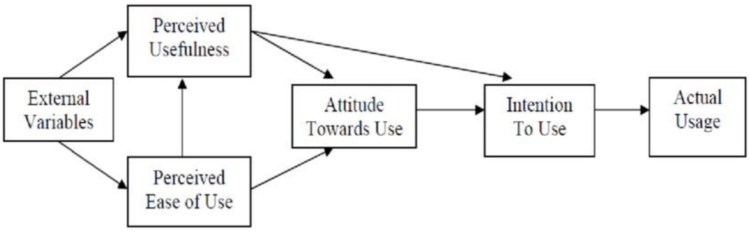

Figure 4.1.6. Technology Acceptance Model (TAM) by Davis (1986)

However, in 1996 Venkatesh and Davis found that both PU and PEU had a direct influence on behavioural intention, which meant that the *attitude* (which mediated PU/PEU and Intention to Use) construct was superfluous and could be removed from the TAM model. This modification was proposed as TAM 2 (Venkatesh and Davis, 2000). In addition to the added antecedents of PU that TAM 2 brings to the table, another notable extension of the TAM2 model is the addition of *experience* and *voluntariness*. Where experience moderates between *subjective norm* and PU and *intention to use*, and voluntariness moderates between *subjective norm* and Intention of Use. See Figure 8.

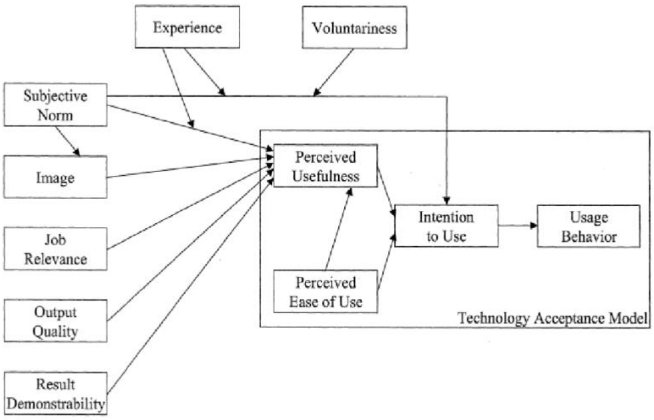

Figure 4.1.7. Visual representation of TAM 2 by Venkatesh and Davis (2000)

Venkatesh (2000) developed the model of determinants of perceived ease of use, in which control, intrinsic motivation and emotion were integrated into the existing TAM (Davis, 1986). Later that same decade Venkatesh and Bala (2008) combined said model of determinants of perceived ease of use (Venkatesh, 2000) with TAM2 (Venkatesh and Davis, 2000) to develop TAM3 (Venkatesh and Bala, 2008). TAM3 incorporates additional antecedents for PEU. See Figure 8.

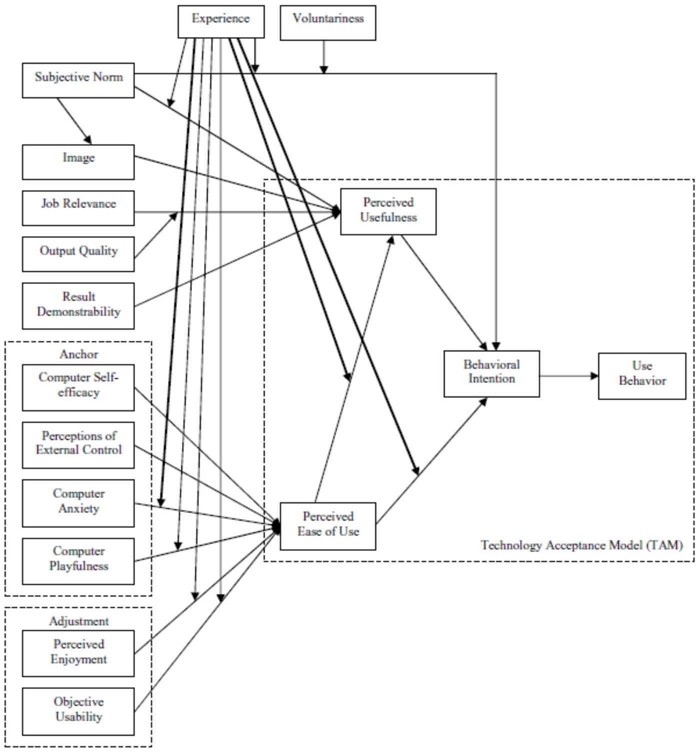

Figure 4.1.8. Visual representation of TAM 3 by Venkatesh and Bala (2008)

Figure 8 above shows that these antecedents of PEU that TAM3 adds to the previous models are mostly related to the relationship between users and computers. Arguably, these factors can be translated to software applications with relatively more ease than other antecedents in the model. One broader drawback of TAM3 in the sense that it is described in the article of Lai (2017) is that it focuses on IT implementation. However, for the purpose of blockchain-based self-sovereign identity applications it may prove to be useful, as this is related to IT implementation.

On the topic of TAM in general, Aldhaban et al. (2015) state that the largest drawback to all TAM models (TAM, TAM2, TAM3) is the omittance of human and social factors within the adoption process, something which is especially relevant to countries that have relatively unique cultural contexts such as China and Saudi Arabia.

Moreover, cultural aspects are relevant for answering the research question, because it makes sense for maximizing the chances of successful market adoption to consider aspects of culture in specific countries and cultures.

4.1.7. Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, Morris, Davis and Davis (2003) was developed to model a more extensive set of factors that had shown to be influencing behavioural intention and use behaviour. The antecedents in UTAUT as formulated by Venkatesh et al. (2003) are *performance expectancy*, *effort expectancy*, *social influence* and *facilitation conditions*.

Performance expectancy is the degree to which a user expects the provided solution will actually tackle the task at hand. *Effort expectancy* is the degree to which a user expects they themselves will need to invest effort when using the solution for the task at hand. *Social influence* is the influence of the social circle or culture the user is embedded in. That is to say, how their environment views the solution.

Facilitating conditions are the conditions that either stimulate or detriment the use of the solution for the task at hand. Note that facilitating conditions only have a direct influence on use behaviour, and not on behavioural intention according to Venkatesh et al. (2003).

In addition, in UTAUT the relations between the antecedents and behavioural intention and use behaviour are moderated by *gender*, *age*, *experience* and *voluntariness* (Venkatesh et al., 2003), which generally increases the accuracy of the model. In interesting thing to is the addition of *gender* and *age* as moderators, compared to TAM (Davis, 1986).

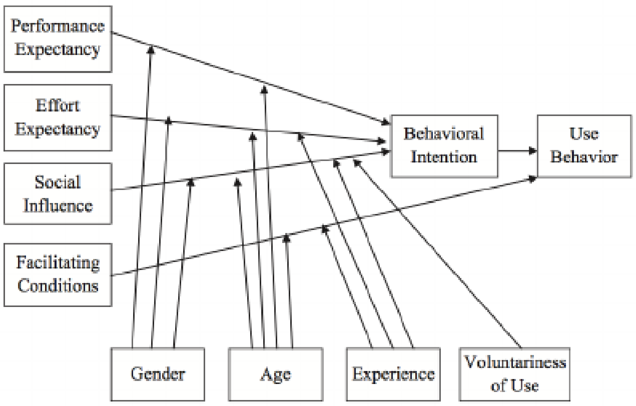

Figure 4.1.9. Visual representation of Unified Theory of Acceptance and Use of Technology by Venkatesh, Morris, Davis and Davis (2003)

4.2. Perceived risk

Studies showed that perceived risk and trust also play an important role in consumer adoption. For instance, the academic literature has looked at risk as an inhibitor with regards to for example online money transactions: when a consumer sees many risks with regards to a product, they are less likely to use it (Slade et al., 2013). Consider also the study by Sok Foon and Chan Yin Fah (2011) in which they examined internet banking adoption in Kuala Lumpur using the UTAUT model. Their research reaffirmed that demographics had little to no effect on the adoption of internet banking. However, effects of perceived risk in either security or trust in the system did have an influence.

As such, there seem to be many dimensions with regards to risk. A few examples are *security risks*, *privacy risks*, *legal risks*, *operational risks* or *market risks*. Abramova and Bohme (2016) furthermore examined the effects of *perceived benefit*, *perceived ease of use* and *perceived risk* on Bitcoin use. They found that perceived benefit had a slight positive effect on usage behaviour. However perceived risks had a strong, significant negative effect on usage behaviour. This means that if certain respondents assessed the use of Bitcoin as risky, they were less likely to use the technology.

Moreover, *trust* can help to diminish the negative effects of perceived risk as it helps to deal with the uncertainty or anxiety of the behaviour and the possible outcomes. Multiple studies have found that trust has a negative effect on perceived risks with regards to mobile payments (Slade et al., 2013). This means that if consumers can place trust in a product or provider, they are more likely to use a product even when there are some risks involved.

Furthermore, it may be relevant to examine perceived risk in particular, because if an innovation for identification (SSI) is to be truly successful, it must be widely accepted by most of the population as a normality. Lichtenstein and Williamson (2006) showed in fact that older people for instance, distrusted internet banking during its earlier years as a new way of doing their banking due to, among other things, general lack of trust in technology and security and privacy risks. The newness of the technology also played a role.

Perceived risk must therefore be considered as a factor in particular to try and minimize, if an innovation is to be successful.

4.3. User interface design, usage and adoption

Any software application is inadvertently linked with user interface design, as it is embedded into software with a front-end which people interact with and should be recognizable and usable to consumers. This is evident for anybody who has a smartphone, as all smartphones in recent times have had a multitude of apps installed for all types of different functions. Whether it be for socializing with friends and strangers, or some sort of pass-time like a game. User interface plays an important role in how well a piece of software is understood, enjoyed and therefore used. According to some commentators, it is one of the reasons why Apple iPad was so successful, where the Microsoft tablet PC's which were launched almost a decade earlier failed (Vogelstein, 2018). These same principles hold for a blockchain SSI application or a product or service built on top of a blockchain SSI architecture or platform. From this it follows that it is relevant to examine the effect of user interface on usage and adoption of innovations in general, as it will also determine the commercial success of the application.

Interface design is the way through which customers and the product communicate with each other (Mayhew, 1999). It facilitates users' control and interaction with a product, and it supports the customer in using the software properly (Cho, Cheng and Lai, 2009). In software, the interface designs relate to for example the menus, the presented icons and the use of touch screen (Parikh and Verma, 2002).

An important aspect of interface design is usability (Mayhew, 1999). It describes how easy the software is to use for new customers and trained customer. When designing the software, different elements need to be taken into account such as the cognitive, physical and perceptual capabilities of people in general, the specific capabilities of the target audience the product needs to reach, the characteristics and requirements of the users' task and the environment in which the users will be fulfilling these tasks (Mayhew, 1999).

Cho, Cheng and Lai (2009) concluded that many studies have found that Perceived User-Interface Design (PUID) plays a very important role in the continued usage of a product. They found an explanation for this effect. They concluded that PUID influenced Perceived Functionality and Perceived System Support, which again positively influenced Perceived Usefulness and Perceived Ease of Use. As stated earlier, Perceived Usefulness and Perceived Ease of Use are positively linked to usage behaviour.

Concluded can be that the design of software can have a profound effect on the use of the software and therefore on the possible success of a product launch. Therefore, understanding and functionality are important when it comes to interface design and stimulating usage: more important than flashy designs users frequently use to impress possible customers (Early and Zender 2008).

4.4. Market readiness

When examining the concept of technology adoption exclusively, it is considered by some researchers as only a 'technology push'-way of looking at the acceptance in the market (Paun, 2011). For instance, one examines their own new technology and tries to Figure out how the market and consumers are going to respond to it.

Paun (2011) however emphasized the importance of *market pull* and described a new tool to hybridize market pull and technology push approaches. In said research it is stated that market pull can be defined as the need or requirement for a new product or a solution to a problem, which comes from the market place itself, with consumers needing and actively seeking a product or service to fill a gap in their needs. See Figure 4.4.1. for a representation of technology push and market pull.

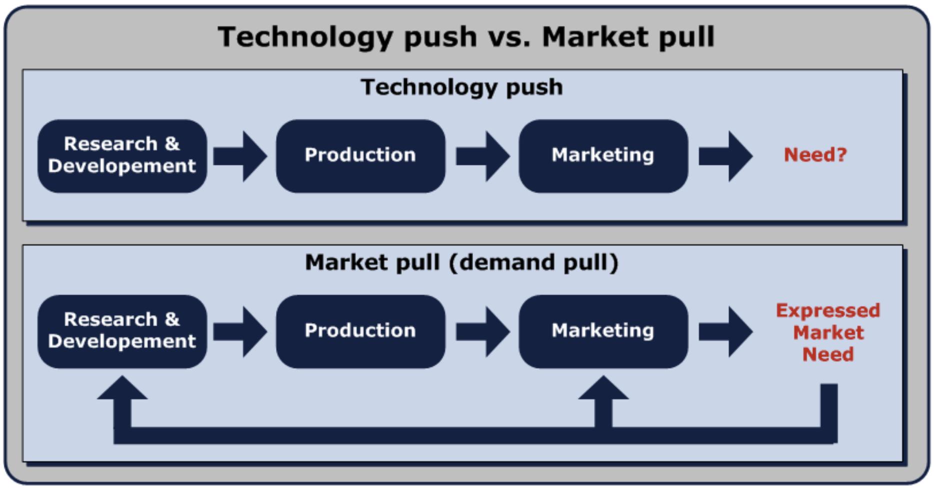

Figure 4.4.1. Visual representation of technology push and market pull

Furthermore, to better understand the dynamics behind market (demand) pull, Paun (2011) developed a scale to measure 'demand readiness' that ranged from the occurrence of feeling "something is missing"' (low) up to 'building the adapted answer to the expressed need in the market' (high). In the research it was defined that the success of an innovation was determined by the combination of *technology readiness level* and *demand readiness level.* Table 2 shows the combined demand level and technology readiness level. Note that technology readiness here is not the same as is referred to by Parasuraman and Colby (2001).

Demand Level	Demand Readiness Level	Technology Readiness Level	Technology Level
1	Occurence of feeling "something is missing"	Market Certification and Sales Authorisation	9
2	Identification of specific need	Product Industrialisation	8
3	Identification of the expected functionalities for new product/service	Industrial Prototype	7
4	Quantification of expected functionalities	Field demonstration of whole system	6
5	Identification of system capabilities	Technology Development	5
6	Translation of the expected functionalities into needed capabilities to build the response	Laboratory Demonstration	4
7	Definition of the necessary and sufficient competencies and resources	Research to prove feasilibility	3
8	Identification of the Experts possessing the competencies	Applied Research	2
9	Building the adapted answer to the expressed need in the market	Fundamental research	1

Table 4.1. Demand Readiness Levels and Technology Readiness Levels (Dent and Pettit, 2011)

Dent and Pettit (2011) highlighted the importance of market pull and used the definition of 'market readiness'. Market readiness relates to the degree of maturity for the need of an innovation by the market. If there is low, or no market readiness for a certain innovation, product or service, then there would not be a need for said innovation. It would follow that the expected commercial success would be limited and market adoption and diffusion would remain relatively low.

A lack of (awareness of) market readiness might explain why certain ground-breaking innovations (such as for example, Google Glass or the Segway) do not fare as well as intended after being launched, or fail altogether (Hurting, 2015), which proves that even when offering a great product with tremendous benefits, the product can still fail. For instance, timing is one of the determining factors for success (Schneider & Hall, 2011). Many companies do not realize this enough and often rush to bring their new product or service to the market as soon as possible. Consider also the example of tablets, which have been around since the early 1990s, but only achieved success in 2010 with Apple's iPad (Vogelstein, 2018). There were other factors at play here, but timing was one of them as well. The idea of "if you build it, they will come" is prevalent in these instances (Schneider & Hall, 2011). Especially if an innovation is disruptive by any standard, it is important to research whether the market is even sensing whether there is a problem to be solved, lest you risk wasting enormous manpower and financial investment into a new idea that is destined to fail if it is up to the market it is trying to enter.

4.5. The role of business models

Baden-Fuller and Haefliger (2013) define a business model as a method for identifying customers, their needs, delivering value and monetizing on that value. According to them, business models can be seen as constructs separate from the actual business, product or service. They are tools which are used to give a handle on the processes around "doing business". Which is exactly delivering value from a product or service to a customer and in turn receiving a reward from it. The latter being the monetization aspect.

However, in real world application, a business model is rarely separated from the eventual business practice. Moreover, literature on this topic is in accordance with each other in that one of the main utilities of a business models are their ability to link two aspects of business operations, the creation of value, and the capturing of value (Amit and Zott, 2001; Zott and Amit, 2010; Casadesus-Masanell and Ricart, 2010; Teece, 2010).

New products' research and development needs to be timely coupled with examination of possible ways of capturing the value from the product on the market, so as to guarantee it's economic and business success, because a great new product does not automatically mean that it will be a success (Teece, 2010). "When executives think of innovation, they all too often neglect the proper analysis and development of business models which can translate technical success into commercial success. Good business model design and implementation, coupled with careful strategic analysis, are necessary for technological innovation to succeed commercially". (Teece, 2010, pp. 184)

Furthermore, existing services, products or technologies can create successful new businesses as well. This is possible by the re-evaluation of their respective business models. It allows for the possibility to apply the existing technologies in new or unique ways (Baden-Fuller and Haefliger, 2013). This in itself can then also lead to an increased adoption rate, due to the new success a technology is enjoying. Technological innovation and business models go hand in hand if a technology is to be widely adopted and used, while the company developing and fielding the technology can continue to develop and deploy their innovation into the market. To reach a point where an innovation is widely accepted in society, assuming the innovation is meant to be commercially distributed, a working and successful business model is necessarily the foundation. detailing the internal mapping of the business, as well as its external connections with suppliers and buyers.

5. Analysis: Cross-reference analysis of literature and expert interviews.

The literature review chapter examined the already established works for models and concepts that exist in terms of technology and innovation diffusion, adoption and acceptance. In this chapter we will examine concrete elements the literature offers that can be used to further build upon. The goal is to exhibit topics, sort-of-speak, that are shown based on the literature to be significantly relevant to the case of the bank's specific SSI applications.

Recall that in the literature review in chapter 4, a number of models for diffusion, acceptance and adoption of technology and innovation were examined and summarized. All elements that were identified and in the literature are listed in Table 5.1.1.

Concept	Label	Description	Source theory
Optimism	*OPT*	To what extent people view technology in a positive light in general and belief that it offers control, flexibility and efficiency.	DIT
Innovativeness	*INN*	The propensity of users to be a pioneer.	DIT
Discomfort	*DIS*	The perceived lack of control and the feeling of being overwhelmed	DIT
Insecurity	*INS*	Distrust or scepticism of technology in general	DIT
Technology Readiness	*TR*	A person's willingness to accept and use new technologies in everyday life	DIT
Task Characteristics	*TKC*	The characteristics of the task that needs to be performed by a user.	TTF
Technology Characteristics	*THC*	The characteristics of the technology that needs to be performed by a user.	TTF
Task-Technology Fit	*TTF*	The fit between a to-be-performed task and a technology which is meant to be used to assist in completing this task	TTF
Performance Impacts	*PI*	The impact of the technology on the performance of the task by the user	TTF
Utilization	*UTI*	The fraction of time a technology is used for a given task	TTF
Attitude (Towards Use of Object))	*ATT*	Personal evaluations and stance towards an object	TRA / TAM / TAM2 / TAM3
Belief	*BEL*	Psychological stat or view between an object and an attribute of said object	TRA
Behaviour	*BEH*	The acting out of earlier formed intention	TRA
Subjective Norms	*SN*	Attitudes derived from what a person believes are the attitudes of the community they are embedded in	TPB / DTPB
Perceived Behavioural Control	*PBC*	The perceived ability to perform a behaviour, which is determined by the total set of accessible control beliefs, which are beliefs about presence of factors that may enhance or limit the performance of a certain behaviour	TPB / DTPB
Perceived Usefulness	*PCU*	Degree to which a person believes an innovation would improve their current job performance	TPB / DTPB / TAM / TAM2 / TAM 3
Perceived Ease of Use	*PEU*	Degree to which a person believes an innovation is easy to use.	TPB / DTPB / TAM / TAM2 / TAM 3
Compatibility	*COM*	Degree to which a person believes an innovation fits with their current needs, values and experiences	DTPB
Intention to Use	*IU*	Degree to which a person aims to use an innovation	TAM / TAM2 / TAM3
Actual Usage	*AU*	Degree to which an innovation is actually used by a person	TAM / TAM2 / TAM3
Image	*IMG*	Degree to which use of an innovation is perceived to raise a person's social status	TAM2 / TAM3
Job Relevance	*JR*	Degree to which a person perceives an innovation to be applicable in their job	TAM2 / TAM3
Output Quality	*OQ*	Degree to which a person perceives an innovation to perform the tasks relating to their job well	TAM2 / TAM3
Result Demonstrability	*RD*	Degree to which the results of the use of an innovation are tangibly showable	TAM2 / TAM3
Computer Self-efficacy	*CSE*	The personal judgment on how well a person believes they can handle (unexpected) situations during computer usage	TAM3
Perceptions of External Control	*PEC*	Degree to which a person perceives that there exist organisational and technical resources to support the use of the system	TAM3
Computer Anxiety	*CA*	The fear a person may have of general computer usage	TAM3
Computer Playfulness	*CP*	Degree to which a person shows cognitive spontaneity during computer interactions	TAM3
Perceived Enjoyment	*PE*	Degree to which the use of an innovation is perceived to be enjoyable by a person, regardless of the results from using the innovation	TAM3
Objective Usability	*OU*	The comparison of innovations based on the actual - not perceived - amount of effort required to perform a task with the innovations	TAM3
Performance Expectancy	*PE*	The degree to which a user expects the provided solution will actually tackle the task at hand	UTAUT
Effort Expectancy	*EE*	The degree to which a user expects they themselves will need to invest effort when using the solution for the task at hand.	UTAUT
Social Influence	*SI*	The influence of the social circle or culture the user is embedded in, or how the user's environment views the innovation	UTAUT
Facilitation Conditions	*FC*	The conditions that either stimulate or detriment the use of the solution for the task at hand	UTAUT
Voluntariness	*VOL*	Degree to which a person perceives adoption to be non-mandatory	UTAUT
Perceived Risk	*PR*	A person's perceived risk about the use of a product, service or provider.	n/a
User Interface Design	*UID*	Front-end interface design which acts as a visual point of contact for a person when using a (digital) innovation	n/a
Market Readiness	*MR*	The degree to which an innovation is ready to be launched and to deliver a commercial offering to a target group.	n/a
Technology Readiness	*TR*	The degree to which the technology of an innovation is ready to be used in the offering.	n/a
Demand Readiness	*DR*	The degree of expression of need by a customer on a given market.	n/a
Technology push	*TP*	The case of a producer or service provider first creating a product without an explicit need by the market before hand	n/a
Market pull	*MP*	The case of a producer or service provider reacting to an explicit market need by offering and producing the product or service the market is demanding	n/a

Table 5.1.1. Elements from literature which play a role in innovation adoption, diffusion and acceptance, their labels for coding, description and from which theory and model they are from.

For convenience, Table 5.1.2. additionally, shows the full names of the theories in the previous table.

Abbreviation	Full name of theory
DIT	Diffusion of Innovation Theory
TTF	Theory of Task-Technology Fit
TRA	Theory of Reasoned Action
TAM	Technology Acceptance Model
TAM2	Technology Acceptance Model 2
TAM3	Technology Acceptance Model 3
TPB	Theory of Planned Behaviour
DTPB	Decomposed Theory of Planned Behaviour
UTAUT	Unified Theory of Acceptance and Use of Technology

Table 5.1.2. Abbreviations of the theories and models with their full name.

To establish which previously listed elements from Table 4.6.1. are considered to be important for the success of SSI applications *according to the experts,* the interviews have been examined in more detail and coded based in part on the method described by Gorden (1992) in his handbook “Basic Interviewing Skills”.

As mentioned, the interviews were fully recorded in audio. Following this, all of them were transcribed verbatim. Finally, the interviews were coded. The coding involved the definition of coding categories, as mentioned by Gorden (1992), with the modification to the method being that the categories were chosen to be the elements as presented in Table 5.1.1, and the code labels were chosen based on acronyms, also in presented in Table 5.1.1., in the second column.

Pieces of texts were then labelled using the codes, to the elements related to those from the table, and were relevant in some way to the topic of SSI adoption, diffusion and acceptance. The number of mentions or occurrences of certain elements from the interviews were recorded and counted.

Furthermore, a *weight designation* was assigned. In addition to Gorden (1992), this was done based loosely on the work of Keller (2017), who proposed a more mathematical approach to interview coding. Due to the limited number of interviews in this research (six) with experts on a highly-niche topic, the mathematical aspects were toned down, but the weight classification of the coding labels proposed by Keller (2017) were used. This was done to facilitate potential differences in perception of the importance of certain elements by the experts. The weight designations are based on perceived importance, self-reported by the experts. These weight designations are: **--**, **-**, **+-**, **+** and **++**, which is based on Scriven and Davidson (2000) qualitative weight and sum (QWS) method, Nijkamp and Van Delft (1977) (a qualitative outranking analysis) and Voogd (1983). Albeit the eventual used method was slightly modified to allow for somewhat more nuance than Scriven and Davidson (2000) because they only mention three weight levels; minor, moderate and high values, and Nijkamp and Van Delft (1977) add three additional level, which proved to be superfluous based on the answers given in the expert interviews.

The weights were thus assigned according to a qualitative assessment and interpretation of the experts’ words. I.e. if an expert for instance said or implied that Market Readiness is important in some way, this was labelled with MR (Market Readiness). If the same expert then subsequently said or implied that the impact of Market Readiness however isn’t very high, then it may have received a weight factor of +- or +. Note that in this context +- means that there isn’t a strong inclination to either positive (+) or negative (-), it is the “default” weight, so to speak.

Notice that in most cases, the weight was "default" (+-). Which is why in the analysis, to minimize clutter, the weight is omitted when it is considered default (+-). Only other weights are explicitly marked in the analysis. The full transcripts, the coded interviews and the labelling can be found in Appendices D through L. Table 5.1.3 on next page shows a full overview of labels per interviewee and the number of occurrences per label. The interviewed experts' names were replaced with generic designators (For example, "EX1"), so as to provide more anonymity.

Question nr.	*Bank 1 - EX1*	*Bank 1- EX2*	*EGB 1 - EX3*	*Org 1 – EX4*	*Bank 2 – EX5*	*Org 2 – EX6*	*PR*	*DRL*	*PEU*	*TP*	*FC*	*INS*	*MR*	*MP*	*COM*	*TR*	*PU*	*RD*	*SI*	*SN*	*ATT*	*THC*	*DIS*	*EE*	*INN*	*VOL*	*TRL*	*PBC*	*UID*	*BEL*	*PEC*	*OQ*	*GL*	*IU*	*OPT*	*TTF*	*IMG*	*NE*	*OU*	*TKC*	*Total*
2	MP, TP, DRL	MP, DRL, PBC	DRL, UID, PEU, PR, INS, FC, TR	DRL, TP, MP, MR, PU, PR, INS,	MP, TP, MR, DRL, INN	TP, TR, MP, DIS (++), EE (++), COM (++), OQ (+), OPT, PEU	2	5	2	4	1	2	2	5	1	2	1	0	0	0	0	0	1	1	1	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	**34**
3	PEU (+), PU, PR, VOL, RD, DRL COM	PBC, MP, DRL, PEU, INS, PR, RD	PEU, PU, EE	PEU, DRL	PEU (+), UID, PR, INS	SI, IMG	3	3	5	0	0	2	0	1	1	0	2	2	1	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	**25**
4	VOL, PEU, PR, INS	PEU (+), PU, TP, RD, FC, INS (+), PR (+)	DIS, THC, FC	PEC, SI, SN, VOL	FC, TP, DRL, MR	PU, RD, THC	2	1	2	2	3	2	1	0	0	0	2	2	1	1	0	2	1	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**25**
5	MR, FC (+)			MR, DRL, MP, IU	TP, FC, VOL, DRL, ATT	TP (+), MP (+), MR (+), TTF, TKC, THC, RD, ATT (+), SN (+)	0	2	0	2	2	0	3	2	0	0	0	1	0	1	2	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	1	**20**
6		MP, TP, DRL, TR, MR	MR, DRL, PR, INS			TP, TRL, DRL, MR	1	3	0	2	0	1	3	1	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**14**
7	FC (+), TP		FC (+), TP, TRL, DRL, MR, ATT	COM, SN, THC, TTF, VOL	TP, FC, RD	RD, SI, GL, NE	0	1	0	3	3	0	1	0	1	1	0	2	1	1	1	1	0	0	0	1	1	0	0	0	0	0	1	0	0	1	0	1	0	0	**21**
8			COM, DRL, MP, PEU, PU		INN, PR, INS, SI, SN, TP, PEU, UID, RD	TP, TRL, DRL, MR, PEC, FC	1	2	2	2	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	**21**
9		PEU (+), EE	INS (+), PR (+)	PEU	PEU, COM, SN, TR, MR, INN, IU, EE, DIS, PU, PR, INS		2	0	3	0	0	2	1	0	1	1	1	0	0	1	0	0	1	2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**17**
10	ATT (+)	COM, PU, FC,	TRL, INS, PR	FC, THC, PR (++), OQ, RD	DIS, BEL, OPT, PR, PEC, PBC	PR, INS, THC, GL	4	0	0	0	2	2	0	0	1	1	1	1	0	0	1	2	1	0	0	0	1	1	0	1	1	1	1	0	1	0	0	0	0	0	**23**
11		TP (+), FC, DRL, MP	PEU		TP, SI, SN, DRL	FC (+), SI (+), ATT, BEL, INN	0	2	1	2	2	0	0	1	0	0	0	0	2	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**14**
12		INS, PR, SI, SN, BEL, ATT	COM		SI, SN, ATT, COM, DRL, INN		1	1	0	0	0	1	0	0	2	0	0	0	2	2	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**13**
13	PEU, PU, PR, COM	PR, INS, PBC, DRL		PEU, UID, OU			2	1	2	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	**11**
							18	**21**	**17**	**17**	**14**	**14**	**12**	**11**	**9**	**8**	**9**	**9**	**8**	**8**	**7**	**6**	**4**	**4**	**5**	**5**	**4**	**4**	**4**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**238**

Table 5.1.3. Coded questions and their label scores, pre-weighing.

In Table 5.1.4. the final scores are shown, including the weights of elements.

Labels	Preliminary Score	Weight Modifier (+)	Weight Modifier (++)	Final Score
PR	18	2	2	**22**
DRL	21			**21**
PEU	17	4		**21**
TP	17	2		**19**
FC	14	4		**18**
INS	14	2		**16**
MR	12	1		**13**
MP	11	1		**12**
COM	9		2	**11**
PU	9			**9**
RD	9			**9**
SI	8	1		**9**
SN	8	1		**9**
ATT	7	2		**9**
TR	6			**6**
THC	6			**6**
DIS	4		2	**6**
EE	4		2	**6**
INN	5			**5**
VOL	5			**5**
TRL	4			**4**
PBC	4			**4**
UID	4			**4**
BEL	3			**3**
PEC	3			**3**
OQ	2	1		**3**
GL	2			**2**
IU	2			**2**
OPT	2			**2**
TTF	2			**2**
IMG	1			**1**
NE	1			**1**
OU	1			**1**
TKC	1			**1**
AU	0			**0**
BEH	0			**0**
CA	0			**0**
CP	0			**0**
CSE	0			**0**
JR	0			**0**
PCU	0			**0**
PI	0			**0**
UTI	0			**0**

Table 5.1.4. Final scores of the cross-reference analysis, including the weighing.

The preliminary and final scores are made visual in Figure 5.1.1.

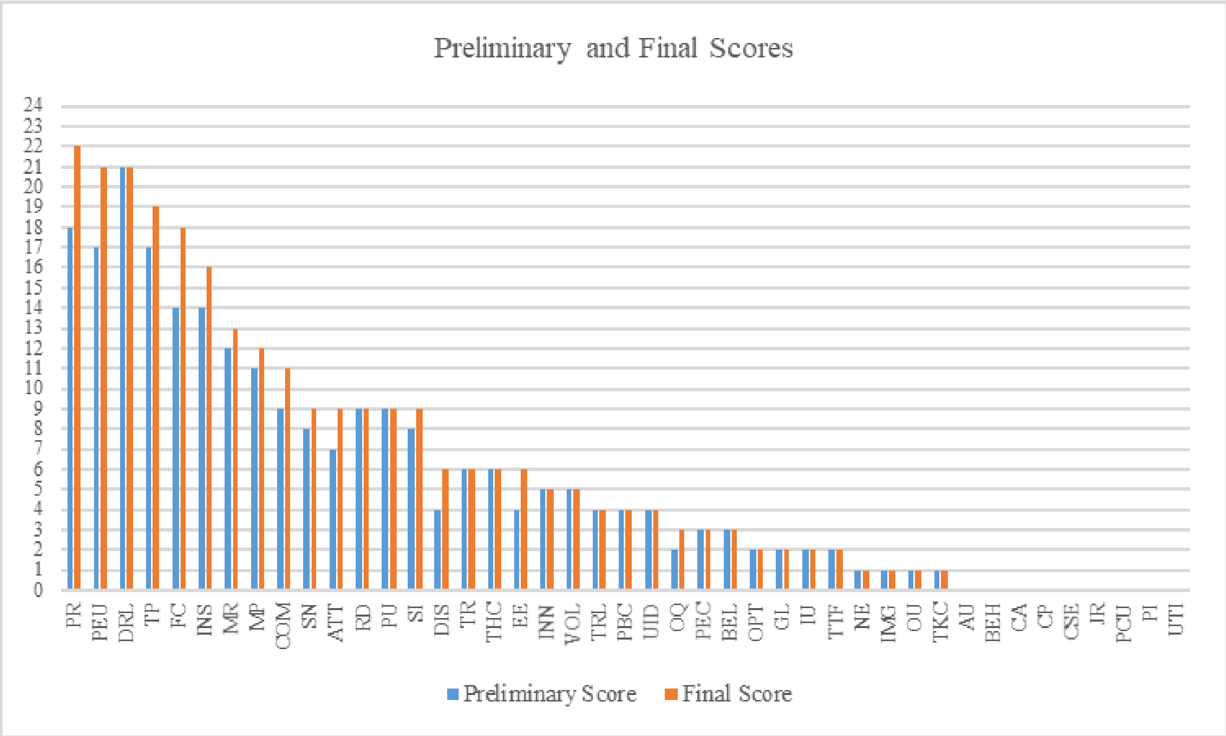

Figure 5.1. Visual representation of the scores in bar format, with preliminary and final scores.

Note that no weight factors of (--) or (-) were recorded, only (+) and (++). The number of occurrences of (+) add one additional point to the final count of an element's score, while the number of (++) elements are counted double. This is translated into a final score in Table 5.1.4., shown in the right most column. The number of occurrences of (+) and (++) is shown in Table 5.1.5.

Elements Weighted Important (+)	**#(+)**
FC (+)	4
PEU (+)	4
ATT (+)	2
INS (+)	2
PR (+)	2
TP (+)	2
MP (+)	1
MR (+)	1
OQ (+)	1
SI (+)	1
SN (+)	1

Elements Weighted Very Important (++)	**#(++)**
COM (++)	1
DIS (++)	1
EE (++)	1
PR (++)	1

Table 5.1.5. Number of occurrences of additional weighing on a label, with both (+) and (++).

The table has been colour-coded to emphasize important elements, and the models they were extracted from. With this information it is now possible to state with more certainty which elements and models are important for SSI adoption, diffusion and acceptance, which provides some handles to expand further upon.

Labels and their associated elements that didn’t receive a single mention were discarded right away. Furthermore, not all labels that did receive a one or more occurrences would be considered, given that there needs to be a significant number of occurrences, of experts talking about its relevance and importance to make it worthwhile to consider. Literature provides multiple possibilities for deciding a cut-off score, with no clear bias for the situation this research is examining. Thus, there is no conclusive literature on which method is best for deciding a cut-off score in the current context. However, the “MEAN+2SD” method provides a reasonably reliable and well-known way with which to determine values in a set that are significantly higher than the mean (Singh, 2006). MEAN+2SD is applied by calculating the mean of a set of numbers and the standard deviation. The standard deviation x2 is then added to the mean to obtain a confidence interval for which it is reasonable to presume it is significantly higher than other numbers in the set (Singh, 2006). It must be noted that this method is often used in statistical calculations, and even though the final scores of the interview coding aren’t statistical, this method nevertheless allows for a numerical approach to decide a cut-off score, instead of arbitrary selection of the top number of elements.

Table 5.1.6. shows the median, mean, standard deviation (and thus the calculated cut-off score) for final scores of Table 5.1.4.

	Full	**Rounded**
Median	**4,000**	**4**
Mean	**6,163**	**6**
Std. Deviation	**6,550**	**7**
Mean + 2xStd.Dev	**19,263**	**19**

Table 5.1.6. Calculated outputs of the Mean+2SD method.

The table shows a cut-off at 19. This leaves the four highest scoring elements to be considered for further analysis. These elements are:

- **PR**: *Perceived Risk* (Score: 22)
- **DRL**: *Demand Readiness Level* (Score: 21)
- **PEU**: *Perceived Ease of Use* (Score: 21)
- **TP**: *Technology Push* (Score: 19)

These elements are mentioned multiple times in the interviews. The views of the experts will help to better understand these elements and how they affect adoption, diffusion and acceptance of SSI applications. Therefore, the following paragraph will substantiate their importance by summarizing the expert’s words on the topics of Perceived Risk, Demand Readiness Level, Perceived Ease of Use and Technology Push.

Perceived Risk is understood as the potential risk a person perceives for use of a product, service or provider. Topics that were often mentioned by the experts as playing a large role for SSI were privacy, security, control over one’s own data and consent. These topics translate into a potential end-user’s, or stakeholder’s, fear of what might happen with their information, who handles said information, and what exactly is considered a TTP. That is to say, which parties would a potential user trust to facilitate an SSI ecosystem and handle their identity information on a daily basis. As was proven by the coding, labelling, weighing and scoring of the interviews and their answers, Perceived Risk was considered the most important element. Thus, especially Perceived Risk needs to receive attention moving forward.

Next, *Demand Readiness Level* is the degree of expression of need by a customer on a given market. In the context of SSI, the experts were mostly united in their views that there is no, and would not be, a demand from the market for SSI. This was a notable insight, as it did not mean that the experts were demotivated to further pursue SSI. On the contrary, they believed that SSI is nevertheless an important innovation to pursue, and an important milestone to achieve as it lays the groundwork for future innovations to be made possible. The general view was that if the market was asked if it wanted SSI, it would most probably not know what SSI is, let alone hold or generate a demand for it. However, when examining what standalone advantages SSI makes possible, such as privacy of data, control of data, consent and the like, experts stated that there is evidence from recent years that the market finds these important. This is noted by experts as being one of the reasons to further pursue SSI innovations. As this would mean that when SSI is eventually introduced into the market, it will prove itself to be useful and then generate its own demand. (Also known as technology push, which will be discussed further down this section.)

Furthermore, *Perceived Ease of Use* is one of the more straightforward elements. It is defined as the degree to which a person believes an innovation is easy to use. This was mentioned multiple times by experts as the most important aspect for the eventual success of an SSI application. This notion is however generalizable, as ease of use plays an important role in every product. If it is easy to use, users will at least not be deterred by unintuitive, or obstructive user interface and thus it will not give them reason to move away from the product or try alternatives. However, if it is not as smooth in use, it will chase users away, drastically impacting its commercial success. There was general agreement that for SSI to be successful, it must adhere to modern principles of user interface design and ease of use.

Finally, *Technology Push*. Technology Push is related to Demand Readiness Level which was discussed in an earlier paragraph. It is defined as the case of a producer or service provider first creating a product without an explicit need by the market beforehand, presenting it into the market, which would implicitly generate demand due to the evident advantages the products have. The connection between Technology Push and Demand Readiness Level becomes clearer now. Due to the low demand from the market for SSI that experts see, but nevertheless their high believe in SSI, they generally support a Technology Push approach for SSI and the market. Their hope is that when the technology is developed and commercially introduced into the market, the advantages they themselves see will become evident for potential end-users as well. This should then lead to greater adoption of SSI application, making it the preferred choice for digital identity solutions.

This chapter step-wise discussed the method of the cross-reference analysis, as well as presented its results. The output of this chapter showed that perceived risk (PR) is the most important concept from the examined literature which should be incorporated into the research and application surrounding SSI adoption and market success. To examine how this can be done, the next chapter, the Synthesis, will present a proposed model with PR as an addition.

6. Synthesis

This chapter will present and substantiate the output from the previous chapters. It will argue the modification of an earlier discussed model template for generating business models in a service-dominant, value-centred context, the Service Dominant Business Model Radar (SDBM/R). For the purposes of this report the modified SDBM/R template will be denoted as *mSDBM/R* (note the lower-case "m"). The chapter will have the following structure; first, the mSDBM/R is presented, with an explanation on how it ties back into the already performed research, and how the output of previous analysis influenced the decision on how, and why, to modify the original SDBM/R. Finally, a validation will be presented performed with experts to further solidify the justification of the mSDBM/R.

6.1. Modifying the SDBM/R

Chapter five of this document has shown that certain elements from the literature, from the fields of innovation acceptance, diffusion, adoption, market readiness and user interface design, are considered to have weight in the eyes of experts who are actively participating in the research and development of SSI and digital identity solutions. Recall that the analysis showed that there were four elements that scored highest based on the cross-reference analysis of the literature review elements and the output of the interviews. These elements were:

- **PR**: *Perceived Risk* (Score: 22)
- **DRL**: *Demand Readiness Level* (Score: 21)
- **PEU**: *Perceived Ease of Use* (Score: 21)
- **TP**: *Technology Push* (Score: 19)

The above elements can potentially be used to enrich and modify the existing SDBM/R. However, not all of them might be useful or make sense to add. As described in chapter 5.1, the experts that were interviewed emphasized that the DRL and TP play a role because they view that potential end-users do not actually demand SSI. Demand Readiness Level (DRL) is thus low. Therefore, they believe that Technology Push (TP) is the best way forward, developing the technology and fielding it into the market in the hopes of it eventually generating its own demand.

The original SDBM/R covers DRL and TP in the sense that from the very first inception of a business model idea, for any co-created value-in-use, the customer is involved in the creation process. Having the customer at the table when the business model is designed means that they are implicit in the creation of a solution, product or service which would be something that they would want, need, and something that would offer them value in the context of the ecosystem. This implies that DRL and TP are already solved with the original SDBM/R. To clarify, nothing is "pushed" into the market, instead the market (customer) is asked how to participate in the business model for some particular offering, which offers an alternative route to technology push (TP) method for SSI solutions which the interviewed experts were favouring. This also means that the market (customer) is asked whether or not a solution is something that they would want ("demand"), which is how the model incorporates the alleged low demand readiness level (DRL).

By contrast, when examining Perceived Ease of Use (PEU) it is an element which is on an entirely different dimension. PEU can be considered to be a given in today's product and service, and only comes into play after the business model is developed. Moreover, PEU does not play any relevant role in the stage in which the SDBM/R is meant to be applied, the business model design for the ecosystem of actors. Therefore, it is left out of the model, and is not considered to be further incorporated in any modification for the SDBM/R.

Finally, there is the Perceived Risk (PR), which is coincidentally also the highest scoring one from the chapter five, the Analysis chapter. PR proved to be a reoccurring and paramount element in the SSI and digital identity narrative with experts. This is reaffirmed by Sok Foon and Chan Yin Fah (2011), who did research on the effect of PR on internet banking and found it to have the strongest (negative) effect on decision to adopt. Additionally, PR is also an element that can be spoken about qualitatively during the SDBM/R workshop. Combined with the fact that PR was considered to be such an important factor according to the experts, the fact that it is possible to map it on the same dimension, and risk in general being relevant during the stage in which business models are drawn up, PR is used to modify the original SDBM/R to incorporate risk. This will also make it fit better with the context of SSI applications within the banking sector.

Since the SDBM/R as it was originally designed is meant to be filled in collectively by all actors involved in the co-created value-in-use during a workshop (Turetken & Grefen, 2017), the question of perceived risk must be examined through the same lens. Chapter five showed that Perceived Risk (PR) was proven to play one of the most important roles in the context of SSI and digital identity applications adoption success.

Seyedhoseini, Noori, and Hatefi (2009) describe how risk events and risk actions are tied together in their assessment and selection methodology of project RRA action. Their "risk events" are tied to PR in the context of this paper, as "perceived risks" can be seen as *perceived risk events*. From this point forward, when "PRE" is used, it means the same as "perceived risk event". Similarly based on Sayedhoseini et al. (2009), the associated "response actions" are the actions performed to counter a risk event. In the context of the SDBM/R they can be seen as potentials actions which are pre-planned to counter any perceived risks, or perceived risk events. For this paper, these concepts are coined "risk response actions" (RRA). This is done for clarity and standardization, so RRA mirrors the PRE. The advantageous aspect of the PREs and its RRAs is that they can be practically mapped on the SDBM/R, in a similar qualitative fashion as actor costs and benefits. However, it is not as straightforward as with costs and benefits. A substantiated decision must be made on how to implement this PR and RRA, as there are more dimensions in the SDBM/R and real life setting in which it is applied than only PRE and its associate RRA.

From this point onward, there is a clear distinction in meaning between *perceived risk* (PR), and *perceived risk event* (PRE), the former being the concept from literature which was uncovered to play an important role for the adoption success of SSI applications according to industry experts. And the latter being a specific perceived risk in an instanced mSDBM/R.

A PRE and its potential RRAs can be practically mapped on the SDBM/R, in a similar fashion as actor costs and benefits. However, how this is added to the model is not initially clear or obvious. A substantiated decision must be made on how to implement PRE and RRA, as there are more dimensions in the SDBM/R and real life setting in which it is applied than only PRE and RRA. For one, one PRE can be interpreted as only applying to one actor, while some other actor might not consider that same PRE. Instead, perceiving some other risk. Additionally, PRE can also be understood by all actors collectively as a risk for the entire ecosystem, which is a PR for the entire collective, so to speak. Moreover, this can theoretically be inverted, to be such that individual actor PRE may be mitigated by some collective RRAs. A method is required to, conveniently map the PREs and RRAs in terms of individual or collective impact and action. For this purpose, the PRE/RRA matrix is proposed, which is shown in Figure 6.2.1. below.

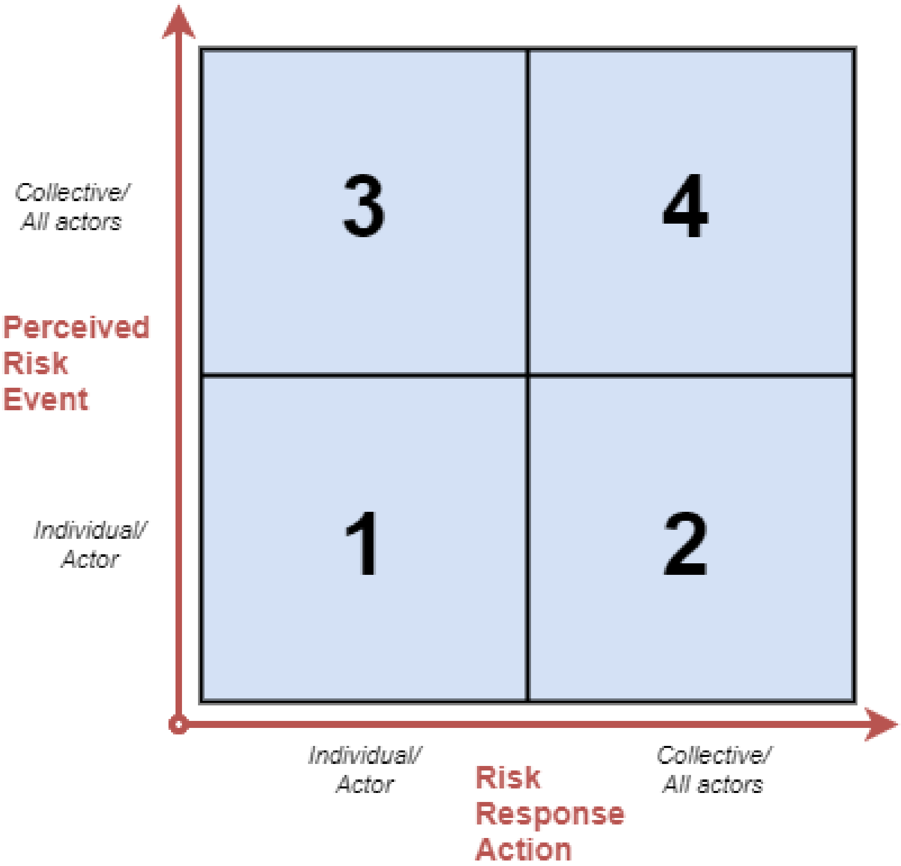

Figure 6.1.1. PRE and RRA matrix.

Each of the fields in Figure 6.2.1. allows for a potential combination for the mSDBM/R. Before further assessing the variants, the next few subsections will present the variant proposals. The variant numbers intentionally correspond with the numbered fields in Figure 6.2.1. above. Variant 1 is discussed in section 6.1.1, Variant 2 is discussed in section 6.1.2, Variant 3 is discussed in Section 6.1.3. and Variant 4 is discussed in section 6.1.4. The combination of PRE and RRA, when mapped in the matrix, can be further categorized to help better formulate follow-up actions to the workshop with regards to the risks.

This categorization isn't a required next step, as it may be unnecessarily detailed for the early stage in which a SDBM/R workshop is organized, but it may help the attendees of a workshop to understand what impact the PRE has, and if they can act alone to counter the PRE with an individual RRA, or if they require more actors from the ecosystem. Or, even the entire ecosystem. For instance, Vargo and Lusch (2015) and Bing et al. (2005) present micro, meso and macro categorization to risk. This is a rough categorization, but useful for analytical purposes (Vargo et al., 2015). *Micro level risks* are risks that may be present due to inherent differences between stakeholders in an ecosystem, or *actors* in the context of the SDBM/R. In addition, Bing et al. (2005) call these types of risks, *endogenous* risks. Endogenous are risks that may occur within the bounds or scope of the project ecosystem. I.e. in the context of an SDBM/R workshop, these risks could be risks that affect actors and their relationships directly, and can be influenced by them in some way They are related to the stakeholder, or actors, and not on the type of project that is being worked in. Vargo and Lusch (2015) also place individual level classification at this level, between B2B and B2C relations. *Meso level risks* represent implementation problems, such as demand and usage, location, design and technology. In addition, according to Vargo and Lusch (2015) these activities can for instance be related to industry and branding. Finally, *Macro level risks* are risks that may occur exogenously, or outside of the actor ecosystem, in the case of the

SDBM/R. These risks are outside of the project at hand, and are typically risks of the national, political, natural or macro-economic kind. (Seyedhoseini et al., 2009; Vargo and Lusch, 2015). Risks of this category arise outside the influence of the actors and their ecosystem but can transcend the boundaries of the project and impact it.

6.1.1. mSDBM/R Variant 1: Individual PRE and individual RRA

The first modified variant of the SDBM/R examines the risk per actor and asks each actor the question: *"What are perceived risks for you in the co-creation of the value-in-use in this ecosystem and how can one or more actors help mitigate this risk?"* This question needs to be answered first by, or for each actor individually. Following this, the actors individually may think of ways in which they themselves can counter their own risks, which other actors in the ecosystem can mitigate their risk, or in which way they can mitigate another actors' risk themselves. For example, if one actor runs the risk of high storage costs during one of the process steps, another actor may recognize that they can withhold shipment based on inventory levels, perhaps pushing actors to integrate their logistic operations better. Figure 6.2.2. shows the variant of the mSDBM/R with the addition of one outer layer (in yellow) for Actor PRE and RRA.

Figure 6.1.2. mSDBM/R Variant 1. Individual PRE and RRA

The additional layer allows for the risk and RRA per actor to be filled in the same way as actor costs and benefits for each actor are filled in. One of the advantages of having actors providing their own risks during a workshop is that other actors can help identify them and offer ideas on how to mitigate them, or even offer solutions by their own actions.

6.1.2. mSDBM/R Variant 2: Individual PRE and collective RRA

The second variant of modifications asks the attending actors: *"What may be perceived risks you that could be mitigated by a collective RRA?".* This variant is conceiving of a situation wherein the collective of actors, the ecosystem as a whole, acts to mitigate a PRE of one or more individual actors.

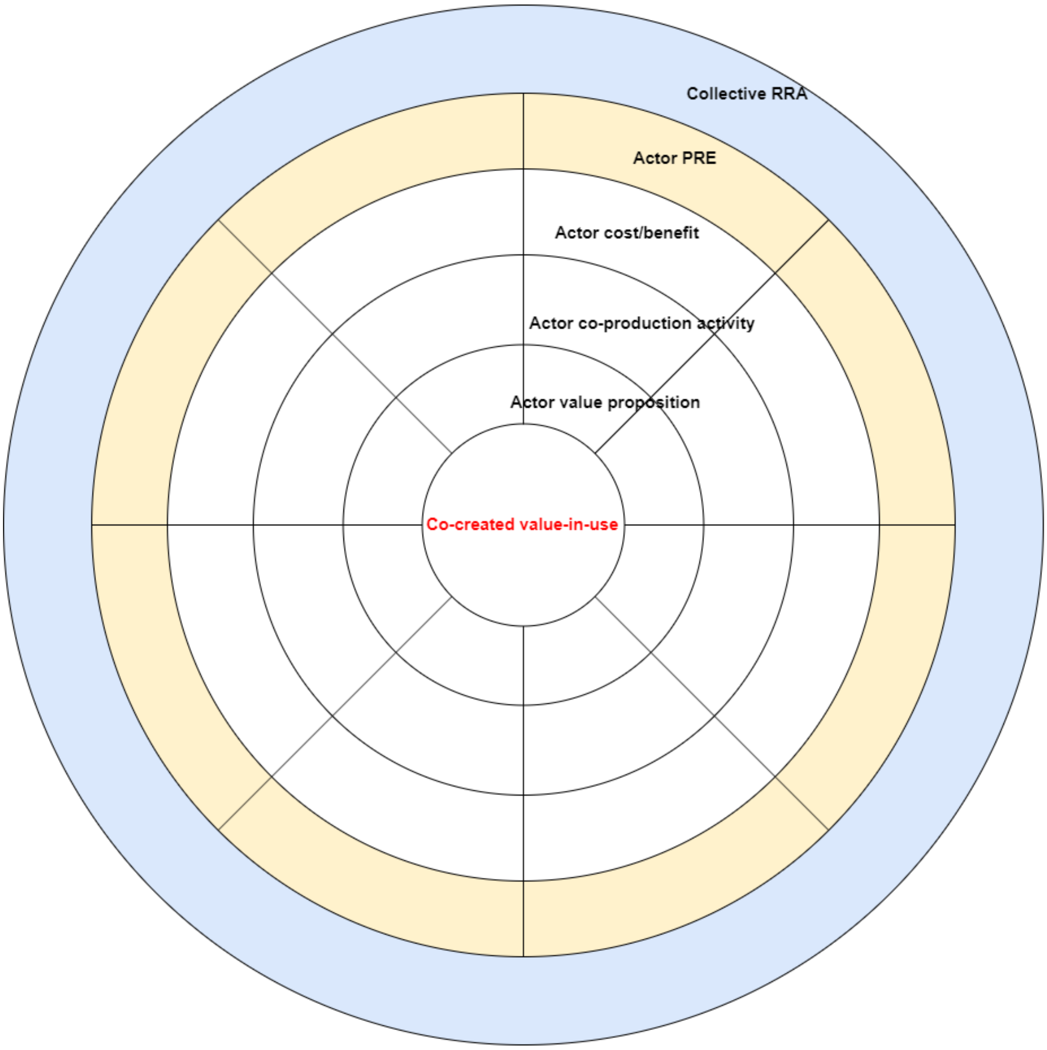

Figure 6.1.3. mSDBM/R Variant 2. Individual PRE and collective RRA.

6.1.3. mSDBM/R Variant 3: Collective PRE and individual RRA

The third variant of modifications poses the actor the question: *"What is the collective risk we have as an ecosystem and what actions can each actor potentially take to help mitigate that risk?"*. The question is two-fold. It first asks the actors to collectively identify a collective PR in a similar fashion as they identified the co-created value-in-use collectively. Then it challenges actors to think of ways in which they can help to counter the risk individually. Variant 3 thus uses a collective PRE, while allowing individual RRA by actors to be proposed during the workshop, as is intended in Variant 1. Although in contrast to Variant 1, where actor PRE and RRA are mapped in the same field in the model, Variant 3 has a separate field for actor RRA only, with the risk being collective. Figure 6.2.4. shows the variant with the collective PRE in yellow, and the actor RRA strategies in blue.

Figure 6.1.4. mSDBM/R Variant 3. Collective PRE and individual RRA.

6.1.4. mSDBM/R Variant 4: Collective PRE and collective RRA

The first modification variant encompasses the entire ecosystem and poses the question to the actors: *"What are risks that may affect all of us, the ecosystem, in our goal to co-create the designated value-in-use and how can we collectively as actors help mitigate that risk?"*. This question is posed to all actors simultaneously. The goal is for them to identify a possible collective risk and then also a collective way in which they may mitigate this risk. For example, the actors collectively might identify a potential risk as being customers growing tired of the proposition over time. They may then provide a possible RRA in the form of annual strategy sessions in which they collectively adjust their business model to fit the new needs of the customer. Figure 6.2.5. is a visual representation of Variant 4 with combined collective PRE in yellow, and the potential collective RRA in turquoise.

Figure 6.1.5. mSDBM/R Variant 4. Collective PRE and collective RRA.

6.1.5. *Summary and selection of mSDBM/R variant*

Figure 6.2.6. shows the mSDBM/R variants mapped in the PRE and RRA matrix from Figure 6.2.1.

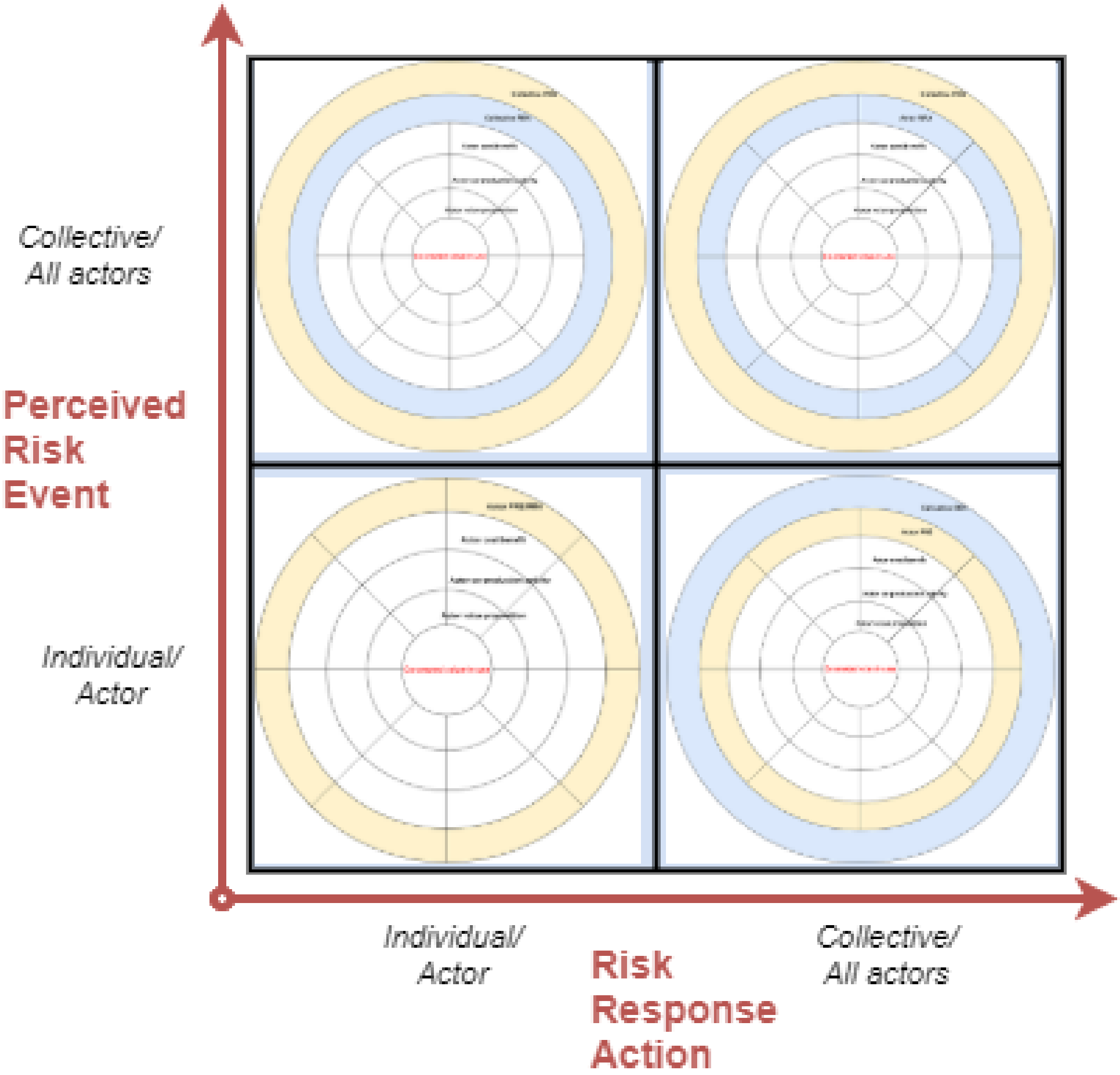

Figure 6.1.6. The mSDBM/R variants mapped onto the PRE and RRA matrix for visual aid.

The addition of PRE and RRA strategies can be a combination between both actors individually, and the ecosystem as a whole perceiving certain risks and thinking of methods counter them. However, due to the way the original SDBM/R is instanced, through the workshop, one of the methods must be selected so to make it feasible to think about with the present actors in said workshop. One variant must be chosen. A number of experts from the bank were asked for their view on the mSDBM/R. With their experience in developing high tech innovations in tightly-knit ecosystems, their views are valuable to assess the usefulness of the variants and select the most fitting one. The method of assessment and validation is discussed in the following sub-section.

6.2. Expert validation and selection of the mSDBM/R variant

This subsection will present the selection method for the initially proposed mSDBM/R variants as well as the validation for the eventual selection of the method. Validation is meant to ensure sufficient accuracy of the model in terms of the purpose of what is meant to be achieved and whether it is right in general terms (Kappelman, 2014). The validation is needed for the proposed mSDBM/R, because it is a newly proposed addition to the original SDBM/R, with the addition of risk. This validation is intended to reinforce the relevance of the addition of risk, and the selection of how the risk is added through one of the four variants which were earlier presented.

6.2.1. Expert selection for validation

The selection was performed by requesting the input from a number of internal experts at the bank. This approach is akin to purposive sampling as presented by Patton (2002), in which experts are selected based on their involvement and specialization in SSI projects, blockchain projects or projects involving other ecosystem-oriented solutions. This enforces their relevance as sources for input on the implementation of a PRE and RRA perspective into the original SDBM/R. An overview of the anonymized experts is shown in Table 6.2.1.

Expert label	Function	Seniority	Involved ecosystem project
EV1	Blockchain Specialist	Medior	Involved in the project management and development of an international trade platform for SME's facilitated by a consortium of European banks.
EV2	Team Lead	Medior	Leads multiple teams, doing research in various emerging technologies. Manages cooperation with various stakeholders in a number of ecosystems.
EV3	Technology Innovation Manager	Senior	Lead the initial research project at the bank into the Ripple crypto currency and its possible applications.
EV4	Technology Innovation Developer	Senior	Involved in most other mentioned projects as both technology specialist, as well as developer.
EV5	Technology Innovation Manager	Senior	Involved in development and research of a blockchain based payment ecosystem intended to facilitate payments for usage of products and services, as opposed to ownership.
EV6	Technology Innovation Manager	Senior	Involved in the project management of the introduction of a trade commodity platform for the European energy sector.

Table 6.2.1. The experts used for input to validate and choose a mSDBM/R variant.

6.2.2. Validation method

The validation of the addition of PR into the original SDBM/R was done by organizing individual meetings with the experts. During the meetings the theoretical background was briefly explained, including the original SDBM/R and it's intended use. The output from the analysis was added to the explanation, in which PR showed to be of great importance according to various external stakeholders, especially in the context of SSI and ecosystem-oriented innovations.

The experts were then first asked globally whether or not the addition of the aspect of Risk would be a valuable one in the context as intended by de SDBM/R workshop. I.e. a setting in which various actors come together and provide input to map a blueprint for a service-dominant business model for realizing a co-created value-in-use for a customer. In this setting, where the actors speak of their value propositions, services they add to make the co-created value-in-use possible and actor costs and benefits; is it valuable to ask the actors what might also be risks they perceive as playing a role, and do they have ideas on how these mentioned risks could be mitigated?

There was consensus by all experts that the addition of risk into the model would be valuable, which enforced the idea that at least the addition of PR, as is suggested by the analysis chapter, would be a valuable additional topic for discussion during the SDBM/R workshop.

Following this first validation, the experts were then presented with the four variants of the model, followed in turn by a back and forth discussion about each variant. The paraphrased feedback of the variants, if any, is shown in Table 6.3.2. Right after each piece of feedback, the table shows the expert label in brackets. The answers on the various models gives an idea of the type of input the experts provided. One drawback of this method is its qualitative nature and the limited number of individuals asked. However, the addition of scoring in the next paragraph allowed for an extra level robustness.

Variant 1	Variant 2	Variant 3	Variant 4
Due to the fact that actors' risks are mostly all unique, this variant more accurately represents the individual actor input. (**EV5**)	Due to the fact that actors' risks are mostly all unique, this variant more accurately represents the individual actor input. (EV5)	Variant 3 is dependant is very case dependant, as it would most likely be rare to have situation in which individual actors would take measures to mitigate an ecosystem-wide perceived risk. (**EV1**)	This variant equalizes the risks for all actors collectively. However, it would not be very realistic to presume that risks would often, or ever, be equal for each actor. (**EV2**)
This variant allows for the possibility of identifying potential actors who are not present at the workshop, but who would be valuable to add to the ecosystem. E.g. risks could be named, while actors who are already present might not have the means to mitigate them well, or at all. Which in turn would force the question, what kind of actors might we be missing? (**EV4**)	This variant would be an illogical and superfluous variant. Realistically actors would not decide to mitigate risk collectively beforehand. If they do, this scenario is covered by Variant 1. (**EV4**)	This variant equalizes the risks for all actors collectively. However, it would not be very realistic to presume that risks would often, or ever, be equal for each actor. (**EV2**)	
This variant is the purest one. It allows for collective PREs to be mapped as well by mapping it in all actors' fields in the mSDBM/R. Furthermore, just as with cost/benefit, you can apply + and - to fit with the qualitative theme of the SDBM/R during the workshop. (**EV6**)		Very few possible actors would fit with this variant. Most likely only the government, if they were represented as an actor during a workshop, would take individual mitigating steps to tackle ecosystem perceived risk. (**EV3**)	
		The timing of this would most likely be off. This variant would more likely be fitting in a later stage, as in, risks that threaten the entire ecosystem, would probably be mitigated by individual actors once they become apparent. Individual actors would not decide to mitigate a collective risk beforehand. (**EV4**)	

Table 6.1. Some statements (paraphrased) from the experts on the four variants of the mSDBM/R.

6.2.3. Validation results

Hereafter the experts were asked to provide a global score, based on their own interpretation, of the four variants. The scoring is done from 1 to 5. The experts were asked to do so based on their view on the model usability and usefulness for their context of blockchain SSI in mind. That is to say, they were asked to score the models based on how they perceive it fits their specific context within the bank. This method is similar as the one presented in the paper of Al-Aaidroos, Jailani, and Mukhtar (2019). Each of the models is not meant to be better or worse than the other, rather, they are scored based on how well they qualitatively fit the experts' context and views. Table 6.3.3. shows the scores per variant by each expert. It clearly shows Variant 1 being preferred by the bank experts, with a final score of 24 out of 30 points.

Expert	Variant 1	Variant 2	Variant 3	Variant 4
EV1	4/5	1/5	2/5	4/5
EV2	4/5	3/5	1/5	1/5
EV3	2/5	4/5	3/5	4/5
EV4	5/5	1/5	4/5	2/5
EV5	4/5	5/5	3/5	2/5
EV6	5/5	3/5	3/5	1/5
Total Scores	**24/30**	**17/30**	**16/30**	**14/30**

Table 6.2.The final scores per expert and variant.

Based on all of the above, the highest scoring variant is Variant 1. In addition to the highest score from this quantitative expert validation method, Variant 1 has a few qualitative advantages in context over the other variants. These are:

- Collective perceived risk could also be conceptualized when all actors in an ecosystem individually state that they happen to share a perceived risk. The one additional layer to the mSDBM/R Variant 1 is sufficient to map collective PR in this sense if a risk can be added for all actors. There wouldn't be a need for a separate collective PR field.
- Likewise, a collective RRA strategy could theoretically be mapped if all actors add the RRA strategy to their field. Which means an entire separate collective RRA field would be superfluous. In addition, collective RRA strategies don't possess the granularity which would be preferred to map a blueprint of a cooperation in an ecosystem as intended in the original SDBM/R.
- The field of the actor cost and benefit in the original SDBM/R has a format which could be applied similarly to the actor risk and RRA field as proposed in Variant 1. Actor cost and benefit are qualitatively mapped using + and – to indicate positive and negative net effect. Same could potentially be done for risk and RRA.
- Moreover, similar to how in the original SDBM/R costs and benefits of one actor can affect the costs and benefits of another actor (e.g. one actor pays a fee (-) while another actor receives that fee (+)), risk and RRA can also be applied between actors. One actor could offer an RRA idea they themselves could perform to take away another actors' perceived risk. This potential method fits with the current way the model is used during the workshop with regards to costs and benefits.

In conclusion, Variant 1 is chosen as the variant to represent the modified SDBM/R (mSDBM/R). The model is used in the same way as the original SDBM/R as described by Turetken and Grefen (2017), with the only difference being that an additional step is added to the workshop format of the SDBM/R. The step is added at the end, after the high-level actor co-production activities are defined, which is usually the final step of the workshop (Turetken & Grefen, 2017). A standard flow for the workshop of the original SDBM/R can be found in Appendix M.

This chapter presented an original model, which was modified by the proposed addition of PR, as it was shown to be crucial to address for adoption success. The winning variant of this chapter, Variant 1 will be taken further to be applied in the following chapter. The following chapter will thus dive into more detail on the case which was chosen for this paper. It will additionally also detail the workshop and the results of the research.

7. Case study: Blockchain-based SSI career credentials application

This chapter will go in-depth on the focal project on which the insights and info learned from the literature and the expert interviews will be applied and thus tested in a real-life environment. Moreover, the mSDBM/R will be applied in a real life setting for the first time.

As is evident from the title of this chapter, and as was mentioned earlier in this document, the project which will act as case for the case study of this thesis is an internally developed blockchain SSI application (BBSA), which holds career credentials, such as diploma's, experience, references etc. The rest of this chapter will first in more detail describe the project, and what it entails. Next, the method of analysis will be discussed, followed by a detailed explanation of one important aspect of the method, the workshop. Finally, the results from the workshop will be presented and discussed, and how they tie into the larger picture.

7.1. Detailed description of Blockchain- based SSI career credentials application

The BBSA is a piece of software being developed and tested by the organisation in cooperation with a number of external parties. The application is essentially a blockchain-based "wallet" which holds an individual's credentials pertaining to their CV, diploma's, references and other miscellaneous certifications. The software is in this sense similar to other crypto-wallets, as seen with crypto currencies. The main difference being the saving of credentials as opposed to crypto currencies.

The incentive for the development of the wallet came from the recognition that the working world is changing as fast as technology and industry is changing. The retirement age is rising, employees switch their jobs sooner than ever, they are required to learn new skills constantly due to the changing working world and they preferably want to be owner of their own data and information.

This translates into potential opportunities for HR and for business in general. HR could facilitate the flexible, always-learning employee of the future with fast, safe and user-friendly software solutions. This could mean less problems with fraud, higher accuracy of information, faster onboarding to prevent loss of talent by applicants leaving during the process, and lower-cost onboarding processes. In addition, the employee receives back control over their own data, which is the underlying goal and principle of SSI.

Currently a blockchain SSI application for career credentials is in its pilot phase with a couple of partner organisations. It is attempting to solve four main frictions that both applicants and HR departments face. First, a lot of time is spent on handling references and certificates by both candidates and HR departments. Second, it is difficult to validate the authenticity of credentials of candidates. Third, to stay compliant with regulatory laws, validation of all certificates is difficult. And lastly, as mentioned before, the data of the applicant is not the applicant's once they apply.

Thus, the blockchain SSI application for career credentials allows for the collecting and persistently storing their references and other credentials. The references are received in the wallet periodically and automatically, sent by the employer. This way, all references are already on the wallet and available to be shared right away by an HR department for screening, which speeds up the screening process, while ensuring the applicant remains owner of their data.

Furthermore, once an applicant passes any exam which are required by law, such as the Dutch WFT, the issuer of the certificate immediately creates a record which the wallet holder can download to his or her wallet. The holder thus obtains an authenticated digital credential with, according to involved HR screeners, credibility equal to a physical certificate.

Finally, the BBSA for career credentials allows the process of checking for compliancy to be more efficient, trustworthy and significantly faster, due to the possibility to verify them digitally. In addition, the data of existing employees is in principle always up to date. This is possible because the employee’s wallet can push the data of any new certification to the HR department, updating their records immediately, which means that whenever an employee wishes to move jobs, all their data will be complete, correct and up-to-date.

Even though the development of the application is pretty far along, employees of the bank working on the application are currently facing questions surrounding whether the different parties that would have to use the application in the future will actually adopt the application in their processes. Moreover, whether there is a sustainable business model with the necessary cooperation of all relevant parties. Therefore, this application was selected as a case study for the application of the new mSDBM/R, as the application of this model could lead to relevant insights with regards to adoption for this specific application.

The four elements that were identified as being important, based on the analysis in chapter five are used as input. The basis for further analysis will be the SDBM/R as described by Turetken et al. (2018), which was additionally identified in the literature as possibly being a valuable model to examine in the context of SSI. This is due to the fact that SSI as an innovation, by its very nature, will require an ecosystem of stakeholder (actors) to cooperate and co-create a value proposition for end-users. The SDBM/R is applicable in exactly such contexts. To potentially make the model fit even better with an SSI application and the ecosystem the blockchain SSI career credentials application of the bank is established in, the model will be (where necessary) enriched and modified with elements that, according to the analysis of the literature and expert interviews, are relevant factors with regards to the adoption, diffusion and acceptance of an SSI application specifically

Figure 7.1.1. shows the original SDBM/R.

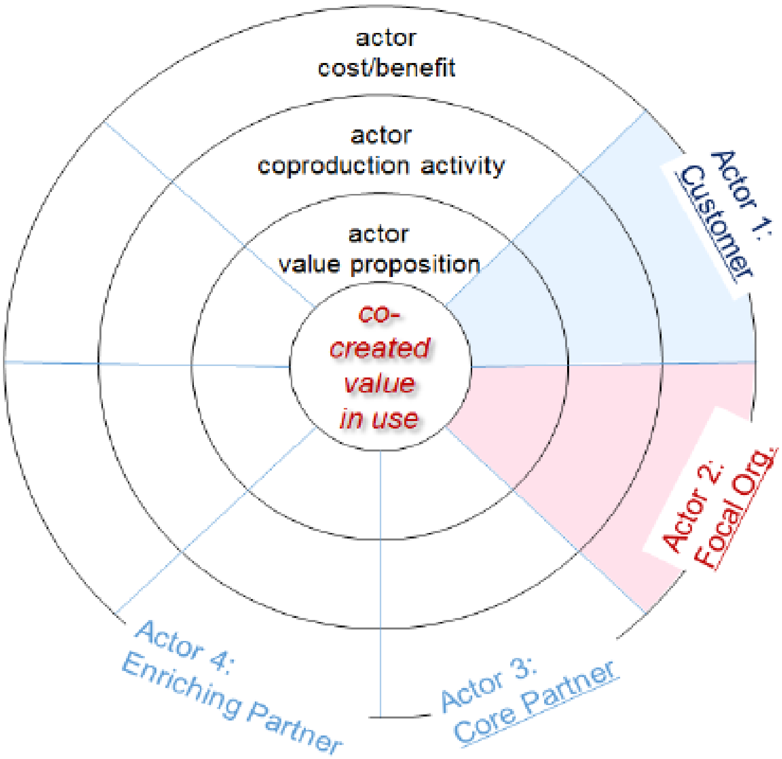

Figure 7.1.1 The Service Dominant Business Model Radar (SDBM/R)

7.2. Workshop explanation

The filling out of the SDBM/R model is done in a workshop setting as described by Grefen and Turetken (2017). The mSDBM/R follows the same method, with the only addition being the risk and risk action step. During the workshop, a number of presumed stakeholders are invited to attend. The set of stakeholders, or "actors", as the model denotes them, are as complete as possible for the intended co-creation of the value-in-use for a customer segment. During the workshop it may also appear that some actors could be added to the group for future examination of the co-created value-in-use and its business blueprint if they appear to be missing for the co-created value-in-use at hand.

The workshop especially adds value due to the dynamic that emerges when all actors need to collaboratively fill in the fields in the SDBM/R. In this context discussions arise around what a certain field should be, which terms exactly to use and how fields fit together. This dynamic ensures that preliminary mapping of the ecosystem is in such a way that it feels positive for all actors, as they all work to map it as positively as possible for themselves. In addition, in this phase they can also identify cost and benefit flows between them, and in the case of the mSDBM/R, they can also help each other in case of perceived risks by one actor that can be countered or prevented by the actions of another actor.

The intended flow during the workshop is done by first inviting industry experts who have some relation with the ecosystem and the intended designed business blueprint. Preferably these experts are part of the actual organisations which would be depicted in the instanced model as actors. Then the following steps are performed (Grefen & Turetken, 2017):

1. First, the attendees must decide together with all actors for which co-created value-in-use the model will be filled in during the workshop.
2. Next, the attendees must decide together for which customer(segment) the co-created value-in-use is intended. The co-created value-in-use is always tied to one specific customer (segment), and vice versa. For other and each combination of co-created value-in-use and customer (segment), a new model must be filled in fresh. In addition, it must also be decided for each customer (segment) how that customer experiences the realisation of the creation and delivery of the co-created value-in-use.
3. Decide which actors will be added to the model, as well as their actor roles. As mentioned earlier, it is preferable if the attendees of the workshop also truly represent the actors or actor organisations.
4. Following this, each actor's value proposition needs to be filled in. This is the part of the co-created value-in-use which each actor contributes to individually.
5. Now for each actor the cost and benefits are mapped. This is done qualitatively, for both financial and non-financial costs and benefits. The flows between the actors can be visualised using arrows between their respective cost and benefit fields. This may later serve as potential input for a customer journey, or "customer experience".
6. The next step is defining the co-production high-level activities of each actor in the eco-system. These are the activities that each actor performs in the business to contribute in the co-creation of value (the actor value proposition). These activities are what the customer is able to directly observe and can therefore be part of the customer journey. In addition, these activities can be mapped in detail in a later stage to business processes, executed by the various actors.
7. The final step, which is only necessary in the case of the mSDBM/R, as opposed to the SDBM/R, is the definition of possible perceived risks events (PRE), and risk response actions (RRA) which each actor sees for themselves, or for other actors. This is added because the literature and expert interviews in the previous chapters have shown that perceived risk can

have an impact on the adoption of new innovations. The addition of perceived risk in this manner will allow for early awareness of potential risks, and it will stimulate actors to come up with ways to counter those risks in the form of risk response actions. Similar to the cost and benefit field, this also allows for actors in this stage to help each other with possible risk actions in the ecosystem so as to minimize the effect of perceived risks in the ecosystem.

The workshop was organized during a session at the bank, with 12 participants from various departments in the bank. No real actor parties were present from the real pilot project, but the individuals who directly communicate with those external parties were present and would play the role of the external party in the workshop. For the purposes of this workshop, the mSDBM/R was used, with the added risk and risk action ring. This was done to test the model in practice. For reference, the model is shown again, in Figure 7.2.1.

Figure 7.2.1. The mSDBM/R. With PRE and RRA.

During the workshop the mSDBM/R was filled in partly during the allocated time. Later individual meetings with various attendees were planned to re-examine fields and finalize the mSDBM/R instance. The image shows e picture of the workshop, on the bank location.

Figure 7.2.2. Some photographs from the SDBM/R workshop at the organisation with professionals from various departments.

The next subsection will discuss the results of the workshop. It will include a filled in mSDBM/R as was the result of the workshop. Additionally, it will analyse the results and offer a potential concrete advice.

7.3. Results from mSDBM/R workshop

The visual of the final filled in model was left out of this document out of confidentiality reasons. The evidence that supports the results as they were implemented into the model was based methodologically on a combination of note-taking during the workshop, as well as summarization of one-on-one conversation with some of the attendees, to complete the picture when necessary. As such, the model shows 8 actors. These actors are as follows:

- *Applicant (Client):* This is the person applying for a new position within the organisation, required to provide their credentials for a check. The attendees together decided that this is the intended client in the mSDBM/R. One of the reasons why this was the case, is the internal wish of the bank to facilitate employee mobility, retention and satisfaction in terms of the application and onboarding processes.
- *Call centre (Focal organisation):* The call centre of the organisation was appointed to be the focal organisation, as it is the department within the bank which is receiving the applicants and therefore the main department to facilitate or organise this co-created value-in-use for the client (applicant).
- *Secondment agency:* For the case of the blockchain SSI, the secondment agency is the actor which pre-filters and provides the applicants to the focal organisation. This actor screens applicants beforehand manually, and connects them to the potential hiring organisation, such as bank.
- *Training and certification company:* This is a private company whose business revolves around providing training and certification for professionals. One of the certifications they provide are the WFT certificates which are often mandatory for work in the financial sector.
- *Governmental central party which stores certification data:* this is the Dutch governments' education implementation service. This organisation stores certification data such as diplomas.
- *Internal Managed Service Provider (MSP) department:* The goal of the MSP is to connect supplier and client, or in this case the secondment agency and the call centre in terms of external hires. The MSP facilitates everything from the demand for external personnel to the drafting of the contract between supplier and client. The department was represented at the workshop and would use the career credentials application for their selection and placement of professionals internally at the bank.
- *Identity Access Management Department*: This is the department at the bank which provides access or authorizations to various IT resources in an effective controlled manner. It is the link between the business and authorization to various resources.
- *Manager*: The manager is the hiring manager who would be accepting an applicant in their team. The attendees of the workshop chose to add the hiring manager as a separate actor due to the distinct tasks and responsibilities the manager has as opposed to the call centre. It also makes the function of the manager more generalizable.

The application of the model on the blockchain SSI career credentials application case led to various insights that may be relevant for possible future adoption of the innovation, as well as add generalizable knowledge on the application of the model in such a setting.

The application of the model confirmed that indeed multiple relevant actors are necessary for the innovation to be possible, and probably more than were able to attend during the workshop. Filling in the 'actor value proposition' and 'actor co-production activity' made clear to the participants that they all have different (but important) roles. For example, the secondment agency was essential for the screening of possible applicants where a party such as the governmental central party which stores certification data was essential for the access to necessary information surrounding diplomas. Without the cooperation of any one of these actors, the innovation cannot reach its (full) potential.

The perceived usefulness differed for the various actors. For some actors, during the workshop, mostly pros were identified such as saving time or money which would help the actors to focus on their core business. As literature has shown that perceived usefulness is linked to adoption, the identification of these benefits can help with the launch of the innovation in the market. However, for some actors the benefits, and therefore the perceived usefulness, wasn't as strong as for others. Or, there were also cons surrounding participating in the innovation (such as high investment costs) which could lead to risks surrounding adoption early on.

The topic surrounding perceived risk led to some valuable conversations and insights. First, when asked whether they believed that risk would be a valuable addition to the model, due to the potential to generate early awareness for it among actors in the ecosystem, the attendees stated that it was. This supports the proposed addition of PR to the original SDMB/R model. When examining the exact mapping of PR during the workshop, for different relevant actors different possible perceived risk events (PREs) were identified. For certain risks, risk response actions (RRA) were defined that could possibly counter the risks. For example, a manager mentioned that a too fast and automated screening might be a PRE as it could lead to a less optimal selection of the right candidate. Building in manual checks was then proposed as a possible RRA. However, for certain risks no possible risk actions were identified during the workshop. If these risks remain present in the minds of actors, they could adversely affect adoption in the future. This however does show that the addition of risk in the model has led to early awareness of risk with actors in the ecosystem and can therefore positively affect adoption in the long-run, if actors communicate and act upon perceived risks in the ecosystem.

Furthermore, it seemed that most PRE and RRA that were mentioned could be denoted as being on the *micro* level, as opposed to *meso* and *macro* (Bing et al., 2005; Vargo and Lusch, 2015). This could mean that the setting, the type of attending actors, or the innovation played a role. But this would require closer examination.

An additional point of interest to mention with regards to the risk aspect of the mSDBM/R, is that during the workshop a large proportion of the attending actors mentioned PREs they saw may cause a problem for the "Onboarding in 1 day", which would actually be inherently solved by using the blockchain SSI career credential application. This could be due to the newness of the model and the setting in which it is applied, or the quality and clarity of the explanation beforehand. One aspect that could have negatively affected the quality of the workshop is the duration. The duration of the workshop was forecasted to be around 2 hours, with one model meant to be filled in about half an hour. From applying the workshop at the bank this was proven to be too little time, at least for this group of professionals. Whether it was the type of innovation, the sector or some other aspect that made it so that there was too little time (such as, once again, the quality of explanation beforehand). Most of the previous applications of the model were done in the mobility domains, with a few applications in healthcare and agri-food (Grefen and Turetken, 2017). Therefore, it might be advisable to research the applicability and usability of the model in the financial sector and for innovation departments specifically, as the number of times the model was applied in these settings is limited.

This chapter presented the case study method of this research, in which the proposed modified SDBM/R model, the mSDBM/R, was applied in a real-life setting at the bank. The results of the workshop were also presented, and their possible implications. The following chapter will be the conclusion and discussion, in which more detailed implications from the case study and the wider research will be discussed. These will be both academic, as well as practical. Some possible managerial advice will be provided as well.

8. Conclusion and discussion

In this chapter the findings of the research and conclusions will be presented and discussed. Furthermore, the chapter will offer some potential managerial implications based on the research output of this document. The research questions and the answering thereof will be the jump-off point for the conclusion and the discussion. Finally, potential managerial implications will be provided.

8.1. Conclusion & discussion

In this thesis an answer was sought to the question which success factors, failure factors, or other relevant elements for market and business success should be emphasized when developing an SSI application from a customer-centred and service dominant perspective. An extensive literature review showed that many elements can play a role. Expert interviews were used to determine which elements and factors seemed most relevant for an SSI application innovation. This was followed by a cross-reference analysis and finally a modification of an existing model. The model was applied to a real-life case at the bank. Through this process, the research question was answered by answering the four sub-questions.

Recall from chapter one that the research question and the sub-questions are:

Research Question

"Which success factors, failure factors, or other relevant elements for market and business success should be emphasized when developing an SSI application from a customer-centred and service dominant perspective?"

To answer the above main research question, the sub-questions have been answered. The combined answers of all sub-questions implicitly answer the main research question.

1. What aspects and dimensions of innovation adoption, diffusion and acceptance are revealed to be relevant for an SSI application based on a scientific literature review?

The first sub-question is answered in chapters four and five. Chapter four presented a literature review on the topics of innovation diffusion, adoption, acceptance, risk, user interface, market readiness, business models in general and service dominant business models. This literature review of chapter four provided the basis and input for chapter five, where in Table 4.6.1. the list of elements relevant for innovation adoption success from the literature review were presented. This list of elements provides the answer to sub-question 1.

2. What believes about adoption of an SSI application do experts from the industry hold, based on their coded answers from an in-depth semi-structured interview?

To answer the second sub-question, various experts from the industry were interviewed. These experts were chosen based on their involvement in projects with SSI or digital identity. Their answers showed that they view SSI adoption as needing to be stimulated from the side of the developing and facilitating parties. There was generally broad agreement that most regular consumers would either not know what SSI is, let alone what problems it could solve, or value it can create. There is no *demand* for SSI applications from the market. Therefore, the experts believe that to achieve adoption of this innovation, the technology must be developed first, in cooperation with other facilitating or developing parties, and then presented into the market. The potential of SSI will be proven after its introduction into the market. Thus, the experts believe that Technology Push (Paun, 2011) needs to happen. Furthermore, while they believe that a robust business model is required for SSI products to make them feasible for the developing and facilitating organisations *and* successful in the market, they do not believe that it is the priority in the short-term. The focus should remain on developing solutions that are technologically functioning. If that means that in the short-term the innovation adds some value or saves some cost in their respective organisations, that is a welcome bonus, but it is not the goal.

3. What elements can be corroborated between the scientific literature review and the semi-structured expert interviews by performing a cross-reference analysis?

chapter five presents the cross-referencing method used to corroborate the elements from literature and the input from the interviews. The elements from literature which were important for the experts were perceived risk, demand readiness, perceived ease of use and technology push. Considering the answer to sub-question 2, these four elements were no surprise, as they confirm quantitatively what was already hinted at in the qualitative interviews. There were other elements that scored high in the analysis chapter, but due to the cut-off method used, they were discarded for the purposes of this thesis. Some of the other high-scoring elements were facilitating conditions, market readiness, insecurity and market pull. Note that these are also related to the top scoring elements by varying amount. This further solidifies the top-scoring elements' position in the analysis.

4. What insights can be derived from the application of a service dominant business model in a workshop setting, modified based on the input from the cross-reference analysis, to develop a blueprint for a business model for SSI applications?

The mSDBM/R was applied to a real-life case (the blockchain SSI career credentials application), which was described in chapter seven. The main insights from that application can be summarized as follows;

The generation of a business model blueprint around such a technological innovation which is dependent on the successful cooperation and implementation of multiple actors in an ecosystem, becomes increasingly infeasible and difficult if actors drop out. It emphasizes the importance of actor involvement not just for the co-creation of value-in-use for a customer (as is the intention of the SDBM/R), but to be able to move forward with a cooperation at all.

The SDBM/R is not only useful for generating business model blueprints between different organizations. It can also be used to generate an analogous blueprint for internal cooperation between departments or individuals within one organization. Or even for a combination of the two, where there is a cooperation between various internal departments of one organization and some external parties. In such a scenario the internal departments have differing risks, costs and benefits, activities and value propositions.

It wasn't enough for the various actors to have a shared co-created value-in-use to motivate cooperation. Individual advantages needed to be made explicitly clear and communicated during the workshop. The SDBM/R literature seems to slightly assume that presenting the group of actors which attended the workshop would simply accept the premise the SDBM/R offers. In some contexts, this might be the case, but it seems that based on the real-life application of the (m)SDBM/R to an already-running project, such as the blockchain SSI career credentials application at the bank, there is a greater need for convincing the attendees of their role. This may be due to the newness of the model for the attendees, the quality and clarity of the explanation or some other factor. It does seem that the model offers the advantage of being applicable in other settings and for other purposes than originally proposed. But in doing so, these application settings need to be explained more thoroughly as well as most likely tested in a similar fashion as the business model blueprint validation methods described by Grefen and Turetken (2017).

One interesting addition would be that there may be an additional useful application for the (m)SDBM/R workshop as a tool to synchronize early communications between actors. This may be useful to an organization's innovation processes as it could make them more efficient, especially for innovations requiring an ecosystem of multiple actors which are required to participate for success. One of the challenges bank innovation managers mentioned in these early stages is receiving the definitive "yes" from potential actors, to enter the cooperation. The SDBM/R workshop can help generate good-will, understanding and buy-in from actors, as after the workshop they should ideally all be aware of each other's costs and benefits, risks and possible risk responses, value propositions, and actual activities to make the cooperation a success.

In addition, the PR element which was introduced through the qualitative research, analysis and synthesis in this document, proposing the mSDBM/R, proved to be a valuable addition. The addition of risk needs to be considered in the context of the standard intended flow of the SDBM/R application. The context as intended is that a workshop is organized during which all – or most – actors required for a co-created value-in-use for a specific client segment, together brainstorm, and map their ecosystem on the level as is presented in the SDBM/R. The addition of PR in this context is motivated by the proposition that it is indeed useful to brainstorm about risks and possible counter actions to risk, in this phase of a cooperation, as it may help to prevent the impact of risks later in a cooperation. It may also simply stimulate awareness of everything that could go wrong in the future, with all actors in the ecosystem.

Furthermore, the various model variants of the mSDBM/R which were presented in the synthesis of chapter five of this document each address a different combination of perceived risk events (PRE) by actors and their complimentary risk response actions (RRA) on each level. The intention is not for the models to be compared in terms of which model is better or worse than the other. Rather, the models were assessed by industry experts for the specific context of the blockchain SSI career credentials application and generating a business model from a workshop around this topic, with the main addition being the perceived risk events and risk response actions.

The perceived risk appeared from research to be an important missing aspect from the original SDBM/R in general, but especially for the specific context of blockchain based SSI applications, which is why it was proposed to be added in via de mSDBM/R. The way in which it was to be implemented was not immediately clear. Therefore, prior to the variants, the academic sources were once again consulted on the topic of risks and their classifications, which yielded PRE/RRA Matrix as presented in chapter six (Figure 6.2.1.). The matrix is the result of a creative leap. The classification it follows is down the axes of perceived risk events, and risk response actions. The additional (arguably optional) classification of PRE and RRA in terms of micro, meso and macro levels represent risks and risk actions in more detail and might help to better define follow-up actions for the actors attending a workshop with respect to the risks. Similar to the way a customer journey can be mapped based on an SDBM/R, an initial draft of risk management strategy for the ecosystem, or individual actors within it, could be written up as well. I.e. If PRE X happens, actors A, B and C can perform RRA Y to counter it.

Using this mapping in the workshop setting as Grefen and Turetken (2017) described for their SDBM/R, means there is a possibility of early awareness generation of potential risks for both individual actors attending, as well as for the ecosystem as a whole. One variant from the four mSDBM/R initial proposals needed to be selected for further application. As mentioned earlier, the models were not better or worse than each other, they were mainly better for the specific context of the blockchain SSI, as in the bank. The experts that were asked to rank the score the variants for validation, thus gave their answers based on that context. It appears that the mSDBM/R variant which allows for indicating perceived risks and risk actions on a micro, or actor level, was the preferred choice. This makes sense for a number of reasons. First, if hypothetically a perceived risk, on micro level, for each actor is the same, and all actors together make up the ecosystem, then the risk may be mapped for meso and macro level as well as it clearly affects all or most actors. If a higher-level risk, or collective risk, is mapped in one of the variants which doesn't allow for actor level mapping of risks, then the granularity or resolution of the risk mapping is lower, making the variant arguably less useful for those cases where actor level mapping is preferred.

The following section will present possible managerial implications of the results of this research, in an attempt to make it valuable and more tangible managers in a real-life setting.

8.2. Managerial recommendations

Not only did the SDBM/R and mSDBM/R prove to be useful for initial mapping of an ecosystem between various actors, the workshop with *internal* departments of a large organization also showed it to be valuable for the initial communications *between* departments. It became clear during the workshop that certain points of interest were not, or not completely, discussed between the departments in an earlier stage of the projects. As the various attendees of the workshop discussed what information should be mapped, and where on the canvas, it became evident that there were still disagreements on how the ecosystem fits together. The (m)SDBM/R forced the attendees to speak with each other and share notes, so to speak. The attendees agreed that the model could be very useful in these initial stages of a new initiative which requires multiple departments to cooperate. This means that for managers it might in turn also be useful to employ the model as early as possible for such initiatives requiring many actors. It can assure that all actors are on the same page, they're aware of each other's costs and benefits and how they all contribute to the whole. In addition, it also maps how they can help each other, the risks that they may perceive and how those risks can be addressed by actors individually or collectively. Ideally, all this should be done before any further practical details are discussed.

The broader practical relevance thus seems to be primarily in the application of the new mSDBM/R. Assuming the limitations of the research are addressed, the model may offer a valuable intermediary step in the development of a successful business model in a context where there are many actors who together, in an ecosystem, must make an innovation work in the market.

Often times there might be a gap between the ideation phase and the problem definitions phase of an innovation, especially in the context of an innovation requiring many actors to succeed. This gap might manifest for those types of innovations when a collective of actors fails to map the full collaborative ecosystem along the dimensions of costs and benefits, risks, risk actions and added value per actor. Moreover, this is the case when their combined focus strays from the value they are trying to create for an end-user or client. Worse yet, if their focus wasn't on the creation of value to begin with. Instead, often times innovation teams that manage new initiatives through a standardized process a list of presumed actors is drafted, and agreement between the various actors is done in a back and forth, unsynchronized manner. This is done to a point when the innovation team feels they've amassed sufficient agreement from the various actors to proceed to map their individual business models in this ecosystem. A representation of how such a process might look is shown in figure 8.2.1.

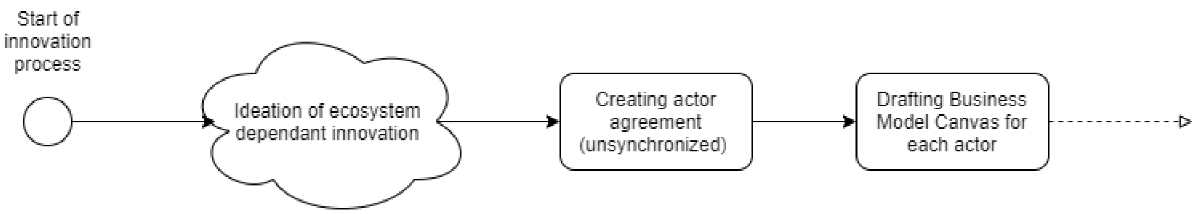

Figure 8.2.1. Placement of process of actor agreement with unsynchronized communication.

The above setup could lead to a number of issues. Firstly, maintaining loyalty from actors in the initiative might be more difficult if the communication on the topic is unsynchronized or ad hoc. Actors only speak with the initiating party, or with some of the other actors, and not always in equal measure, depth and coverage on the topic with each actor. Communication on the initiative might therefore be suboptimal, pieces of the larger message might go missing in translation. The innovation team and actors that are truly on board with the idea can potentially move forward in developing a detailed business model for their part of the cooperation, while other actors might still have reservations. This can lead to misunderstandings later in the process, which can lead to dropout among actors, or dissatisfaction, which in turn may lead to problems with the ecosystem innovation if they are largely dependent on all or most actors cooperating. Furthermore, getting actors on board initially with an innovation initiative is also challenging when communication is unsynchronized. Expectations may then also be unclear, as well as the value an actor receives from entering into a cooperation or what they are expected to invest. Finally, a clear idea of how each actor is tied together, in the larger ecosystem might also be difficult to conceptualize in the initial stages of a cooperation if the communication is unsynchronized. There would be an incomplete picture of which actor does what for another actor. For instance, which actors' inputs and outputs are connected, or to-be connected.

The (m)SDBM/R model can act as a tool to close this gap between ideation and detailed mapping of the business models of individual actors in the ecosystem, or of the ecosystem as a whole. The model would allow actors to better manage expectation and communicate responsibilities, costs and benefits and risks and risk actions. With the (m)SDBM/R this is done in an early stage, from a high-level view. Actors in such a cooperation first spend a day or an afternoon to map the ecosystem with all actors present, and only continue to the next phase of detailed mapping of each actors' processes and business models when each actor is clear on the larger picture and has a positive outlook about it. The mSDBM/R is preferred over the SDBM/R due to the incorporation of risk into the model, which was proven in this research to play an important role in BBSAs, but would presumably be generalizable to other ecosystem dependant innovations as well. Figure 8.2.2. shows the same process as in figure 8.2.1., with the differences being the actor agreement being synchronized and embedded during the mSDBM/R workshop.

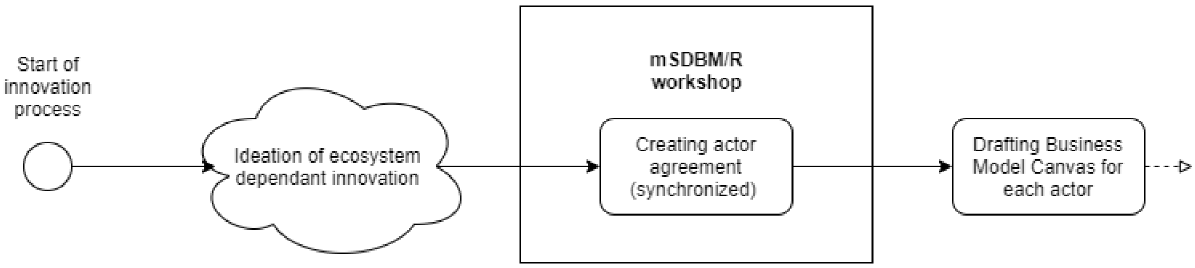

Figure 8.2.2. Placement of process of actor agreement with synchronized communication, within mSDBM/R.

Thus, based on the research of this thesis, it is advisable for managers involved in innovations which are dependent on an ecosystem of many actors, to use a tool or method of mapping the ecosystem on a high-level early on. This will increase the probability of actor buy-in and satisfaction early on, and would therefore decrease the chances of problems later on in the process. In addition, risk plays an important role, and should be addressed. It is valuable for actors to become aware of potentials risks earlier on, and perhaps already have some idea on how to counter those risks (PRE and RRA). Especially on a micro and meso level, where actors can have a direct influence. The mSDBM/R model which was presented in an earlier chapter offers the handles to address these issues. Incorporating the model into the standard way-of-working is therefore advisable.

This chapter answered and discussed the research questions presented in the introduction. It offered some discussion on the findings of the research as well as presented some possible managerial implications. The following, and last, chapter will discuss the limitations of this work, and propose a few potential directions for future research.

9. Limitations and further research

This chapter will discuss the limitations of this research, offer some insights into possible generalizable practical relevance and theoretical relevance. Finally, a number of suggestions will be given for potential future research directions.

9.1. Limitations of this work

This study attempted to identify the specific elements from contemporary academic literature on the topics of innovation adoption for the specific case of BBSAs, so as to better understand what would improve the adoption rate of this new technology.

One evident shortcoming here is that it would be infeasible in the timeframe of this research to find and research every single model and theory of about innovation adoption and to assess it for usability for this context. Similar so for recent theories and models, which are undoubtedly being worked on during the time of this writing. Therefore, it can be safely stated that not all theory of innovation adoption, diffusion or acceptance has been examined, and there are probably elements that could have been useful to add into the literature review and synthesis of this document. Nevertheless, the elements which were found in the literature review were from various established sources and models (Lai, 2017), which should give them sufficient credence as a basis for a master's thesis on innovation adoption in the practical setting within an organisation.

Furthermore, although interviewing is a well-known, tried and true qualitative research method, some comments on the limitations here are in order. First, the number of interviewees was limited to "only" six, which is a relatively small number of interviews. Generally speaking, the more interviews are done with various people, the higher the expected quality of information, and trust in that information being correct and generalizable. Moreover, the effects of bias are expected to be higher. Even though the method of transcribing, labelling and coding is a standard way of working in this regard, and it should prevent a part of bias seeping through, there is still the weighing method for of the labels. The weights of certain labels are fully self-reported. If an interviewee is very outspoken and uses large words regularly, most likely they will weigh the importance of certain innovation adoption elements as being higher than would otherwise be the case. Similarly, if a person is calmer, more modest, they could unconsciously undersell the relevance of certain things. The weighing in this regard is very sensitive to bias. Having more interviews counters this bias. Thus, the relatively low number of interviews, and the self-reported weighing are definitely limitations of the research to consider. However, there is another factor which plays an important role. The interviewees were all experts on very specific topics, pertaining to digital identity, SSI, blockchain and the research being performed by various parties in the present. This makes them more reliable on the information they are providing in terms of technical knowledge, which in turn makes their answers more valuable in some regards, despite the earlier described shortcomings. However, it cannot be ignored that because all interviewees were involved in Blockchain, a biased towards Blockchain solutions might exist and should also be taken into account when evaluating this work.

Nevertheless, regardless of how many expert interviews are performed, the individuals asked about their input are experts. This means that they are involved on the development side of SSI applications and inherently hold certain biases. In this research, no non-experts were asked about their opinion. This is a prominent short-coming as it could have offered the opportunity to compare the views of experts with the views of consumers, which could have been valuable input for the development of SSI solutions, and how to better introduce them into the market.

Another important aspect of this work is the modification, or expansion, of the Service Dominant Business Model Radar (SDBM/R). The modified SDBM/R (or mSDBM/R) builds upon the earlier described qualitative research, using the input from the expert interviews to add an additional layer to the model. Namely, perceived risk. The research showed that risks were paramount for the specific context of blockchain-based SSI applications, and digital identity solutions within the ecosystem of banks, government and research institutes. This is the context that was presented to the interviewees, and these are the projects they were all involved with, and the sectors they worked in. However, whether perceived risks would be a useful or welcome addition to the SDBM/R in other contexts or for other types of innovations, is not clear from this work.

Finally, the process of how and where to apply the mSDBM/R is not explicitly addressed. The advice given is, that the modified model is advised to be used in certain parts of the innovation process within the bank. However, with the exception of the managerial implications in chapter 8, there is no research presented in this document on where and why the best place would be to implement the SDBM/R and mSDBM/R.

9.2. Recommendations for further research

The recommendations for further research on the basis of this thesis are linked to the limitations as discussed in sub section 9.1.

First, it might be a useful endeavour to further research market success and adoption for SSI products. SSI is a new concept and products based on its principles are still rare. The advantages for facilitating and developing parties such as the bank, or the government, are evident in the minimizing of administration, more reliable information or less mistakes. However, for the everyman, SSI is an unknown concept. In the interviews some experts stated that it is an extremely difficult endeavour to try and explain SSI to consumers. Rather, present them with a product which offers all the advantages of SSI, and focus on those advantages. This scenario seems plausible, and although experts were leaning towards a technology push method, it could still be commercially valuable to research in detail the views of consumers on these advantages, and how marketing them would influence adoption success of SSI (and thus commercial success of an SSI product).

Additionally, in earlier drafts of the research plan for this thesis, a questionnaire was incorporated intended for potential end-users of SSI products of the bank. It was meant to measure the demand and opinions on various aspects of SSI or digital identity products, so as to better offer advice on how to construct an SSI application to increase its odds of commercial success and widespread adoption. Due to the pivot towards business models and the SDBM/R, the questionnaire became unnecessary for the purposes of this research. However, performing such a questionnaire might still be valuable for SSI adoption. In addition to adding value as product market research, it could simultaneously be used to test certain believes experts hold about what consumers think about SSI, digital identity, privacy, trusted third parties, and related concepts.

One of the things that the workshop showed was that most PRE and RRA which attending actors added to the model were on a micro level. Whether this was coincidental or whether it had something to do with the context, the setting, the actors attending, or the type of sector or innovation is unclear. It might be useful to research the types of risk mappings with regards to micro, meso and macro level, and how they can be better incorporated into the SDBM/R. Also, it may be important to thoroughly validate the usefulness of this level of mapping in the stage wherein the SDBM/R workshop is intended to be organized (early cooperation). Research into the actual identified risks in the workshop might also be advisable, as those risks could be generalizable to other settings and organisations as well.

Finally, the research of this thesis was limited in scope to blockchain-based SSI applications. The mSDBM/R was thusly applied exclusively in this context, and exclusively for this innovation. Further testing of the mSDBM/R in other contexts, for other types of innovations is recommended to establish its usefulness in these other settings. Thus, validation studies for other industries and other products are recommended to be performed in some future work.

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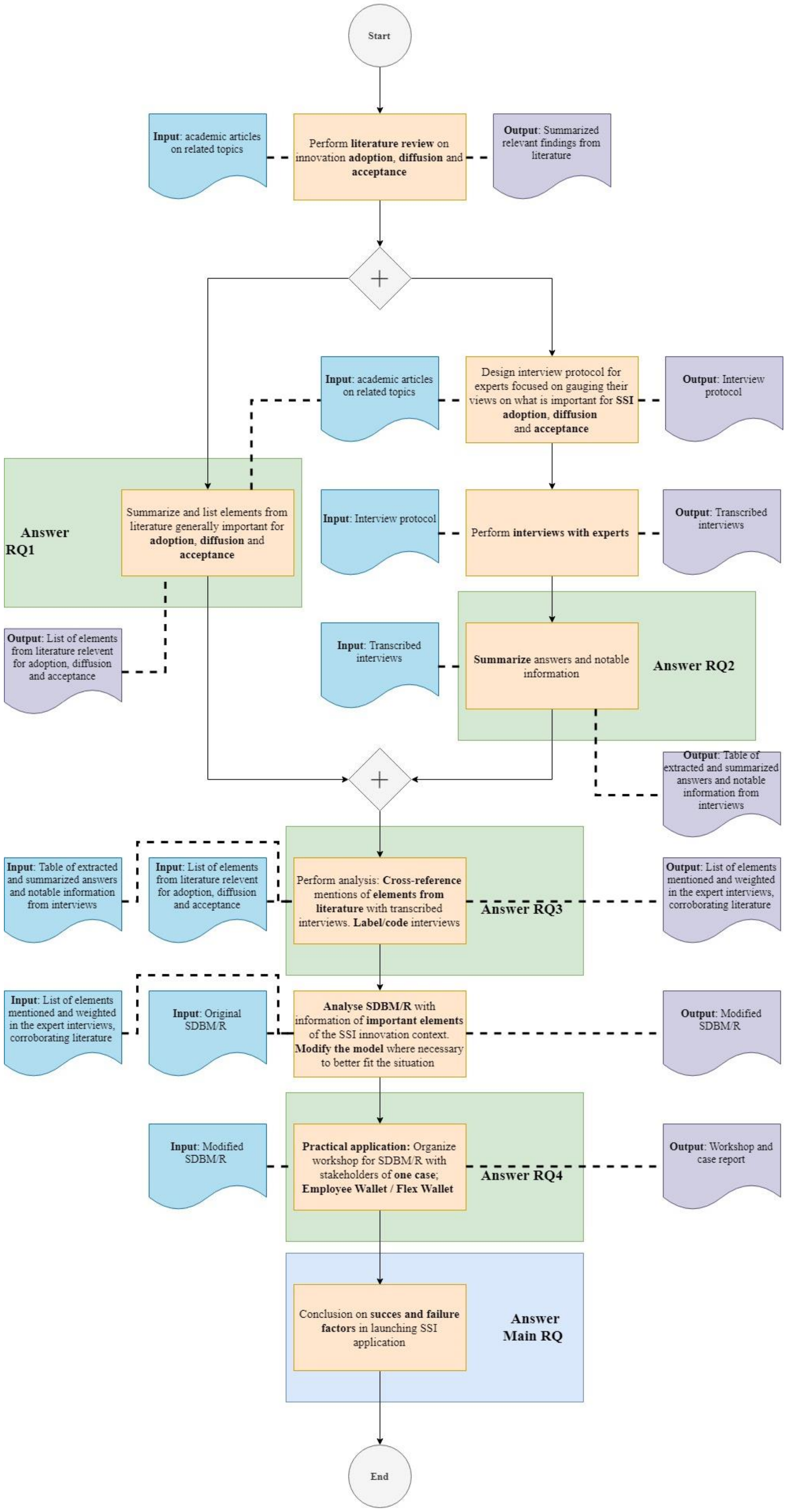
Appendix A: Initial Literature Keyword Search Table

Literature Keyword Search Table		**# articles found in database**			
Keyword	**Search term**	**Google Scholar**	**JSTOR**	**ScienceDirect**	**Scopus**
Self-sovereign identity	“Self-Sovereign Identity”	343	2	8	7
	“Self-Sovereign Identity” + ”questionnaire”	9	0	0	0
	“Self-Sovereign Identity” + ”survey”	119	0	3	13
	“Self-Sovereign Identity” + ”interviews”	38	0	1	1
	“Self-Sovereign Identity” + ”validation”	130	0	5	2
	“Self-Sovereign Identity” + ”market”	190	1	5	7
	“Self-Sovereign Identity”+("incentives" OR "incentive")	135	1	4	0
Innovation adoption	“innovation adoption”	57.000	562	2.209	1.351
	“innovation diffusion”	68.100	1.606	3.384	2.318
	"innovation adoption" + “model”	40.400	961	2.058	528
	"innovation diffusion" + “model”	60.800	2.509	3.202	1.298
User experience	"user experience"	995.000	2.025	19.389	25.697
	“user experience” + “design”	664.000	1.579	16.630	9.906
	"user interface"	3.090.000	10.153	79.730	131.078
	"user interface design"	109.000	732	3.781	3.965
Blockchain	“blockchain”	79.400	225	1.241	4.272
	"blockchain technology"	36.900	79	601	1.564
	“blockchain identity”	277	1	3	1
	“blockchain” + ”identity”	16.600	80	481	290

Appendix B: Research protocol outline



Appendix C: Expert Interview Protocol

Description: **ETC=5 min**

This document acts as a guide to lead the questions and conversations on the topic of blockchain-based *self-sovereign identity* (SSI). The total time for this interview is 60 minutes. Behind each topic/question you will see the estimated time for completion (ETC). This description has ETC= 5 min. All times are approximations. If consented to, the interview will be recorded and transcribed. All names will be anonymized in this case. In any case, the transcripts will not leave the possession of the bank blockchain team, and will never be made public.

This interview will cover the following topics;

- Your background, experience and role.
- A brief description of methods, practices and challenges with regard to Self-Sovereign Identity (opinion);
- Details regarding what problems were meant to be solved via this technology;
- Perceptions of the market and market readiness of the technology.
- An overview of key practices and drivers of the success or failure of the technology implementation;
- Possible reasons why SSI might not succeed

Name:

Function:

Responsibilities and their relationships to this project:

I. General background of interviewee **ETC=5 min**

1. What is your role or function, and how does it relate to SSI and/or blockchain? How long have you been doing this?
Wat is jouw rol of functie en hoe staat het in verband tot SSI en/of blockchain? Hoe lang doe je dit al?

II. Adoption of SSI **ETC=30 min**

2. In your estimation, is there a need for SSI in the market? If there is, what observations or experiences do you base this on?

Volgens jouw inschatting, is er een vraag voor SSI toepassingen vanuit de markt? En zo ja, welke observaties en ervaringen baseer je dit op?

3. What do you think would be the main reasons for somebody to use, and not use, an SSI solution?
   Wat denk je dat de belangrijkste redenen zouden zijn voor iemand om wel en niet een SSI oplossing te gebruiken?

4. What (market-related) problems do you foresee with SSI in the short term and long term?
   Welke (markt gerelateerde) problemen voorzie je met SSI in de nabije en verre toekomst?

5. In your estimation, how far along is the technology to being applied in society?
   Hoe ver is de technologie van toepassing in de maatschappij naar jouw inschatting?

6. How do you feel about the timing of SSI and the current solutions being developed?
   Wat vind je van de timing van SSI en de oplossingen die momenteel worden ontwikkeld?

7. What are, according to you, the most important stakeholders in the creation of ecosystems or infrastructure for SSI? Who should take this upon themselves?
   Wat zijn volgens jou de belangrijkste stakeholders voor de creatie van ecosystemen of infrastructuren voor SSI? Wie zou dit op zich moeten nemen?

8. What is, according to you, the target audience (demographic) of potential end-users for early SSI solutions?

Wat is volgens jou de doelgroep (demografisch) van potentiële eindgebruikers voor de eerste SSI oplossingen?

9. Generally speaking, in what way would SSI applications for end-users differ from currently used digital identity solutions in terms of user experience? (iDIN, DigID, Facebook, Google, passport, id-card)
Op welke manier zouden SSI toepassingen voor eindgebruikers verschillen van huidige digitale identiteitsoplossingen in gebruikerservaring? (iDIN, DigID, Facebook, Google, paspoort, ID kaart)

10. What are the risks associated with SSI that may not be evident? Which of these risks may have an impact on willingness to use SSI solutions, and why?
Wat zijn risico's geassocieerd met SSI die eventueel niet evident zijn? Welke van deze risico's heeft mogelijk impact op de bereidheid om SSI oplossingen te gebruiken?

11. Do you have a view on what needs to happen for SSI to accelerate its speed of adoption?
Heb je een idee bij wat er zou moeten gebeuren om de adoptie van SSI te versnellen?

12. Besides SSI, are there other ideas/philosophies about identification which could be pursued in the world, and what could this mean for SSI?
Behalve SSI, zijn er andere ideeën/filosofieën over identificatie die mogelijk zullen worden nagestreefd in de wereld, en wat betekenen die voor SSI?

13. Finally, are there certain specific questions that you would want potential end-users of SSI solutions to be asked? (Maybe certain hypotheses you would want to test?)

Tenslotte, zijn er bepaalde specifieke vragen die je potentiële eindgebruikers van SSI zou willen stellen? (Mogelijke hypothesen die je zou willen testen?)

III. General questions regarding your project/track **ETC=20 min**

14. What does the project you are working on aim to achieve?
Wat probeert het project waar je aan werkt te bereiken?

15. What is/was the problem that needs to be solved via this project?
Wat is/was het probleem dat opgelost moest worden met project?

16. What is the importance or need of solving this problem?
Waarom is het belangrijk of nodig dat dit probleem wordt opgelost?

17. What is the added value of this technology? Why/how does this project solve this problem?
Wat is de toegevoegde waarde van de technologie? Waarom/hoe lost deze technologie het probleem op?

18. What were/are the bottlenecks/issues with this project and/or technology up until now?
Wat zijn/waren de knelpunten/problemen met dit project of deze technologie?

19. Could you name 3 ways in which the daily lives of people could change through this technology?
Kun je 3 manieren benoemen hoe het dagelijkse leven van mensen verandert door deze technologie?

20. Why was technology in particular chosen to be developed? (Ex. can it be achieved without blockchain?)
Waarom is deze technologie in het bijzonder gekozen om verder te worden ontwikkeld? (Bijv. kan hetzelfde worden bereikt zonder blockchain?)

21. Can you name other initiatives, projects or pilots within or outside the organisation currently working on something similar as your project tries to achieve? How do those initiatives compare to your project?
Kun je andere initiatieven, projecten of pilots noemen binnen of buiten de organisatie die momenteel bezig zijn met iets soortgelijks als jouw project? Hoe verhouden die initiatieven zich tot jouw project?

Appendix K: Interview Answers Labels per Question/Interviewee

	Mentioned concepts, constructs or factors from Literature and Weights					
Question Nr.	**Bank 1 – EX1**	**Bank 1 - EX2**	**EGB 1 - EX3**	**Org 1 - EX4**	**Bank 2 - EX5**	**Org 2 -**
2	MP , TP , DRL	MP , DRL , PBC	DRL, UID, PEU, PR, INS, FC, TR	DRL, TP, MP, MR, PU, PR, INS,	MP, TP, MR, DRL, INN	TP, TR, (++), EI (++), O PEU
3	PEU (+), PU , PR , VOL , RD , DRL COM	PBC , MP , DRL , PEU , INS , PR , RD	PEU, PU, EE	PEU, DRL	PEU (+), UID, PR, INS	SI, IMC
4	VOL , PEU , PR , INS	PEU (+), PU, TP, RD , FC, INS (+) , PR (+)	DIS, THC, FC	PEC, SI, SN, VOL	FC, TP, DRL, MR	PU, RD
5	MR , FC (+)			MR, DRL, MP, IU	TP, FC, VOL, DRL, ATT	TP (+), (+), TT RD, AT
6		MP, TP, DRL, TR, MR	MR , DRL, PR, INS			TP, TR
7	FC (+), TP		FC (+), TP, TRL, DRL, MR, ATT	COM, SN, THC, TTF, VOL	TP, FC, RD	RD, SI,
8			COM, DRL, MP, PEU, PU		INN, PR, INS, SI, SN, TP, PEU, UID, RD	TP, TR PEC, FC
9		PEU (+), EE	INS (+), PR (+)	PEU	PEU, COM, SN, TR, MR, INN, IU, EE, DIS, PU, PR, INS	
10	ATT (+)	COM, PU, FC,	TRL, INS, PR	FC, THC, PR (++), OQ, RD	DIS, BEL, OPT, PR, PEC, PBC	PR, INS
11		TP (+), FC, DRL, MP	PEU		TP, SI, SN, DRL	FC (+), BEL, IN
12		INS, PR, SI, SN, BEL, ATT	COM		SI, SN, ATT, COM, DRL, INN	
13	PEU , PU , PR , COM	PR , INS, PBC, DRL		PEU, UID, OU		

Appendix L: Labelling Occurrences per Interviewee

Occurrences per Stakeholder

Question nr.	2	3	4	5	6	7	8	9	10	11	12	13
Bank 1 - EX1	MP , TP , DRL	PEU (+), PU , PR , VOL , RD , DRL COM	VOL , PEU , PR , INS	MR , FC (+)		FC (+), TP			ATT (+)			PEU , PU , PR , COM
Bank 1 - EX2	MP , DRL , PBC	PBC , MP , DRL , PEU , INS , PR , RD	PEU (+), PU, TP, RD , FC, INS (+) , PR (+)		MP, TP, DRL, TR, MR			PEU (+), EE	COM, PU, FC,	TP (+), FC, DRL, MP	INS, PR, SI, SN, BEL, ATT	PR , INS, PBC, DRL
EGB 1 - EX3	DRL, UID, PEU, PR, INS, FC, TR	PEU, PU, EE	DIS, THC, FC		MR , DRL, PR, INS	FC (+), TP, TRL, DRL, MR, ATT	COM, DRL, MP, PEU, PU	INS (+), PR (+)	TRL, INS, PR	PEU	COM	
Org 1 – EX4	DRL, TP, MP, MR, PU, PR, INS,	PEU, DRL	PEC, SI, SN, VOL	MR, DRL, MP, IU		COM, SN, THC, TTF, VOL		PEU	FC, THC, PR (++), OQ, RD			PEU, UID, OU
Bank 2 - EX5	MP, TP, MR, DRL, INN	PEU (+), UID, PR, INS	FC, TP, DRL, MR	TP, FC, VOL, DRL, ATT		TP, FC, RD	INN, PR, INS, SI, SN, TP, PEU, UID, RD	PEU, COM, SN, TR, MR, INN, IU, EE, DIS, PU, PR, INS	DIS, BEL, OPT, PR, PEC, PBC	TP, SI, SN, DRL	SI, SN, ATT, COM, DRL, INN	
Org 2 - EX6	TP, TR, MP, DIS (++), EE (++), COM (++), OQ (+), OPT, PEU	SI, IMG	PU, RD, THC	TP (+), MP (+), MR (+), TTF, TKC, THC, RD, ATT (+), SN (+)	TP, TRL, DRL, MR	RD, SI, GL, NE	TP, TRL, DRL, MR, PEC, FC		PR, INS, THC, GL	FC (+), SI (+), ATT, BEL, INN		

	PR	*DRL*	*PEU*	*TP*	*FC*	*INS*	*MR*	*MP*	*COM*	*TR*	*PU*	*RD*	*SI*	*SN*	*ATT*	*THC*	*DIS*	*EE*	*INN*	*VOL*	*TRL*	*PBC*	*UID*
Bank 1 - EX1	3	2	3	2	2	1	1	1	2	0	2	1	0	0	1	0	0	0	0	2	0	0	0
Bank 1 - EX2	4	5	3	3	3	4	1	4	1	1	2	2	1	1	1	0	0	1	0	0	0	3	0
EGB 1 - EX3	4	4	4	1	3	4	2	1	2	3	2	0	0	0	1	1	1	1	0	0	2	0	1
Org 1 – EX4	2	3	3	1	1	1	2	2	1	0	1	1	1	2	0	2	0	0	0	2	0	0	1
Bank 2 - EX5	4	5	3	6	3	3	3	1	2	1	1	2	3	4	2	0	2	1	4	1	0	1	2
Org 2 - EX6	1	2	1	4	2	1	3	2	1	3	1	3	3	1	2	3	1	1	1	0	2	0	0
	18	**21**	**17**	**17**	**14**	**14**	**12**	**11**	**9**	**8**	**9**	**9**	**8**	**8**	**7**	**6**	**4**	**4**	**5**	**5**	**4**	**4**	**4**

Appendix M: How to use the original SDBM/R in a workshop setting

The SDBM/R was designed by Turetken and Grefen (2017) to be ideally filled in during a workshop with all actors present, including the customer. During the workshop the actors together decide what all fields in the SDBM/R should contain, which creates a dynamic in which potential new insights arise on which a business model can be developed that guarantees a positive outcome for all actors at the table, and the ecosystem as a whole.

The steps in the workshop are as follows:

1. Decide the co-created value-in-use, and for which customer segment this co-created value-in-use is defined.
2. Decide on which actors are required to be present.
3. Appoint actor roles, such as core partners and enriching partners.
4. Define the value proposition for each actor.
5. Define the costs and benefits (qualitatively) for each actor. Optionally add cost and benefit flows to indicate relations between actors in the ecosystem.
6. Define the high-level co-creation activities each actor should perform to make their value proposition possible.