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BLOCKCHAIN FOR MICROLENDING

TOWARDS A SOLUTION FOR POVERTY REDUCTION AND FINANCIAL INCLUSION OF THE UNDERPRIVILEGED THROUGH TRANSPARENCY AND AUDITABILITY

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Abstract

The purpose of this paper is to propose **the conceptual design of a blockchain-based solution for group microlending suitable for the needs of developing countries**. Our goal is to contribute to the growing body of research dedicated to greater **financial inclusion** and **poverty reduction** in the most needy parts of the world. The blockchain technology shows great promise in the provision of financial services to unbanked individuals in a **trustworthy, transparent and auditable** manner.

Our solution builds on the design of Mukkamala et al. (2018) and provides complementary enhancements to its core functionality. We gathered our understanding of the context in which our solution will be embedded from the activity of **Mukti, a social business operating in underprivileged regions of India**, which has led to the delineation of our focus to this geographic area. Nevertheless, our concept was designed to ensure its **generalizability** to different regions.

The research philosophy of this paper is based on a **positivist epistemological view** through which two research strategies - **action research and case-study** - are perceived and applied. Action research provides the structured approach to our research, while the case study of Mukti provides us with deep understanding of the challenges to be faced with our solution. The data collection was based on two multi qualitative methods - the interview and the analysis of secondary data on microlending and blockchain. We approach the defined **research question inductively** and extract insights and findings from our chosen sources

Our research has shown that the most suitable blockchain network, which could be a synergistic complement to Mukkamala et al.(2018), would base on **Proof-of-Authority** or **Proof-of-Publication** as a consensus mechanism and incorporate **smart contracts** to automate the transfer of assets. Furthermore, **security tokens** proved to best serve as digital assets for blockchain-based microlending. As a final technicality, the introduction of the **crypto-ATM** was presented and suggested as a enhancing addition. To provide a comprehensive perspective on our work, we employ **economic and business administration tools** to assess the internal and external circumstances of our concept's value. The issue of **information asymmetry** has been identified as a main inhibitor of trust in microlending contracts and is mitigated by the use of our blockchain design. The external circumstances of our design's adoption are evaluated through the concepts of **switching costs**, and its internal coherence within the case organization assessed by means of **IT alignment.**

Our paper provides a **new value proposition** for the various social business worldwide, regardless of the exact location. Firstly, it gives a **comprehensive design of the blockchain-based solution,** which is not provided in academic literature. Secondly, the incorporation of all stakeholders (social businesses, investors and borrowers) ensured the fulfillment of the necessities of all parties.

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For sake of clarity and simplicity, these abbreviations will be used throughout the paper.

Abbreviation	Meaning
SHG	Self-help groups
SB	Social business
MFI	Micro-finance institutions

Table 1: Table of abbreviations

Introduction

Poverty is one of the most predominant challenges of the world today, hampering socio-economic development and equality. The issue found its place at the first position on the list of the 8 UN Millennium Development Goals valid until 2015[1], and is now the top priority of the UN Sustainable Development Goals for 2030[2]. Despite the extraordinary efforts dedicated to this cause, over 783 million people worldwide still live in extreme poverty and are financially excluded from formal financial systems[3]. One of the geographical regions most affected by poverty and financial exclusion is East and Southeast Asia (Lichtfous, Yadav & Fratino, 2018). India, being the largest of the Southeast Asian countries, has a higher number of people experiencing poverty than the neighboring countries (UN, 2018)[4].

A plethora of organizations and businesses have been established for the sake of addressing these socio-economic inequalities. Due to their efforts, a great deal of substantial work with the common goal of poverty eradication, equality and economic growth is being delivered. In this context, microlending - loans of small amounts accorded to the underprivileged - is often mentioned as an efficient financial mechanism for the reduction of poverty and for socio-economic empowerment. However, there are many challenges related to this practice, especially in social microlending businesses. Their reliance solely on donations for the continuation of their operational activity renders them sensitive to any fluctuations in the incoming funds. The inflow of donations, in turn, is determined by numerous factors, the most notable of which is the trust of donors and investors in the business. Consequently, there is a need for a solution which could improve the transparency and auditability of the microlending process and lead to increased trust from the investors and to more frequent donations. The blockchain technology, as a distributed and immutable ledger, has the potential to deliver these characteristics.

Importance

Around 10% of the world population lives in extreme poverty (World Bank, 2015). In India, due to massive financial inclusion and poverty eradication efforts, the current extreme poverty rate is nearly 4% (Kharas, Hamel & Hofer, 2018). Due to societal and cultural implications, financial exclusion predominantly impacts migrants, ethnic minorities, the elderly, and women (Varghese & Viswanathan, 2018). Moreover, rural areas are affected by poverty more significantly than other regions (Schuetz & Venkatesh, 2019). These kinds of sources of financial exclusion are complex and multidimensional, and cannot be solved by a singular action.

1 https://www.un.org/millenniumgoals/bkgd.shtml
2 https://www.un.org/sustainabledevelopment/
3 https://www.un.org/sustainabledevelopment/
4 https://www.ndtv.com/india-news/over-10-years-poverty-rate-in-india-reduced-to-half-un-report-1919756

Nevertheless, developments in technology and the financial sector can avert these issues and give access to financial services to these groups, which can eventually lead to the reduction of poverty (Schuetz & Venkatesh, 2019).

In the last few years, researchers and practitioners in the field of microlending have started to move their attention towards innovative technological solutions such as blockchain in order to better address the needs of the poor (Kshestri, 2017). The technology's potential to reduce corruption and fraud, improve operational efficiency and reduce transaction costs is praised as being the gateway towards overall economic improvement in impoverished regions (Kshestri, 2017). Our work builds on the potential of blockchain and adds to the growing body of research dedicated to this domain.

Motivation

In this thesis we investigate the possibility of implementing blockchain in order to produce a fitting solution for microlending that can guarantee trust, transparency and auditability. Our research bases on the circumstances and challenges which are faced by Mukti, a social business operating in India. Mukti is part of The Organization for Empowerment, whose goal is the social development of certain needy areas, where microlending is its main enabler (Sengupta, 2019). Therefore, in our work we emphasize the context of India. However, we aim to make our findings applicable to different geographical points.

Despite extensive financial inclusion efforts, which raised the percentage of Indian adults with bank accounts from 35% in 2011 to 80% in 2018 (ET Bureau, 2018), a large proportion of the rural population still remains unbanked, the majority of which are women (Schuetz & Venkatesh, 2019). Worldwide, over 1.7 billion adults do not have bank accounts[5]. By the use of blockchain to support the microlending process, the need for a bank account for receiving payments will be annulled (Lichtfous, Yadav & Fratino, 2019). Blockchain is a digital ledger which functions as an immutable, append-only distributed database, and is praised for its incorruptibility, trustworthiness and autonomy, as well as the transparency and visibility which it offers to the network participants (Swanson, 2015). The technology is also lauded for its contribution to financial inclusion (Lichtfous, Yadav & Fratino, 2019). As a result, they will be able to receive financial support and possibly build creditworthiness in order to also be accepted by formal financial institutions. Our research has shown that little academic attention has been given to the topic of blockchain applications in microlending.

Through this thesis, we aim to contribute to the domain literature by providing complementary specifications to an existing solution and analyzing their suitability. We hope that our proposed blockchain-based

[5] https://globalfindex.worldbank.org/

microlending concept would not only provide the underprivileged with assets for their everyday lives, but also enable their financial inclusion, opening a wide range of new possibilities

Research question

The aim of our master thesis is to design, contextualize, constructively assess and eventually present a suitable blockchain solution for providing microlending in developing areas. We complement existing studies on this topic by providing a holistic conceptual design of a blockchain solution consisting of multiple components. Our research focuses on the poorest, rural areas of India. Nevertheless, the solution is designed in a universal way in order to enable the implementation in different geographical locations with a similar profile. The paper 'Converging Blockchain for Socio-Economic Development' by Mukkamala et al. (2018) serves as a basis on which we build our analysis and design. Therefore, our main research question is stated as follows:

How should a blockchain-based solution for microlending in developing countries be designed in order to ensure trust, transparency and auditability and positively impact poverty and financial inclusion?

Relevance

Academic Relevance

Due to the recentness of the blockchain technology, and its initial purpose as a medium for the circulation and creation of cryptocurrencies, the attention of researchers and practitioners has only lately started to shift towards other possible applications. Consequently, the technology's applicability to fields related to social businesses has not been researched to any significant extent. Through our work, we address this paucity by delivering an overview on the current stance of research on blockchain for microlending and formulating the conceptual design for a possible implementation.

Additionally, our chosen research question resonates with the overall structure and learning objectives of the CMIT program, because it captures both the business and the information systems perspectives. We analyze the challenges of the microlending activity within the larger context of social business, address them by formulating the conceptual design for a technology-enabled solution, which we finally assess through the lens of multiple relevant business theories. The CMIT programme operates on the premise that, in the modern world, business and technology are inextricably intertwined and influence each other. Our research question mirrors this premise as it introduces a gateway towards finding a suitable organizational solution for the microlending aspect of social business based on the blockchain technology. The business aspect of our programme provided us with grounds to assess and accurately identify the challenges which need to be tackled by an organisation to achieve its business goals. On the other hand, the focus on the technology enabled the

use of IT as a tool to add value to the business activity of an organisation and to address these issues. The research question is therefore analogous to the synergistic nature of our programme.

Practical Relevance

There are numerous microlending entities operating in developing regions of the world, providing the poor with much needed financial support. Unfortunately, despite their undeniable importance, the growth of such companies is impeded by a lack of funds in terms of both volume and regularity (Sengupta, 2019). In this sense, the reliance on donations instead of profits for operational continuity might be more advantageous for the borrowers due to lower (or even non-existing) interest rates, but it is undoubtedly more challenging for the business.

The digitalization of the microlending procedure through the use of automated accounting systems and analysis tools would be a desirable first step towards improving some of these companies' processes and towards cost optimization (Sengupta, 2019). This, however, would be beneficial for the business internally, and not for its relations to external actors, such as investors or auditors.

To create external credibility and trust, the business needs to provide irrefutable evidence of its honest behaviour with the donation money. We posit that the blockchain technology holds intrinsic characteristics which will allow social businesses to provide such evidence. Our papers' relevance lies in the investigation of this assumption and the contribution to the microlending field by producing a conceptual design and making recommendations of how a blockchain solution could be implemented.

Thesis Structure

The thesis is structured as presented in Table 2 where a brief description of the content for each chapter is provided.

Thesis structure	*Description*
Introduction	— *describes the importance of the topic by giving a brief introduction to the notions of poverty and financial inclusion and introduces microlending and blockchain as a change enabler* — *mentions our objectives for the thesis and presents Mukti as an example of a Social Business organization, which is used in the thesis* — *presents the main problem formulation, relevance and motivation for the paper*
Delimitations	— *specifies the scope of our thesis*
Methodology	— *presents the research approaches adopted in this research, according to the research onion of Saunders et al. (2006)* —
Context	— *provides the reader with the overview of the situation of on poverty in India through statistics, presentation of causes of poverty* — *introduces the notion of social businesses and their situation in India* —
Theoretical background	— *presents theoretical groundings on the blockchain technology, microlending and relevant business administration and economic theories used in the paper*
Literature review	— *gives an overview of the academic publications on the topic of blockchain in microlending*
Case study: Mukti	— *presents Mukti as a case company*
Analysis: Blockchain concept and evaluation	— *provides the reader with advantages and challenges for the blockchain implementation* — *analyzes and critically assesses the solution of Mukkalama et al.(2018)* — *presents and critically assesses the separate four components of our proposed blockchain solution*
Findings and recommendations	— *summarizes the specification of the final solution and formulates recommendations to tackle previously posed problems*
Discussion	— *presents the comprehensive answer for the research questions* — *discusses the findings of our research and its implications to the problem of poverty and financial inclusion* — *highlights the challenges for the solution* — *presents topics for future work*
Conclusion	— *concludes the paper*

Table 2 Thesis structure

Delimitations

Both domains combined in this thesis have a vast and complex nature. Microloans have started gaining attention as far back as the 1950's, and have undergone several significant developments since. The history and socio-economic considerations behind microloans are therefore extremely rich and multifarious. Likewise, the blockchain technology has gathered immense public attention ever since its introduction in 2009, and has been documented extensively. Moreover, its rapid pace of development has resulted in many applications in domains which reach far beyond the financial functionality of Bitcoins. It becomes evident that these two fields merge into a significant knowledge base. We therefore need to limit our research in order to meticulously investigate the defined topic.

To focus the scope of the thesis and to comprehensively answer the research question, we intentionally forgo complementary blockchain-based topics, such as collateral ownership or identity management, which might have the potential to effectively support the trustworthiness of the microlending process in developing countries. These topics are addressed in *Discussion.*

Similarly, we only concentrate on microloans, and disregard other mechanisms of microfinancing such as savings or microinsurance. Moreover, we focus solely on the process of group lending due to its high relevance to our research question.

Regarding the technicalities of the blockchain-based solution, due to time and space constraints, we are not able to scrutinize all of its possible technical aspects. Therefore, we deliver a framework-agnostic blockchain network by describing on the most crucial elements of the setup, such as the consensus mechanisms, permissions, and native assets. Furthermore, based on the same limitations, we do not provide a prototype for the physical implementation. In *Discussion,* we touch upon these two topics as a reference for future research.

Methodology

Research design

Saunders, Lewis & Thornhill (2006) propose a universal tool which helps to logically present the comprehensive research methodology, which lies at the very core of academic research – the research onion. The authors present six layers, where each one covers a different aspect of the research approach and narrows down the scope of its analysis. The tool will be widely used in this section in order to extensively present the methodological approach applied to our research.

Research philosophy

Ontology and epistemology

The central considerations regarding research philosophy revolve around the determination of ontology and epistemology (Easterby-Smith et al., 2012). Issues of ontology and epistemology tend to intertwine and emerge together, which makes them inseparable (Cotty, 2007). Saunders et al. (2006) define ontology as a study of the nature of reality and present it as an imperative concept raising questions regarding the very fundamental views on the way of the world functioning and the commitment towards them. The authors divide the concept of ontology into two distinct aspects: *objectivism*, where social entities exist separately to the external social actors, and *subjectivism*, stating that social phenomena derive from the perceptions of the actors (Saunders et al., 2006). Therefore, the first ontological stand assumes the independency between the events and the social actors – the facts are happening outside of their perception. It could be stated that this view believes in the existence of the "single truth", which is detached from the individual judgement or feeling. Subjectivism, on the other hand, allows multiple ways of reality interpretation depending on the perception, beliefs and way of thinking of the given individual. From the researcher's point of view, it is necessary to scrutinize the subjective motives and reasoning of the actors to understand their actions and points of view - the researcher needs to get into the character of the actor, so she can sense and understand the actor's subjective reality, and come up with meaningful conclusions (Saunders et al., 2006).

Taking into consideration the focus and the goal of our study and its exploratory nature, we find the objective approach more suitable. The aim is to propose a blockchain-based solution for facilitating microlending in developing areas of India. Despite the objective ontological approach of our study, we comprehensively scrutinize the motives and challenges of each of the involved actors. During the design of our solution, we do take into account all the stakeholders' individual points of view, however we regard these as generalized requirements rather than individual perceptions. We do not analyze any particular borrower or investor, but

see them as representations of their respective stakeholder groups. This analysis is performed solely to identify the crucial challenges in order to address them accordingly with the technological enhancement of the process. Moreover, we assume that the motives and behavioral patterns of the stakeholders would be akin in similar settings. This is strongly connected with the core focus on the generalization of our solution, which enables its implementation in numerous geographical locations of similar characteristics. We therefore use the objective ontological view for this paper.

Epistemology is the study of knowledge which aims to facilitate the exploration of the world's nature by answering the question *"how we know what we know"* (Easterby-Smith et al., 2012). Saunders et al. (2006) proffer the three epistemological perspectives – *positivism*, *realism* and *interpretivism*.

Positivism and *realism* could be perceived as relatively similar views, which approach the development of knowledge in a very scientific way. The academics divide the *realism* into two types – *direct realism* (basing on the statement "what you see is what you get" and the assumption that the human senses can be a trusted means to accurately capture the world) and *critical realism* (which argues that the senses can be deceptive since they present only sensations, not the representation of reality) (Saunders et al., 2006). Remenyi et al (1998, p. 33) in Saunders et al. (2006) underscore that in the positivist view, the researcher is ultimately independent of the subject of the research, which is called "value free". Simply speaking, the value of the research is not biased by feelings or points of view.

In order to balance the rigid and very rational coloring of the two previously presented stands, interpretivism comes into the picture of the epistemological considerations. The perspective heralds that the difference between managing research among objects and among humans in the roles of social actors needs to be emphasized (Saunders et al., 2006). The stance assumes that the people act on events basing on their own interpretation and self-established meanings. The main implication for the researcher selecting the interpretivist perspective is the necessity to adopt an empathetic approach towards the research subject and aim to capture its point of view (Saunders et al., 2006). Therefore, the approach is very suitable in fields like organizational behavior or human resources management, where the complex human interactions and emotions play a significant role in the analysis and outcomes formulation of the research.

Remenyi et al (1998, p. 32) refers to the perspective of *positivism* by giving the example of "*the work with an observable social reality, where the end product of such research can be law-like generalizations similar to those produced by the physical and natural scientists*". Based on this statement, the epistemological perspective of *positivism* was selected for this study. As researchers, we observe the reality of the poverty in India in order to provide an appropriate blockchain-based end solution, which could be generalized and spread to regions of similar needs. It is worth noticing that our thesis analyses the social reality of the underprivileged,

rather than focusing on the social actors as individuals, which would be more akin to *interpretivism.* It undermines the importance of the generalizability of the research and outcomes (Saunders et al., 2006), which is one of the crucial goals for our study. The assessment needs to be as objective as possible in order to ensure generalization. Therefore, the epistemological view of interpretivism is rejected in terms of this thesis.

Despite the strong links between particular views, Easterby-Smith et al. (2012) underscore that the further methodological choices which are built on the ontological and epistemological stances, depend on the extent to which research requires it. Therefore, even though the research philosophy significantly affects the further research choices, a certain degree of flexibility is allowed in order to fulfill the goal of the research. Having established the fundamentals of the research philosophy, we proceed with the presentation of the research approach.

Research approach

Saunders et al. (2006) state that every research requires the involvement of theory, which causes the emergence of a crucial question regarding the design of the research – the decision whether the study would be approached in a deductive or inductive way, and the awareness of what kind of implication this choice would have. The research approach is illustrated by the second layer of the research onion of Saunders et al. (2006).

The deductive approach to research is characterized by the presence of a predefined hypothesis or hypotheses, whose scrutiny and testing is the goal of the research. Collis and Hussey (2003) claim that the approach is usually applied when dealing with quantitative research in the domain of natural sciences, where the researchers primarily pose a theory and aim to prove or reject it basing on the subsequent data analysis. Nevertheless, Locke (2007) claims that the hypothetico-deductive method can impede the progress of science, therefore it cannot be clearly and universally stated that any particular approach should be always applied to a given type of research. This implies that each research is characterized by different features and requires individual methodological assessment.

There are three distinct characteristics of the deductive research approach, which capture the very core of its logic (Saunders et al., 2006). "*The search to explain the causal relationship between variables*" is the first one presented by the authors. (Saunders et al., 2006, p.117)By stating the hypothesis, it is necessary to establish the reasons and chronological connection between the events influencing it. In order to enable the justification and the rigorous testing of the hypothesis, the collection of quantitative and/or qualitative data is needed, which is an essence of the second characteristic. The third characteristic revolves around "*the controls to allow the testing of hypothesis*", which ensures that any deviation in the realm of the analyzed topic is a function of

pre-specified variables of the hypothesis (Saunders et al., 2006, p.118). Last but not least, Saunders et al. (2006) mention the notions of operationalization (the facts need to be quantified) and generalization (the selection of the samples of sufficient size so they can serve as a credible sample mirroring the behaviors of the whole population) as indispensable characteristics of the deductive approach. The authors underscore that the success of the rigorous hypothesis testing strongly depends on the objectivity and independence of the researcher towards the observed phenomenon, which generally implies the research paradigm of realism. At the opposite pole to the deductive approach, there is the bottom-up inductive approach, which focuses on theory development as a result of the data collection and analysis. The aim is to explore the new concept and to generate the new theory or idea basing on the data.

The selection of the research approach may seem difficult or even unnecessary (Saunders et al., 2006). Due to this fact, Easter-Smith et al. (2002) present three major reasons why the clarification of this aspect is so influential for the development of the project. First of all, it helps decide on further methodological paths like research strategies, choices or data collection techniques in terms of its credibility and evidence (Saunders et al., 2006). Moreover, it supports the researcher in matching the aforementioned strategies with the research goal. Lastly, the general knowledge regarding the research approaches enables the adjustment of the design to deal with upcoming obstacles (Easter-Smith et al., 2002). Therefore, we find it crucial to establish the research approach at the very beginning of our study.

The deductive approach has the tendency to a very rigid and highly structured methodology, which may excessively narrow down the scope of analysis or lead to an elimination of alternative explanations (Saunders et al., 2006). In order to avoid this limitation, the inductive research approach was applied in this paper. The aim of this thesis is highly exploration-oriented, where we strive to answer an open research question and build on data collection to creatively come up with the best answer. In the inductive approach, the pre-specified hypothesis is replaced by the open research question (Saunders et al., 2006). Moreover, the pre-analysis of the topic proved that a lack of the pre-specified hypothesis would enable us to be more creative and possibly come up with better suited solutions for our settings. The inductive approach is recommended when the problem strongly depends on a particular context of analyzed events (Saunders et al., 2006). In our research, there is no need for an abundance of collected data, which is a characteristic of the deductive approach (Saunders et al., 2006). Extensive data samples, which would have a generalization power, are not necessary in our case. Therefore, throughout the paper, we perform exploratory analysis in order to define and assess multiple components aggregating to the final solution which would most accurately address the needs of our focus group.

Research strategy

Even though some of the research strategies are clearly assigned to one of the research philosophies, it is impossible and incorrect to assume that these cannot overlap (Saunders et al., 2006). Therefore, when establishing the research strategies, mutual permeation is possible. Saunders et al. (2006) underscore that the researcher primarily should focus on selecting the strategy which would lead to the most precise and accurate answer to the research question and fulfill the research goals, regardless of taxonomy or labeling.

Building on this statement, we adopt two research strategies which will intertwine to most comprehensively cover the expected scope of the study, address the research question and meet the research goal – *action research and case study.* From both strategies we take the intrinsic features which help to best address the preliminary stated research objectives. *Action research* captures the practical aspect of our work and underscores the attempts to address the theoretical challenges with the action-oriented approach. *Case study*, however, supports our pursuits to get in-depth understanding of the challenges of microlending in developing countries, basing on Mukti. Nevertheless, our focus does not lie on Mukti solely. Mukti serves as a reference point enabling the generalization of the solution.

Action research

Saunders et al. (2006) present four common themes, which draw a collective, unified understanding of this research strategy. "*Research in action rather research about action*" is the first of the aforementioned themes (Coghlan & Brannick, 2005).

The second theme highlights the mutual participation of practitioners and researchers or other parties, representing either theoretical or practical approaches. This is of high relevance for our study, because we synergistically combine the collected theoretical knowledge with the practical realm of microlending in developing settings. Although we rely mainly on previous academic research on the blockchain technology and its suitability for microlending, our research has a very serious practical application. Thanks to the in-depth understanding of the situation in India, the conceptual design of the solution would address the challenges of the region and enable its implementation in the real world. Nevertheless, we clearly state that the aim of our thesis is to conceptualize the technology- enabled solution, but not in to implement it.

The third theme gives rise to "the action research spiral" (Appendix 1), which shows the iterative sequence of the process of diagnosing, planning, taking action and evaluating (Saunders et al., 2006). The goal of the spiral is to improve a single solution by a process of repetition.

Nevertheless, we intentionally deviate from the third theme of the action research by neglecting the iteration of the steps of the action research spiral. Due to the time and space limitations of the thesis we cannot provide

a prototype and implement it to the real settings. If our project had a wider time and space span, we would certainly perform multiple iterations and the implementation of the solution. In this paper, we present several blockchain components and address the pre-specified challenges of microlending in developing countries with the conceptual design of the final solution. Consequently, the step of 'Taking action' is represented by a conceptual design instead of a physical implementation. The steps of the spiral, as we adapted them to our paper, are as follows:

Step of spiral	Adaptation to our paper
Diagnosing	Analysis of interview with Gora Sengupta and selected research papers
Planning	Literature review of microlending, blockchain and related technologies
Taking Action	Creation of conceptual design
Evaluating	Critical assessment of each component separately and evaluation of the final solution

Table 3 Adaptation of the action research spiral

The last theme presented by the authors are "the implications beyond the immediate project, (…), the results could inform other contexts" (Saunders, Lewis & Thornhill, 2006). It mirrors our focus on the generalization and the implementation of the concepts to other geographical settings, where conditions and behavioral aspects would be similar.

Case study

Robson (2002, p.178) presents a definition of a case study as "*a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence*". As mentioned before, this research strategy helps us analyze in-depth the current situation of microlending in developing countries in order to address them with blockchain designs, however, we do not base our scrutiny on multiple sources. We motivate the lack of the necessity of numerous sources by the relative similarity in *modus operandi* of social businesses in developing countries. The *Case study* research strategy is recommended when the research requires deep understanding of the context in order to answer the stated "how" question of Saunders et al. (2006). Taking into consideration that we analyze the

overall social activity of Mukti as an example company, from the perspective of the research strategy taxonomy, we base on the sub-strategies of the single and holistic case (Yin, 2003).

Research Choices and Techniques of Data Collection

The data collection was performed in two-fold and consisted of two qualitative methods – the interview and the analysis of existing data, namely credible publications on the selected topics. In this section, we present the 4th and 6th layers of the research onion (Saunders et al., 2006).

Considering that in our study, the analysis of the interview, numerous academic papers and technology-oriented publications serve as a database which we use to answer the research question, it can be stated that we focus only on qualitative methods as a research choice (Saunders et al., 2006). No surveys, statistical analysis or any other type of quantitative method aiming to quantify the results are used in the research, therefore our thesis uses a multi-method qualitative study – the interview and secondary data on the topic.

Primary Data: Interview

Easterby-Smith et al. (2012) present the taxonomy of interview types and discuss their characteristics. The highly formalized interviews tend to follow a detailed list of questions, sometimes accompanied by a predefined set of answers (Easterby-Smith et al., 2012). There is no room for interpretation or creativity from the perspective of the interviewee. At the opposite pole to the highly formalized interviews, the unstructured manner of addressing the interviewee can be found. This type aims mostly to stimulate the conversation and encourage its spontaneous nature, which is of much importance in ethnographic research strategies (Easterby-Smith et al., 2012). Semi-structured interviews are a more flexible alternative to the very rigid nature of the highly-structured type, but still provide a certain degree of formality. Taking into consideration the fact that our research required the collection of very specific and pre-defined information, selecting a fully unstructured interview would not be suitable. On the other hand, in order to gather as many insights as possible from the interviewee (also the ones not specified in the list of questions), it was necessary to leave some room for flexibility. Therefore, to profoundly understand the context and the challenges of the domain, we based our assessment on a semi-structured interview with Gora Sengupta. Gora Sengupta is a professional representing the vast field of IT with the focus on network management and cyber security. He contributes to the social activity of Mukti Community Development Fund (CDF) with his broad experience and advisory.

The interview took place on the 15th of March 2019 via Skype, due to distinct geographical locations, and was conducted by Agnieszka Turkiewicz and Silvana Marinescu. The interview transcript can be found in Appendix 3. Given that the interview was conducted mainly due to exploratory purposes, namely getting the general perspective of the situation and challenges of microlending in India, a certain degree of freedom had to be

ensured. Therefore, the interview was semi-structured in order to allow us and the respondent to elaborate on side topics, if necessary. The direction of the interview was indicated by 17 questions, which were pre-defined and shared with the interviewee before the interview. For the sake of clarification, the questions were divided into three categories: *Introductory questions, Microfinancing, Technology and Blockchain*. 16 questions fall into the main track of the interview, while one question of lower importance was kept as a back-up. The template with the questionnaire can be found in Appendix 2.

As a result of the singular nature of our interview, we did not gather a significant base of primary qualitative data. The interview was therefore not a main source of data for our solution. However, in order to approach its analysis in alignment with academic requirements, we proceeded with its coding. This process helped us to extract the relevant information from the interview and to understand better the context in which Mukti and other similar social businesses operate.

Gorden (1992) suggests that regardless of the type, structure or purpose of the interview, certain steps need to be taken in order to ensure the reliable coding of the interview. Each of them will be presented and discussed in the context of our interview with Gora Sengupta in order to properly code it:

1. Defining the coding categories

We have defined the following three categories, which were essential for our study:

Mukti and its social activity – the category collects all the information related to Mukti in general, the nature of its social activity and details about its operational daily work. The challenges and strategic goals of the organization fall into this group as well.

Blockchain - related information – the category contains information regarding blockchain-based solutions in developing areas of India. The data collected revolves around challenges, requirements and guidelines for the effective implementation.

Situation of the geographical region – the category gathers the information on the current, specific problems of the area in order to get best possible understanding of the context.

Considering that the categories are clearly defined and that a given piece of information would unlikely fall into to multiple groups at the same time, the divisions are mutually exclusive (Gorden, 1992).

2. Assigning Category Symbols

In order to enable the collection and analysis of the collected data, an abstract symbol should be assigned to each category to enable its representation (Gorden, 1992). The label can be of different types (i.e. a symbol, a color or a letter etc.). Therefore, in order to group the data, we assign a specific coloring to each of the categories, which is depicted in Table 4.

Category	Symbol (selection of coloring)
Mukti and its social activity	yellow
Blockchain - related information	blue
Situation of the geographical region	pink

Table 4 Assignment of categories for the interview coding

3. Classifying relevant information

Gorden (1992) claims that one of the ways for classifying relevant information from the interview is reading through the transcript, selecting the data of high importance for the research, and labelling it with the appropriate symbol. We followed this strategy, and the classified interview transcripts can be found in Appendix 3.

4. Testing the reliability of coding

The testing of the coding reliability can be assessed in multiple ways. In our research, we adopted the approach presented by Gorden (1992) – the independent coder method, where two different researchers code the same interview separately and compare the results. It needs to be underscored that each of us performed an independent coding of the interview. For the sake of process credibility, we ensured that both of us had a comprehensive understanding regarding the categories and their labeling.

5. Measuring reliability

The percentage agreement (*"the percentage of information that was classified into the same category by two independent coders*") and the reliability coefficient ("*takes into account not only the number of categories in the coding system, but also how the information is distributed throughout the categories*") are two crucial measures of the coding reliability (Gorden, 1992). The author claims that the first measure is not suitable for the comparison of the reliability of coding two different interviews revolving around the same topic. This is not our case, therefore we select this method of measurement for our study. Given the straightforwardness and singularity of our interview, we consider the percentage agreement to be sufficient for the analysis of the reliability. The results of the percentage agreement are presented in Table 5. The count was word-based, since

we considered wording as the main information carrier in our qualitative study. Each coder marked certain pieces of the interview and labeled them with one of the symbols. Further, we analyzed the level of previously presented percentage agreement between the coders. Thus, Table 5 depicts:

- The number of words assigned to each category by each coder (columns 1 and 3)
- The ratio of the words considered as relevant within given category and the total number words considered as relevant (falling to any of the categories) by each coder (columns 2 and 4)
- The number of works assigned to the same category by both coders (column 5)
- The percentage of information within one which was classified into the same category by both coders (column 6)

Column number	1	2	3	4	5	6
	Coder 1		**Coder 2**		**Commonly classified**	
	Number of words within the category	% of total	Number of words within the category	% of total	Number of words within the category	The percentage agreement per category
Mukti and its social activity	697	60%	1011	64%	516	43%
Blockchain - related information	331	29%	392	25%	323	81%
Situation of the Sunderbans region	126	11%	182	11%	113	58%

Table 5 The percentage agreement calculation

The results of the percentage measurement varied depending on the category. The highest score of 81% was assigned to "Blockchain-related information", while "Mukti and its social activity" was identified with the lowest level of agreement between coders (43%). Gorden (1992) underscores that the interpretation of the result can be tricky since there is no valid method which can indicate an acceptable threshold for this measurement. Moreover, during the process of coding, we were selecting entire sentences (as described in *Testing and reliability of coding*), instead of single words or other configurations, which strongly lowered the overall performance within some categories. Therefore, the percentage agreement at the levels of 43%, 81% and 58% is satisfactory for us. Additionally, due to the singularity of our interview, the probability of overlooking important information was low.

6. Locating Sources of Unreliability

The author defines three general sources of unreliability which may lead to a significant drop in coefficient reliability – the coding categories, the ambiguity of the information coded and the incompetence of the coders (Gorden, 1992). The first source can be easily eliminated in our case due to the very clear distinction among the categories and their mutual exclusivity. In order to mitigate the risk of the second source of unreliability, during coding we intentionally did not limit the information coded to an absolute minimum. The objective was

to select the amount of data sufficient to understand the context and the meaning of the selected data by the external reader, who does not possess any knowledge on the topic. Therefore, there was not room for information ambiguity.

Lastly, the coders may be at fault due to their lack of logical reasoning or understanding of the definitions (Gorden, 1992). However, as mentioned before, the categories were defined in a very exclusive manner in order to avoid the categories' potential overlapping and misclassification performed by the coder. Therefore, we can state that this unreliability source was effectively avoided.

Secondary data: Existing data

The data collected during the interview helped establish the current state of microfinancing in the poorest areas of India. The analysis of existing academic papers on the blockchain technology and microlending was aimed at enabling the creation of a conceptual design from a technological point of view and, through the combination with the information from the interview, enable the critical assessment of the solution. Due to the novelty and complexity of the blockchain phenomenon, academic papers covering the topic to a satisfactory level of detail are very scarce. Moreover, the constant development of the technology and its remarkably high pace significantly surpass the tempo of publishing academic papers. Therefore, publications found on portals and websites devoted to the technology proved to be more up to date. Due to this fact, we also used information from non-academic sources. To sum up, the types of materials taken into consideration were academic journals, publications, and non-academic texts published on domain-specific portals. The choice of papers to be considered in *Literature Review* was made in accordance to their relevance and date of publication. The relevance was assessed based on its relatedness to the research question, and the earliest accepted date of publication was set to 01.01.2014.

Data collection for the literature review was performed on five academic database search engines: EBSCOhost, ScienceDirect, and Google Scholar.

The keywords used for the search were the following, where the words in each phrase were linked by the logical AND operator: *blockchain microlending, blockchain microloans, blockchain microcredit, blockchain microfinance, blockchain social business*. Due to the large number of irrelevant papers retrieved by the search, additional parameters were changed for the searches on Sciencedirect and Google Scholar. In Sciencedirect, the 'Handbook of Blockchain, Digital Finance, and Inclusion' was selected as the publication title, as the other publications were not on related topics. In Google Scholar, the search was reduced by means of the parameter 'allintitle:' to only show results for searches whose title contained the keywords from the query, disregarding the body. The searches were performed by filtering for the date. The searches were performed by filtering for the date. The table beneath depicts the number of results delivered by each search engine and keyword:

	EBSCOhost	Google Scholar	Sciencedirect
blockchain microlending	2	1	2
blockchain microloans	2	0	5
blockchain microcredit	0	0	11
blockchain microfinance	2	0	26
blockchain social business	2	2	17
blockchain financial inclusion	7	11	17

Table 6 Data collection for literature review

Out of the total of 97 results in the initial search on all engines, only 7 presented the necessary information. The rest either focused on very broad applications of blockchain for microlending, or were irrelevant in the context of our research question. The final selection was done on the basis of the abstract and conclusion of those papers. These chosen works are described in *Literature Review.* Easterby-Smith et al. et al., (2006) underscores the importance of the credibility of a given work. One of the points of the credibility assessment is the replicability of the work. In order to ensure this characteristic, we presented the exact steps taken while selecting the literature review.

The summary of the techniques of data collection and their contribution for the final outcome of the paper is presented in Figure 1:

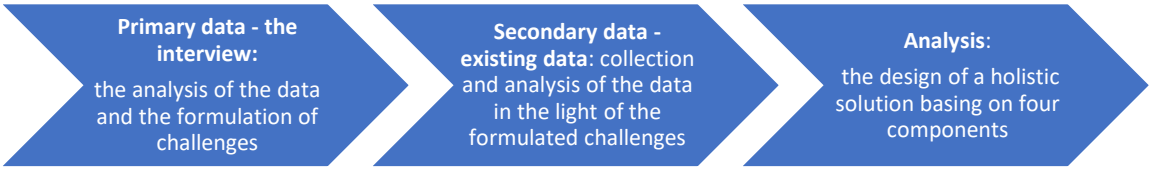

Figure 1 The conceptual summary of the techniques of data collection used

Time horizons

The determination of the time horizons strongly influences the course of the research and is mostly motivated by the nature of the primarily stated research question. Due to its importance, Saunders et al. (2006) illustrated this aspect in the fifth layer of the research onion, presenting two types of time horizons – cross-sectional and longitudinal studies. The fact that our research is an analysis of the current possibilities to implement blockchain to microlending in developing areas in India, proves that our study is cross-sectional in terms of time horizon. We focus on a "snapshot" of this phenomenon in a particular point in time which will not be prolonged. In contrast, longitudinal studies are seen as a long-term diary due to their extensive time horizon (Saunders et al., 2006). In our case, the longitudinal nature would not serve the main purpose, on the contrary, it would defeat it. Our intention is to react on the current situation of a particular setting and give a solution which would be suitable in the present situation. The dynamic development of the social situation and of the technology could impede the implementation of the same solution for a broader time span.

The summary of the most important methodological stances of our research is presented in Figure 2, basing on the simplistic framework presented by Crotty (1998). The framework allows the permeation of epistemological and ontological considerations. Therefore, the latter is not explicitly presented on the framework, however its meaning is captured.

Figure 2 The summary of methodological stances applied to this paper, according to the framework of Crotty (1998)

Research Limitations

We first wish to emphasize the noticeable scarcity of academic literature on technical descriptions of blockchain-based microlending. This has compelled us to derive our research from non-academic papers, which led to a certain difficulty in the assessment of their credibility. This challenge would not have to be faced in the case of using academic papers due to peer reviews and citation statistics. Moreover, the lack of complementary literature in the domain hindered a potential comparison to ideas presented by other researchers.

Our single point of contact with Mukti can be seen as a further limitation. We initiated contact with several other social microlending businesses, but unfortunately received no response. We contacted five additional companies aside from Mukti: FINCA UK, Esaf Bank, Grameen, Everex, Uulala. The E-Mail transcripts of our initial contacts to these companies can be found in Appendix 4. Despite the invaluable inputs from Mukti, we believe that the collection of data from other social organizations, perhaps also from distinct geographical locations, would have enriched this thesis.

Furthermore, due to financial and time constraints, performing a field research was not possible. This opportunity would have also been highly useful for this research. The broader base of primary data would have given us more in-depth understanding of the settings, and helped us come up with a solution which would respond even more accurately to the needs of the stakeholders.

Lastly, despite delivering a comprehensive conceptual design, we do not have the means for its physical implementation and further evaluation.

Coherence of the research

The coherence of this research is ensured by the selection of the most suitable research methods and theories in order to answer our research question and lead to the generalizability of our findings. The selection of the positivist ontological perspective allowed us to approach the research question with an unbiased and objective view, which is crucial in studies striving towards the generalizability of their findings. Thus, it is a suitable choice for our thesis. Since our research is performed in a relatively new domain, it is mainly of exploratory nature, and it has therefore prompted us to use the inductive approach. This has translated into the formulation of a research question to be answered, rather than a hypothesis to be tested.

We conclude our research with guidelines for the blockchain-based solution and its implications for financial inclusion and poverty reduction, which fully addresses the research question.

Context

The World Bank considers the poverty line as the level of income representing the minimum of financial means adequate in a particular country (currently at the level of 1,90 US$ per day), along which the notion of extreme poverty can be defined[6]. The most recent statistics of the World Bank (2015) reported that 10% of the world population lives below the poverty line[6].

The Poverty Manual (2005) presents three methods based on which the estimation of the poverty line is created – the cost of basic needs, food energy intake, and subjective evaluations. The first element is most commonly used and represents the estimated cost of purchasing a sufficient amount of food in order to meet the minimum of daily nutrition needs. The food energy intake method is utilized when information about food acquisition costs is missing (World Bank Institute, 2005). The major concept behind this technique is the juxtaposition between the expenditure and income per capita against the daily caloric intake. The last method bases on surveying individuals and gathering subjective statements regarding the minimum financial requirements for living (World Bank Institute, 2005). Callan & Nolan (1991), however, claim that each and every method has its significant flaws at a theoretical and empirical level, which leads to the lack of dominance of any particular one. The significant point of discussion in terms of the poverty line is the question of whether it should be perceived as an absolute or a relative concept (Hagenaars & van Praag, 1985).

Since 1990 there has been a constant decline in global poverty, which indicates the impactful actions taken to improve the situation. Nevertheless, the uneven geographical distribution of world poverty makes some regions suffer from hardship significantly more than others (Yunus, 2007). This discrepancy, along with the scale of the phenomenon, impedes some regions, such as Sub-Saharan Africa, South Asia and the Pacific, from keeping up with the comparable pace of development, and makes them suffer extreme poverty due to natural disasters, lack of education and lack of governance.

Focus on India

India is the second largest population in the world, whose size is estimated to significantly exceed the level of 1,37 billion by 2020[7]. Currently, India constitutes around 18% of the world population.[8] Despite this extraordinary growth rate, 3,7%[9] of the population is acknowledged to live below the poverty line, experiencing extreme poverty, which translates to a lack of basic, everyday necessities, such as food, clothes, shelter or access to sanitation units[9]. However, this only reflects extreme poverty. 28% of the Indian population

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6 https://www.worldbank.org/en/topic/poverty/overview
7 https://www.statista.com/statistics/263766/total-population-of-india/
8 https://www.worldometers.info/world-population/
9 https://worldpoverty.io/

lives in general poverty (UN, 2018), which is defined as "a state, in which one do not have an access to the usual of socially acceptable amount of money or material possessions".[10] Moreover, according to a report by Quartz India (Iyer, 2018), 75% of the current average income of generation Y stems from family and social connections, which to some degree indisposes unprivileged parts of the society to move up in the economic ladder.

Nevertheless, due to social actions taken on the situation, India's poverty is expected to decrease to 0,2% until 2030[9].Figure 3 presents the expected drop of the poverty rate in timeline of 15 years (2015-2030), juxtaposed with the predicted increase of the population.

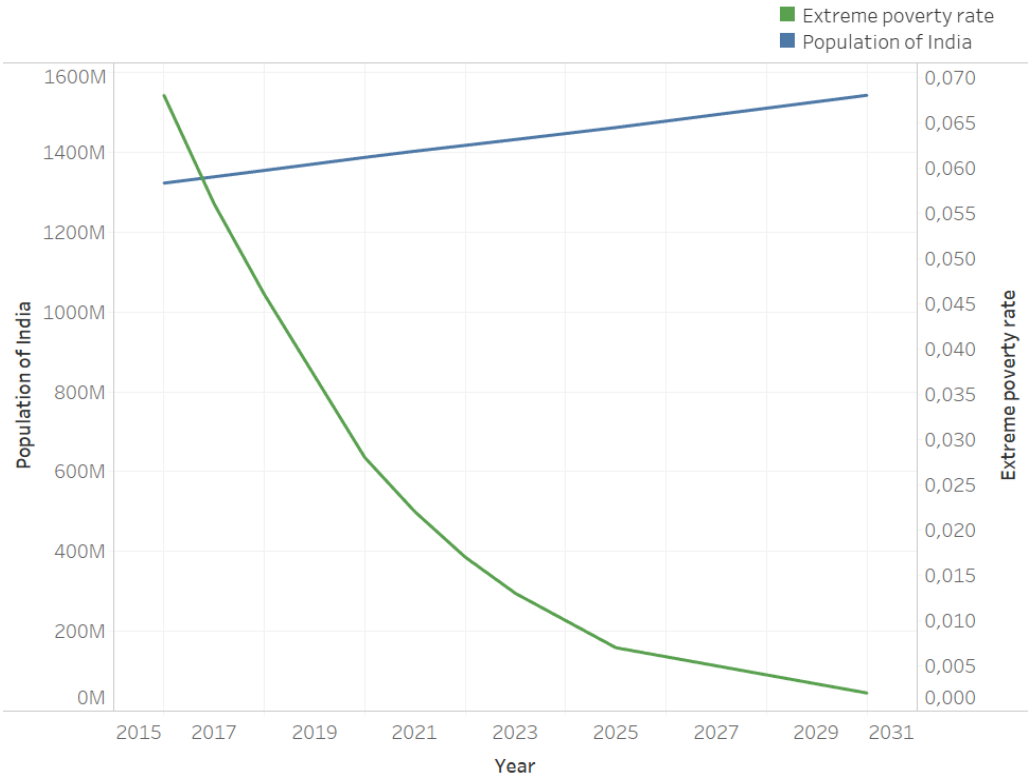


Figure 3 The predicted poverty rate juxtaposed with the expected increase in the population in India for 2015-2030; Source: https://worldpoverty.io/ (own elaboration)

10 https://www.merriam-webster.com/dictionary/poverty

Causes of poverty in India

Dr. Radhika Kapur (2014) identifies several causes of poverty in India, dividing them into five distinctive yet permeating categories: climate factors, demographic issues, economic, personal and social causes.

Firstly, frequent weather conditions like floods, cyclones, or heatwaves are fateful and have a detrimental influence on India's infrastructure and agriculture. The potential destruction of crops, which are a major occupation and source of income for the population in rural areas, is directly connected to the exacerbation of the poverty (Kapur, 2014). Aside from the rough climate conditions, the population growth dynamics and complementary demographics factors are also of great importance while scrutinizing the causes of hardship in India.

It needs to be underscored that India experiences a much higher population growth rate than other countries characterized by similar demographics. Five of the world's most populous countries were selected for the comparison: China, Indonesia, Brazil, India and Russian Federation. The United States of America were excluded due to an incomparably better economic situation, which would lead to unreliable conclusions. Appendix 5 presents the statistics for the population growth of the aforementioned countries in the interval 2000-2017.

The growth rate of India is the highest from all the presented ones, significantly exceeding those of China and Russia, which can be characterized as the most developed countries within the study. Despite this outstanding growth rate, the Indian economy struggles with constant, unproportional and very rapid upsurge of the country's population, which exacerbates the poverty. For the sake of comparison, Appendix 6 shows the poverty headcount ratio as a percentage of the countries' population in each location. It clearly shows that the aforementioned growth rate does not translate into economic growth - India stands out significantly with its poverty headcount ratio. Additionally, there is a noticeable discrepancy between the growth rate of the population and the pace of national income growth in India. The country's population rate grows unproportionally faster than its GDP growth rate, which deepens the level of poverty (Kapur, 2014). Figure 4 presents the GDP growth rate and the pace of population growth rate in the years 2000-2018, indicating the constant decline in GDP rate with a very high relative population growth rate (comparison in Figure 3). The phenomenon impedes the potential poverty decline, due to the constantly increasing number of inhabitants and the decline in the already low income level per capita.

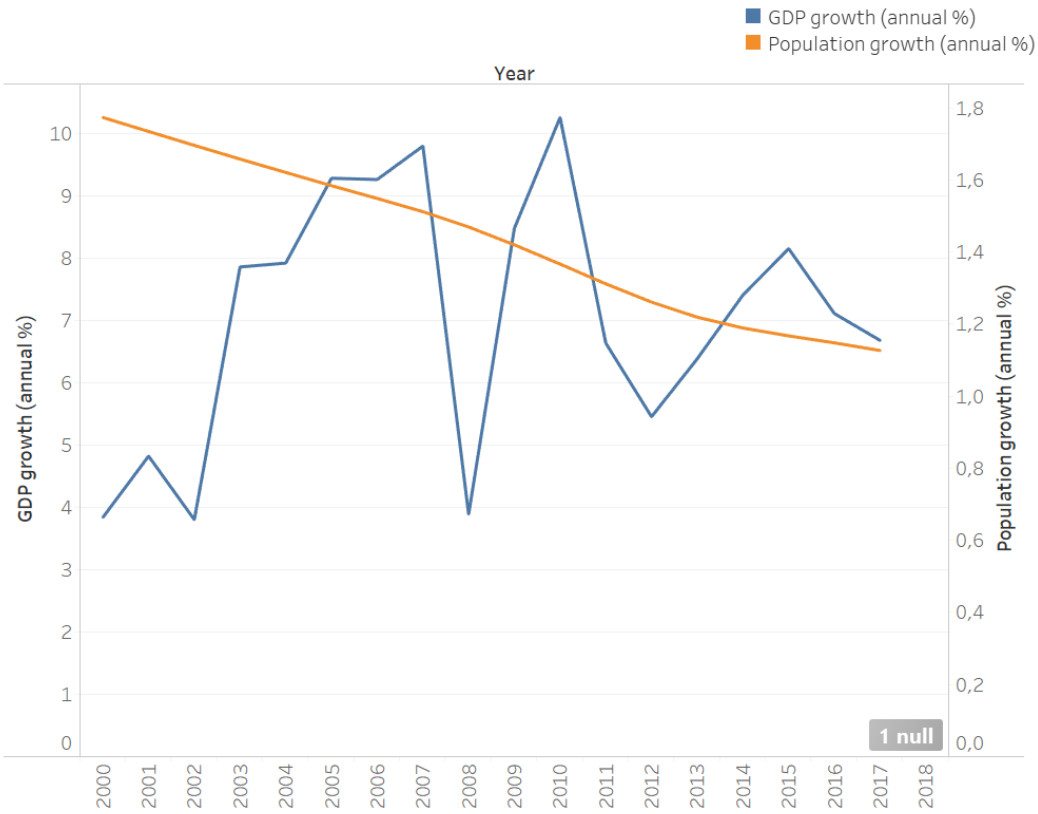


Figure 4 The GDP growth rate and the pace of population growth rate in the years 2000-2018; Source: https://data.worldbank.org (own elaboration)

Moreover, the upsurge in the population leads to an increase of the labor supply available on the market. Under the assumption that labor demand stays stable, this further leads to a decline in the salary level. Kapur (2014) suggests that the problem is more severe in rural areas, where families tend to live in joined households. The income and living standards of these households are lowered due to the larger number of home-dwellers. This so called "joint family" concept, creates the opportunity for some participants, who are unwilling to contribute with their work, to "parasitize" and live on the income generated by others (Kapur, 2014).

The third factor mentioned by the author revolves around personal and social causes defined by more intangible factors, like a potential lack of motivation and general indolence, which trigger the life in escalating poverty.

The limited access to adequate education is strongly connected to the struggle with poverty elimination. Despite the fact that in 2011 the school enrollment rate for primary education was 92,25%[11], the most recent data (from 2015) on the illiteracy rate in India indicate that 28 % of the overall population is not capable to

11 https://data.worldbank.org/indicator/SE.PRM.NENR?locations=IN&view=chart)

read and write[12]. Moreover, there is a gap of 18% between the literacy rate for men (81%) and women (63%), which could be an intimation of the pervading patriarchal system, stopping women from getting similar privileges, i.e. equal access to education. Interestingly, Tilak (2006) criticizes the focus on primary education as it does not provide sufficient skills for potential employment. The author proves, despite prior research, that post-elementary education contributes significantly to poverty reduction, which highlights the importance of the issue and a necessity of providing this opportunity to the wider population (Tilak, 2006).

The lack of education and access to the newest solutions smoothly introduces the first of the economic causes of Indian poverty suggested by Kapur (2014), which is low agricultural productivity induced by the application of traditional farming techniques. Moreover, the author claims that the distribution of land and assets is significantly skewed. The majority of operational holdings belong to the closed group of farmers leading to an aggravation in the poverty of the remaining groups. According to the study of Sarma, Saha & Jayakumar (2017), there is a noticeable trend towards increasing asset concentration at the top, the households at the bottom suffering from insufficiency. The observation was valid for both rural and urban areas. Despite the occasional availability of better paid employment offers in more distant locations, the proposal does not always meet with straightforward approval. The general mobility of the labor in India motivated by the higher wages is strongly hampered by the simple unwillingness to leave households and families (Kapur, 2014). Moreover, the employment opportunities are vastly limited due to the aforementioned disproportionate growth rate between population and GDP, which causes unemployment and the widely spread phenomenon of underemployment.

Last but not least, a very meaningful factor influencing the citizens' wealth and wellbeing is the presence of the deep-rooted caste system, which is very rigid in some areas of India. The caste system divides the population into four different social groups assigning a clear hierarchy to each of them – Brahmins, being at the top of the hierarchical pyramid, are the priests and teachers, Kshatriyas are the warriors and kings, Vaisyas are the famers, merchants and artisans, while Sudras are the laborers (Rao, 2010). The importance of the castes descended accordingly. There is, however, a group of "Untouchables", also known as Dalits or Harijans, who are entirely separated from the rest of the society, being assigned the lowest jobs that others refused to perform, such as cleaning human waste, digging graves or disposing of dead animals (Pal, 1999). All these tasks are performed with bare feet and hands, hence Harijans are highly exposed to all types of infections, which is the bitter genesis of the name "untouchables" (Rao, 2010). The affiliation to any of the aforementioned castes is tainted by birth, therefore one cannot change one's fate, despite potential personal capabilities or external

12 https://www.statista.com/statistics/271335/literacy-rate-in-india/

help. The inability of influencing your own life and development due to the caste determination has a massive impact on one's wealth and potential professional opportunities.

As an additional remark, the importance of financial inclusion needs to be underlined. Varghese & Viswanathan (2018) posit that the financial inclusion of the underprivileged, defined as "an access to appropriate, low cost, fair and safe financial products and services from main-stream service providers", is absolutely necessary to unlock their financial growth potential. According to the 59th National Sample Survey Office (NSSO), 51,4% of rural inhabitants in India do not have access to either formal or informal financial services, only 27% having access to a formal financial system, leading to 73% of the rural population not participating in any formal economic system (Varghese & Viswanathan, 2018). The authors underline that the separation from the financial system aggravates the poverty by creating a vicious circle - without savings, insurance or affordable credits, no bank account can be opened, which leads to the inability to perform any digital financial operation and the lack of assets. Therefore, financial inclusion needs to be taken into consideration while analysing the causes of the poverty.

Building on the prior analysis, it needs to be highlighted that the issue of poverty is more critical in rural areas than in the cities. According to Statista, in 2017, 66,4% of the Indian population lived in villages outside of the urban infrastructure [13], whereas 80% of the country's poverty was concentrated in rural areas without access to education or every day supplies[14]. The poverty rate in rural areas reached the level of 4,25%, exceeding the country's average by 0,55 percentage points[15]. This disproportion makes this phenomenon a meaningful social issue requiring to be addressed.

Current situation of social businesses and micro crediting in India

According to the British Council (2016), social enterprise activity is rapidly developing - 57% of social enterprises are 5 years old or younger-, which reflects the current societal urge to take entrepreneurial action and improve the quality of life. The acceleration of this process is supported by more than 50 impact funds and investors engaging in the multiple different stages of the enterprises' development (British Council, 2016). In a 2014 study, 1,6 billion was invested in 220 social enterprises (Intellecap, 2014).

Yunus (2007) defines the notion of social businesses or social enterprises as a non-loss, non-dividend company aiming to respond to a particular social problem whose financial means are re-invested in order to expand the business. According to Yunus (2007), two factors induced the emergence of social businesses. The first factor

13 https://www.statista.com/statistics/271312/urbanization-in-india/
14 http://www.worldbank.org/en/news/infographic/2016/05/27/india-s-poverty-profile
15 https://worldpoverty.io/methodology/index.php?language=en

revolved around the insufficient and inadequate government contribution in providing support for the underprivileged. The massive disproportion between the slow pace of human development and the significantly high growth in GDP, which was discussed before, was considered as a second factor. The unfulfillment of these two factors led to the inevitable reinforcement of the poverty. Yunus (2007) underscored that the Indian population is willing to change their fate, once given the means. Therefore, the concept of the social business has been successful in these settings.

However, due to their intrinsic features, social businesses face numerous challenges, especially regarding the transparency of transactions, credibility and trust among the participants. Given the nature of these issues, some of them could be solved with the help of currently available technology, without the need for the social business to dedicate additional resources. Therefore, the implementation of blockchain and its suitability will be investigated to address these challenges.

Theoretical Background

In this section, we collect existing knowledge in the domains of blockchain and microlending in order to create the foundation on which we build our final solution. We further introduce relevant business and economic concepts through which the applicability, suitability and adoption of our final solution will be assessed.

Blockchain

The introduction of Bitcoin and therefore of the blockchain technology – the encrypted and decentralized protocol for peer-to-peer transactions of new digital cash, based on the secure distributed ledger (Nakamoto, 2009) - enabled the redefinition of how financial business activities could be organized and gave a promise of their future implementation to different sectors. Due to its technological design, the blockchain is one of the first solutions which can be broadly implemented giving birth to tamper-proof immutability, transparency and auditability.

We now present the multiple aspects of the blockchain technology, as well as its technological underpinnings. We start with the introduction of the blockchain generations and the general characteristics of the technology. We then follow with the in-depth description of several consensus mechanisms such as Proof of Work (the blockchain technology behind Bitcoin), Proof of Stake and Proof of Authority. Each of the validation schemas is scrutinized in light of its modus operandi, incentivization and general suitability for specific settings.

Generations of Blockchain

Swan (2015) analyses the development of the technology in the modern world through computing paradigms, which were sequentially emerging throughout the last decades. As powers enabling the world's omnipresent connectivity, the author identifies the PC and the appearance of the Internet as a first disruption. These were followed by the emergence of mobile and social networks. The prophecy of the currently emerging paradigm is revolving around the enhancement of the aforementioned world of computing by basing on the blockchain cryptography. Undeniably, the author argues that the emergence of the blockchain technology and its influence on various industries made it into one of the most disruptive phenomena in the last few years, having the potential to entirely redesign and redefine operations in numerous sectors. Since the introduction of Bitcoin in 2009 (Nakamoto, 2009), the blockchain technology has developed significantly – from its initial structure of distributed ledger to the promise of distributed cloud computing, enabling the communication and cooperation among blockchains (Swan, 2015). For the sake of simplicity and clarification, the academic literature divides the development of this technology into three categories: Blockchain 1.0, Blockchain 2.0, Blockchain 3.0 (Swan, 2015).

The first generation of blockchain is strictly connected with the implementation of cryptocurrencies to cash-related activities like currency transfers or digital payment systems (Swan, 2015). Bitcoin is an obvious and conspicuous example here. Blockchain 2.0, however, as a network on which developers can build applications, incorporates all kinds of financial applications characterized by a higher level of complexity than cash transactions such as bonds, stocks, mortgages, or derivatives like futures or options (Swan, 2015). Smart contracts and smart property are further critical features of the second generation of blockchain. Blockchain 2.0 emerged just a few years after the introduction of the first generation and opened the door to the maintenance of more complex applications and use cases of assets on the blockchain (Azam, 2018) . Introduced in 2013, Ethereum is a great example of Blockchain 2.0 due to its smart contract compatibility. From a distributed database in the first generation, the blockchain technology was transformed into the distributed computer serving as a base for applications and smart contracts (Swan,2015).

Swan (2015) states that, as a response to the challenges mostly revolving around the scalability of the blockchain, Blockchain 3.0 is being developed to extend the capacities of existing blockchains. The third and most extensive blockchain generation goes beyond financial-related operations like currency transfers or broadly defined financial markets. Blockchain 3.0 represents the implementation of the technology in a wide range of sectors including health, science, culture, entrepreneurship, government (votes/ election) or even arts (Swan, 2015), where the flow of information among blockchains is necessary and has to be enabled. The

author acknowledges that one of the main focuses and challenges of the third generation of blockchain is ensuring the scalability of distributed computers, so the promise of the global distributed computer is fulfilled.

General characteristics and types of blockchains

Taking into consideration that, in contrast to fiat currencies, there is no central party responsible for security issues, the preservation of the ledger must be ensured by the technological solutions (Narayanan, et al., 2016). Regardless of the design or general purpose of a blockchain, the technology, by definition, should ensure several certain features like transparency, auditability, and immutability, which mostly derive from two major characteristics of the technology - distributed ownership and lack of intermediaries.

Blockchain technology appeared as a response to the failure of central financial institutions in 2008 and enabled a cooperation among trustless and anonymous parties, entirely eliminating the presence of the intermediary, whose credibility had to be taken for granted due to the lack of any other verification mechanism (Jabbar & Bjørn, 2017). Due to the consensus mechanisms and the distribution of the ledger among multiple nodes in the blockchain, the necessity of any intermediary facilitating the transactions is eliminated (Zohar, 2015). Instead of keeping the ledger on one server or multiple servers owned by one party, the blockchain is based on the transaction log, which is distributed across the network, eliminating a single point of a potential failure (Churchill, 2015). The responsibility and privilege of storing the final version of the ledger and managing all the activities in the network does not belong anymore to one central party, but to the whole network. Given the underlying assumption of distrust among the nodes in the network, the distributed nature of the ledger allows for its constant verification for every network participant. Hence the potential manipulation in the database is strongly impeded, which ensures the transparency of the transactions for all the nodes equally. Each node can continuously keep an eye on the state of the ledger and proceedings of the other nodes. Mukkamala et al (2018) present a compilation of the core characteristics of the blockchain (Table 7). The features of immutability, decentralization and transparency were discussed. The notion of pseudonymity refers to the elimination of any type of the participants' identity or the creation of artificial names for only for the network usage (Mukkamala et al., 2018).

Moreover, the properties of transparency and traceability are strongly ensured by the timestamping, the possibility to follow through the chronological order of the transactions, which is the last characteristic mentioned by Mukkamala et al.(2018). The concept of timestamping for the sake of security and easy establishment of the chronological order of assets' creation was already mentioned in 1991 in the paper of Haber and Stornetta (Narayanan, et al., 2016). However, the solution was implemented in the realm of digital documentation. The immutability and reliability of the idea lies in the impossibility of timestamping

manipulation once it was created. This example accurately reflects the concept behind the hash functions in the blockchain realm, which will be discussed further (Narayanan, et al., 2016).

Immutability	Data written to the chain cannot be changed or deleted without consensus
Decentralization	No single point of failure/control achieved by decentralised & distributed architecture
Transparency	All data sent through the blockchain is visible to all network participants
Pseudonymity	The identity of data senders and receivers is unknown
Chronology	Every transaction is time-stamped and can be traced back

Table 7 Core characteristics of blockchain by Mukkamala et al. (2018) (own elaboration)

Zohar (2015) presents two major issues which have to be taken into consideration while implementing blockchain. One of them is the aforementioned substitution of the central authority managing the final version of the ledger with the consensus mechanism. In traditional settings, the main role of this central authority is to prevent one of the most crucial issues in the financial realm, especially related to digital currencies, namely the double spending problem. Each transaction asset is assigned with a string of bits, or so called hashes (explained further in section "Proof-of-Work") enabling the identification and uniqueness of the asset. In contrast to fiat currencies, the hash of trading components can be easily copied and used in multiple transactions nearly simultaneously, with very short time intervals in between. Zohar (2015) claims that a relatively small size of the ledger would cause an upsurge in the transaction validation time and therefore enhance the manageability and preservation of the ledger. Nevertheless, due to the relative ease of asset replication, the double spending problem is still one of the key issues that cryptocurrencies need to solve (Narayanan, et al., 2016, p. 44).

Technical concepts behind blockchains

Taking into consideration the different usage of blockchain-based platforms, there are three main types of blockchain technologies: public (the network is open for all the interested nodes, who can check and verify transactions), consortium (the setting in which there is a clear pre-specified authority assignment) and private (there is an authority managing the access to the data, where a preliminary identification process is required before joining the network) blockchain (Lin & Liao, 2017). Private blockchains are owned by a network administrator who has complete control over node permissions and full access to the ledger (Szymański, 2018). Consortium and private blockchains are usually preferred in business applications due to their similarity to market mechanisms and increased level of security.

Despite the fact that the modus operandi and premises of blockchain always stay the same regardless of the design, the ledger's endorsement process is an important, pre-specified criterion determining the suitability of the blockchain solution.

Consensus mechanisms

The credibility and authenticity of blockchain technology, as a distributed ledger based on a peer-to-peer network is assured by synchronization among the network participants, the so-called consensus mechanism (Zohar, 2015). Swanson (2015) defines a consensus mechanism as a set of procedures and actions aiming to reach agreement on the current state of the ledger among some or all validating nodes, in order to ensure the distribution of a coherent, one "version of truth" among the network participants. Thereby, the most crucial promises and characteristics of blockchain are provided – the elimination of the central authority supervision in charge of managing the transactions or storing the final version of the database (Rennock, Cohn and Butcher, 2018).

The selection of suitable consensus mechanisms for a given blockchain strongly depends on its purpose, design and distinct characteristics of the blockchain per se. Satoshi Nakamoto's (2009) initial proposal of Proof-of-Work as a consensus mechanism for the initial blockchain (Bitcoin) was undoubtedly revolutionary and very meaningful, however the solution proved to have serious detriments and be advantageous only in particular settings. The development of the blockchain technology and its implementation to different areas highlighted the unsuitability and downsides of the mechanism, which gave rise to the creation of other validation processes like Proof-of-Stake, Proof-of-Authority, Proof-of-Publication and many others. The most commonly used consensus mechanisms will be presented in-depth in the following sections.

Proof-of-Work

In order to give a comprehensive analysis of the first consensus mechanism, the proof-of-work concept will be presented in the realm of its first usage - Bitcoin.

Jabbar & Bjørn (2017) broadly define Bitcoin as "*a technical protocol with hard-coded rules for monetary transactions between peers*" which enables the recording of all transactions without the need for a trusted intermediary. Importantly, the public blockchains like Bitcoin assume by default the participation of trustless, anonymous nodes, whose "cooperation" needs to be managed and structured by the consensus mechanism. The security of Bitcoin transactions is ensured by the usage of public-/ private-key cryptography, while each of the transactions requires the private key in order to spend the desired amount of Bitcoins associated with the given Bitcoin address (Jabbar & Bjørn, 2017). Due to the assignment of the public key to the Bitcoin address, the validation of the transaction is possible. The private key, however, gives the selected recipient an exclusive opportunity to decode the sent message. Therefore, a pair of public and private keys needs to be created by each user in order to enable the interaction with blockchain- based technologies – the private key is used to sign a user's transactions of her own, while the corresponding public key serves as the aforementioned address (Mukkamala et al., 2018).

Bitcoins are programmed to be created on average every 10 minutes, but there is no precise, fixed schedule (Narayanan, et al., 2016). Moreover, there is a guaranteed scarcity of Bitcoins, which ensures the supply-demand manageability of the asset (Zohar, 2015). Bitcoin's inflation rate was designed in a way to mimic the stable inflation rate of gold, rendering the currency to become even scarcer than the commodity (Hays & Coronado, 2018). It ensures the relative value keeping of the asset due to the lack of possible inflation and also refrains from the potential influence of external parties on the cryptocurrency.

Mining and hash functions

"*A bitcoin is created by miners, using complex mathematical "proof of work" procedure by computing hashes*" (Dwivedi, Srivastava, & Singh, 2018). The statement of Dwivedi, Srivastava, & Singh (2018) neatly encapsulates three crucial terms– Proof-of-Work, hashes and mining – which are required to understand the technical underpinnings of Bitcoin and its consensus mechanism. Proof-of-Work is intrinsically a highly advanced cryptographic puzzle, which, once solved, enables the transaction validation and the addition of the new block to the chain (Jabbar & Bjørn, 2017), while mining is a process of repeated trials to solve this mathematical problem (Narayanan, et al., 2016, p. 65). The mining process lies at the very basis of the blockchain with Proof-of-Work and is a key factor fortifying the security of the network (Narayanan, et al., 2016, p. 17). In case of Bitcoin, the nodes compete to validate the set of transactions and add a new block to the chain in order to be rewarded by the coin – further explanation in the subsection "Incentivization". Hence, a strong competitive

environment is created for the miners. Mining is a process that requires a random trial approach to be performed, which results in the massive computational burden incurred by every node aiming to guess the appropriate hash (Narayanan, et al., 2016, p. 65). Therefore, the scalability of the blockchain based on Proof-of-Work is strongly hampered due to environmental jeopardy. Despite the fact that the computational power required to participate in the mining race is substantial, numerous nodes are incentivized enough to be willing to devote the resources and broadcast the new block to the ledger. Therefore, the aggregated hashing power in the network may vary (Jabbar and Bjørn, 2017), which gives a raise to the matter of the Proof-of-Work optimization and complexity management. In order to keep the duration of mining (more or less 10 min) stable and the Bitcoin creation as expected, the protocol is self-adjusting to the level of hashing power on the network - Proof-of-Work's difficulty increases with the upsurge of the computational power (Jabbar and Bjørn, 2017).

The result of the mining process is the determination of the hash and broadcasting of a new block to the network. The miner shares the block to the directly connected nodes, so the generated Proof-of-Work can be verified. If the correctness of the hash is confirmed, the schema is repeated and the block is broadcasted further in the same manner. The identification of which version of the leger is the valid and correct one bases on the determination of the longest chain i.e. the chain with the highest number of Proof-of-Work (Swanson, 2015). Due to the gradual ledger verification performed by the majority of nodes, the preliminary detection of any malicious behavior is enhanced and diminishes the probability of the addition of the hacked block. Moreover, in order to change the ledger, the hacker would have to solve the Proof-of-Work puzzle in a faster pace than the other participating nodes together, which additionally enables the quantification of the Bitcoin security system (Narayanan, et al., 2016, p. 17).

A crucial element of the security and data integrity provision are hash functions, due to their provision of the chronological sequence of blocks in the chain. Each block is marked with a hash, which is a product of the mining (explained earlier in this section). Each block is assigned not only with a hash of its own, but also with a hash of its predecessor, which strongly indisposes the chance of any unnoticed manipulation in the sequence of the blocks (Figure 5).

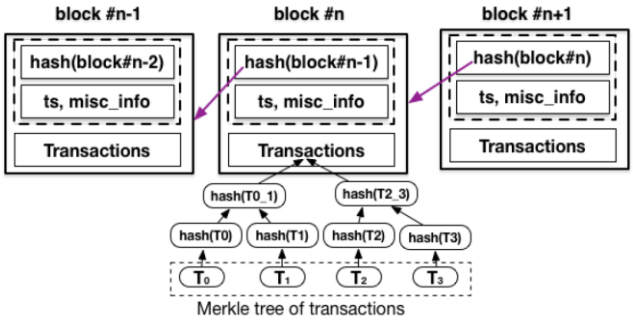


Figure 5 The visualization of hash functions - way of operating by Mukkamala et al.(2018)

In case of malicious behavior, the hacker would have to change the information on all the blocks way back to the so-called Genesis block – the block initiating the blockchain (Jabbar & Bjørn, 2017) – which would be burdensome and hardly unnoticed. Therefore, hash functions are indispensable elements enhancing the notions of transparency and traceability of the blockchains based on Proof-of-Work.

Narayanan, et al. (2016, p. 65) present three distinctive characteristics of hash functions, which need to be fulfilled in order to ensure the expected blockchain functionality. Computational difficulty is the first property, which can be explained by the previously presented nature of Proof-of-Work and ensuring of the ledger security. Second, the cost should be parameterizable, and not fixed, which is strongly connected with the aforementioned sensitivity of the algorithm to the upsurge of the hash power on the network. Last but not least, the triviality of verification has to be ensured in order to enable the remaining nodes to validate a new block and preserve the coherency of the ledger. Moreover, Mukkamala et al. (2018) present complementary properties: the deterministic, efficient and distributed nature of hash functions, their collision resistance and preimage-resistance. The determinism of the hashes indicates that the same input always has to create the same results, which is created within certain time constraints (the property of efficiency). The distributed characteristic of the function presents the even spread across the range of potential outputs, which eliminates the risk of a correlation between the similar hashes and similar data. The preimage-resistance is a very important property security-wise. It means that no input data can be found based on the value of the hash function. Lastly, the creation of the same hash for two different inputs must be infeasible, which is captured by the last property of collision resistance.

Based on the work of (Narayanan, et al., 2016, p. 55), in contrast to other consensus mechanisms, Proof-of-Work strongly bases on the notion of randomness and does not foresee a precisely pre-defined starting or ending point for the consensus mechanism. This is caused by the process of mining underlying the concept of Proof-of-Work.

Incentivization

The incentivization mechanisms to perform the validation process of the ledger are twofold - block reward and transaction fees (Narayanan, et al., 2016). The principle behind the block reward revolves around the inclusion of a special, coin-creation transaction to the potentially appended block (Narayanan, et al., 2016, p. 62). When the block is added, the new coin is created and serves as a tangible compensation. As a reward, the validator is allowed to indicate the recipient of the coin and thereby compensate the effort put into the ledger validation. Obviously, in the vast majority of cases, the nodes would indicate themselves aiming to enrich their own portfolio.

The second mechanism serving as an encouragement for the validation activity are transaction fees. In contrast to the block reward, where the promise of a potential prize can be programmed in the block per se, the logic of this procedure is purely transaction-based. The incentivization is created by the nodes and not by the validator. Once the total value of any transaction outcomes is lower than the total value of transaction inputs, the difference can serve as a transaction fee (Narayanan, et al., 2016, p. 63). The creator of the transaction is responsible for setting these values and does not have any restrictions regarding them. The node, which happens to validate the block containing the transaction, can take this fee and treat is as a compensation for its computational burden dedicated to preserving the ledger. Nevertheless, it needs to be remembered that regardless of the type of the incentive mechanism, the reward will be "delivered" only in case of the long-term consensus branch – the agreement on the final state of the ledger by all the nodes (Narayanan, et al., 2016, p. 62).

Security issues

Despite the well-designed security system, the probability of a successful malicious behavior on Proof-of-Work-based blockchains cannot be minimized to zero. As presented before, the Proof-of-Work mechanism gives the nodes an opportunity to combine their CPU in order to enhance the chances of the successful mining process by creating "mining pools" (Lin & Liao, 2017). In case of obtaining 51% of the computing power, an entity is able to add hacked blocks to the ledger and validate them as the correct ones. That kind of attack is called "the majority attack" or "51% attack" since the entity gains the majority of the decisive power over the network, thereby entirely controlling it (Lin & Liao, 2017).

The blockchain based on Proof-of-Work, due to enabling the collaboration among trustless, fully anonymous nodes, is often a suitable choice for public blockchains. Nevertheless, due to the random trial approach to mining, the proof of work algorithm is burdened with the high computational consumption, which makes it a very inappropriate solution for cases where the scalability is a critical criterion. Such an amount of electrical power required to mine the block and validate the ledger has extremely detrimental influence on the

environment. Due to this fact, multiple entities resign from the usage of Proof-of-Work and strive to implement an alternative consensus mechanism.

Proof-of-Stake

From the business point of view, a reasonable alternative to the aforementioned consensus mechanisms is Proof-of-Stake, where the endorsement activity is assigned based on the proportion of the currency ownership of the nodes (Narayanan, et al., 2016, p. 64). In Proof-of-Stake, the node responsible for the block generation provides a proof confirming its access to a given number of coins before getting the acceptance by the network (Vasin, 2014). The generation of each block requires the transfer of the coins to oneself in order to prove the ownership (Vasin, 2014). Therefore, the core principle assumes the assignment of the endorsement right to the nodes owning the highest stake (the probability of being assigned the endorsement right is proportional to the amount of coins "locked-up"). This incentivization process slightly builds on the mechanisms observed in financial markets due to the application of the economic and behavioral study to the validation management.

The parties holding the highest stakes are naturally mostly interested in the proper ledger's preservation, due to potential losses, which by definition would be relatively higher than for other participants. Therefore, the right to validate the final state of the ledger is assigned to the aforementioned nodes. Additionally, Mukkamala et al (2018) mention that one of the influencing factors could be the length of a node's presence on the network. Nevertheless, the system which bases on the objective assessment of the asset value may be biased. The inability of the unified estimation of the stake value is a major issue when applying Proof-of-Stake. It can be expected that the same stake may not be "valued" equally by different nodes, taken into account the remaining holdings in their portfolio (Dhariwal, 2018).

At the beginning of this chapter, the matter of the scalability of the blockchain solution was mentioned as a major challenge for the technology. In contrast to the Proof-of-Work mechanisms, the validation is no longer a mining race, where the computational power is the winning determinant and a reward in the form of i.e. Bitcoin promised. Therefore, the computational burden of the Proof-of-Stake as a consensus mechanism is significantly lower when compared with Proof-of-Work, which augurs well for the blockchain implementation in the broader spectrum.

Proof-of- Authority

Due to its stake-base logic, Proof-of-Authority is conceptually very similar to the priorly presented Proof-of-Stake (Dhariwal, 2018). However, in this case the real identity of the node is put on stake, not the coins. Any malicious behavior of the validator is supposed to be refrained by the potential loss of reputation or possible

various unpleasant consequences in the real world. It needs to be underscored that this consensus mechanism requires three critical settings, which need to be in place in order to enable the success of the Proof-of-Authority implementation (Dhariwal, 2018).

First of all, effective control mechanisms need to be implemented to ensure that the declared identity of the node is in alignment with reality. The incentive for the correct ledger preservation would be non-existing, if the identity were falsified. Second of all, in order to create equal chances for all the network participants, the rules regarding the assignment of the validation activity must be clearly stated and easily accessible. Lastly, the validation process requires an additional effort for which the node would like to be rewarded. Therefore, it is crucial to create mechanisms in which the right to endorse the ledger is not easy to get and unpleasant to lose (Dhariwal, 2018). It needs to be underscored that the fact of revealing the node's real identity slightly undermines the concept of anonymity on the blockchain. Hence, this solution, as well as Proof-of-Stake, are preferable choices when applied to private blockchains or consortia (Rennock, Cohn, & Butcher, 2018).

Smart contracts

The term *smart contracts* was coined already in 1990s, when computer scientist Nick Szabo defined it as "a computerized transaction protocol that executes the terms of a contract" (Szabo, 1997). Smart contract is simply speaking a piece of code, in majority consisting of numerous "if-else" statements, which trigger given actions when certain conditions are fulfilled. The emergence of the smart contracts was mostly motivated by the claim that the general purpose of security would be more attainable when the transactional relations would be automated and make a contractual breach very expensive (Szabo, 1997). Grybniak (2017) presents three key properties of smart contracts: *autonomy* (after launching the contract, no action needs to be done apart from the autonomous triggering), *auto-sufficiency* (allowance for the larger capacity storage through the encoded actions), and *decentralization* (the lack of the central authority storing the contract).

The main blockchain framework enabling the usage of smart contracts was Ethereum (Blockgeeks, 2019). Ethereum is not a one purpose platform, but is designed to build applications on it (Blockgeeks, 2019). Therefore, in contrast to Bitcoin, Ethereum has numerous other functionalities other than trading cryptocurrencies. The idea behind the introduction of Ethereum was to build on existing solutions like Bitcoin, however with the focus on increased overall security of the network and transactional speed (Fintech Network, 2016).

Digital assets

Most blockchains are designed to support the circulation of digital assets on their infrastructure. In some cases, such as for the Bitcoin blockchain, coins are given as a reward for validation and mining. This incentive is absent on private and permissioned blockchains. The terms 'coins' and 'tokens' sometimes get used interchangeably and can thus create confusion (Long, 2018), which possibly stems from the fact that coins are a form of specifically designed tokens (Euler, 2018). The difference between the two lies in the possibility of coins to be used as a means of exchange in the same way as any fiat currency, and of using them to purchase tokens (Shevchenko, 2018). Furthermore, coins need their own blockchain and can be used for multiple purposes (Long, 2018). Tokens, on the other hand, can live on existing blockchains, such as Ethereum, and serve as a sort of contract that can only be used for a single purpose (Long, 2018). This differentiation invites a comparison and term delimitation for cryptocoins across different geographies and legislations. Depending on region and jurisdiction, cryptocurrencies have different names when they are referred to by official entities. The name varies from the more generalistic *digital currency* in Argentina, Thailand and Australia, or *cyber/electronic currency* in Italy, Lebanon and Colombia, to the more specific terms of *virtual commodity* in Canada, China and Taiwan, or even the rather counterintuitive *payment token* or *crypto token* in Germany and Switzerland (Goitom, 2018).

Euler (2018) presents a comprehensive taxonomy of cryptographic tokens, which can be seen in Appendix 7. In the taxonomy it can clearly be observed that the market for tokens is quite complex and encompassing. Token types are categorized based on various technological and utilitarian considerations. First, token archetypes are a meta-description of the intended functionality of each respective token type. Euler (2018) lists four archetypes: cryptocurrencies, tokenized assets, tokenized platforms, and tokens-as-a-share.
Cryptocurrencies represent the likes of Bitcoin, and are therefore the coins to which we refer in previous sections. Tokenized assets represent a 'real-life' asset such as gold, where the issuing party has to own the asset represented by the tokens (Whittaker & Reid, 2018). The value of such tokens is usually stable and secure, as it is tied to assets with quantifiable monetary value. The third type, tokenized platform, is a distributed environment on which token-based applications can be built. Here, the tokens are seen as the 'fuel' of the platform (Whittaker & Reid, 2018). Platform tokens receive their value from the network on which they exist, and rarely have value outside of that network (Euler, 2018).
And finally, tokens-as-a-share represent tokenized investment instruments that behave like stocks or currencies, and which are programmable by means of smart contracts.

Another layer of the taxonomy is represented by different criteria which can be used to delineate each token type: technical layer, purpose, underlying value, utility, and legal status. The archetypes are shown in Appendix

8. Each criterion is further marked with the token archetypes which it characterizes. It needs to be underlined that these criteria are not mutually exclusive, on the contrary, they are seen as different perspectives of characterizing the same token. A token can have any number of these characteristics, or even all of them (Euler, 2018).

Cryptocurrency ATMs

The first cryptocurrency ATMs were built for the exchange of Bitcoins and appeared as the result of financial inclusion efforts for the unbanked and less technically inclined, and are generally referred to as BTMs, a term which stands for 'Bitcoin Teller Machines' (Unocoin, 2018). Sometimes, BTMs are also referred to as 'kiosks' (Bitcoin, com, 2019). Despite the origin of the name, the term 'BTM' is generally used in the industry to define teller machines for any type of cryptocurrency, be it Bitcoin or any Altcoin[16]. Altcoin is a term which refers cryptocurrencies that are not Bitcoin (Frankenfield, 2018). A newer generation of machines is a hybrid between fiat currency ATMs and cryptocurrency ATMs. These machines provide access to traditional banking infrastructures, enabling regular cash withdrawals and deposits, as well as access to different cryptocurrency exchanges, thus also offering the possibility to buy or sell cryptocoins (Trilliant Whitepaper, n.d.). Some companies even offer software than can be installed on regular ATMs to connect them to cryptocurrency exchanges, thereby transforming them into hybrid machines (ATMmarketplace, 2018).

Before BTMs were introduced, the buying and selling of cryptocurrencies was done completely online and could not be cash-based, therefore it was only restricted to people who had bank accounts and who possessed some measure of technical knowledge (Fortney, 2019). Even nowadays, 10 years after the initial introduction of Bitcoin and after numerous business models have sprung up to capitalize on the technology, it is still considered difficult for the main public to trade cryptocurrencies (Eissler, 2018). BTMs allow people to purchase cryptocoins with both a card and with cash, therefore unbanked individuals can become a part of the network, presuming that they have the necessary means to keep a wallet (e.g. a mobile phone). Moreover, BTMs also have similar usage instructions to regular ATMs, thereby simplifying the process of buying and selling cryptocoins compared to buying them online. This, however, comes with a cost, as BTMs have much higher fees than online exchanges (Unocoin, 2018). BTM owners incur the costs for installation and maintenance, and also have to register for a money transmitter status, which can be a costly and bureaucratic process, further increasing the costs for the end user to between 5-10% of the online price (Unocoin, 2018). Transaction fees vary from operator to operator, but generally average around 8.8% of the transaction value for buying, and 7%[17] for selling (Unocoin, 2018).

16 https://lamassu.is/

[17] https://coinatmradar.com/charts/?from=body

We now continue by providing a description of how the buying and selling process works.

Buying crypto-assets

Most commonly, BTMs are one-way, meaning that people can only purchase crypto-assets, and not sell them[18]. Buying corresponds to an exchange of fiat currency for the crypto-asset being bought (Unocoin, 2018). The steps for buying from a BTM depend on the manufacturer, but there are some general steps required by every BTM (Stephenson, 2018). For a first time user, there are usually some additional identification steps, such as scanning an ID, or even one's fingerprint (CoinATM Radar, 2015). The general process starts with the user entering their mobile number and scanning the QR code of their wallet. If they do not have a wallet, they can choose to have one generated for them. They then receive a confirmation SMS on their phone which they need to enter in the machine and, if they asked for a wallet to be generated, they also receive on their phone the QR code to that wallet (Eissler, 2018).

The following step highly depends on the manufacturer of the machine. For some machines, the user can proceed to selecting the amount of crypto-assets they wish to buy. For others, an additional identification step is needed where the user needs to confirm their identity by means of their pre-entered ID and fingerprint (Leonard, 2018). This, however, is mostly the case when the user is making larger transactions, the limits of which are determined by the BTM operator (Leonard, 2018). Depending on local regulation, it is possible that identification will always be required, and that the operator of the BTM will run background checks based on this information for anti-money laundering and anti-terrorism reasons (General Bytes, website). After selecting the amount they wish to purchase, the user simply needs to introduce the corresponding amount of fiat currency in the banknote receiver of the machine and the coins will be sent to the wallet whose QR code was scanned earlier (Eissler, 2018).

Selling crypto-assets

Although most machines are one-way, some BTMs also support the inverse process, allowing people to sell crypto-assets, which is the equivalent of exchanging Bitcoins from their wallet for fiat currency (Leonard, 2018). About 30% of machines can perform this type of transaction (Trilliant, n.d.). This feature is especially relevant to our case, since we envisage a solution in which investors can safely transfer crypto-assets visible on the blockchain up to the point of withdrawal by the borrower.

The process of selling crypto-assets in return for cash, is, expectedly, quite similar to the process of buying. If it is a first-time user, they undergo the same initial identification and wallet creation steps as with the case of

[18] *https://coinatmradar.com/charts/*

buying. The difference in the selling process starts after they have received and confirmed the verification code from their phone. The user needs to scan the QR code indicated by the machine, send the desired amount of crypto-assets to the wallet indicated by the QR code, and enter in the machine the confirmation number received after the transaction has been completed (Coin Cloud, 2018). There can be a lag between selling crypto-assets and receiving the cash (Coin Cloud, 2018). The transaction made by the user to the BTM first needs to be confirmed in order to avoid the double spending problem. The user receives a redeem code with which she can return to the BTM to withdraw the cash after having received a confirmation to their phone (CoinATM Radar, 2014). The waiting time depends on the cryptocurrency which is being used. For Bitcoin transactions, this process can last anywhere between 1 and 24 hours, as the transaction needs to be validated on the network (CoinATM Radar, 2014). It is an accepted practice within the Bitcoin community to consider a transaction validated once it has been accepted in at least 6 blocks, therefore some BTMs require the user to wait for 6 validations until they can withdraw the money (Bonneau, 2015). This validation chain is required in order to ensure that the transaction made by the user is not in a fork, thereby risking to become invalid once a reorganization takes place. A reorganization after 6 validations is extremely unlikely (Bonneau, 2015). Other cryptocurrencies can have a validation duration of only several minutes[19].

How a crypto ATM works

Despite the similarity in usage, on the backend side, BTMs are quite different from regular ATMs. As opposed to ATMs, BTMs are not connected to a bank account or traditional banking infrastructure, but to one or more online cryptocurrency exchanges (Leonard, 2018). When a person uses the BTM to buy or sell crypto-assets, the machine performs that transaction on the exchange(s) to which it is connected (CoinATM Radar, 2015). The BTM works less like a traditional teller machine and more as a sort of physical store for buying and/or selling crypto-assets as an alternative to trading them online. Approximately two thirds of machines only support buying, as the operation is easier and quicker to perform than selling (Škraba, 2019).

A BTM represents a node in the blockchain network underlying the cryptocurrency or -currencies supported by the BTM (Coin Cloud, 2018; General Bytes, website). Depending on how the machine is set up, it can either run a full node itself, or run a hosted node (Lamassu, 2019)[20]. A hosted node is provided by a third-party service and spares the BTM operator from hosting their own node (Lamassu, 2019).

There are two main types of nodes: full nodes and light nodes (Sardan, 2018). Full nodes run a copy of the entire ledger, and validate every single transaction, whereas light nodes only save a partial copy (Sardan,

19 https://support.gatehub.net/hc/en-us/articles/115003268785-How-long-do-cryptocurrency-deposits-take-
[20] https://lamassu.is/

2018). Full nodes can be run by goodwilling network participants who wish to preserve the integrity and security of the blockchain and put their computing capacity at the network's disposal, however this does not happen very often. Running full nodes requires intense processing capacity and a very fast and reliable internet connection (Bruno, 2017). This is why, in public blockchains, coin rewards are created as an incentive for participants to run full nodes (Coinmonks, 2018). Miners, for instance, always have to run full nodes for the purpose of adding new blocks and often also for transaction validation (Beedham, 2019). However, full nodes necessitate higher computing power and memory capacity and can therefore usually not be run on smaller devices such as cellphones (Sardan, 2018).

Light nodes emerged as a way to solve this problem. Light nodes do not save a copy of the entire ledger, but instead depend on and communicate with full nodes in order to receive the head of the latest version of the chain (Sardan, 2018). Light nodes are especially useful in allowing participation in the network of devices with low computational power and memory capacity. Expectedly, this type of node is extremely popular in most blockchains (Coinmonks, 2018). This advantage to the users, however, comes with a disadvantage to the network - light nodes do not help the blockchain network as they cannot serve as either miners or validators (Sardan, 2018).

Microloans

In this section, we refer to social businesses, or SBs, as microfinance institutions (MFIs). The reason for this is that the literature on microloans mainly focuses on entities whose sole business purpose it is to offer microcredit, encompassing both profit-and non-profit oriented businesses.

Financial inclusion is often mentioned as a first step towards the reduction of poverty (Bahng, 2013). Creating access to credit for the poor is acknowledged as being one of the most direct and effective measures towards this goal (Misra, 2006). As mentioned in *Context,* most people living in poverty, especially in rural areas of developing countries, do not have access to basic amenities. This also includes traditional financial systems. They are therefore unable to make savings or have easy access to cash, and their creditworthiness can only be investigated with tremendous effort in order to warrant a loan (Salampasis & Mention, 2017). Consequently, in order to ensure financial inclusion for the poor, a new solution, which could leave out the factors that are staples of the lending practices in traditional banks, was needed. Amongst several other initiatives, microloans emerged as a powerful and widely accepted tool towards this goal. Microloans are non-collateralized small amounts of money given to a person or group of people, with either low interest, or no interest at all (Mukkamala et al., 2018).

For people living in extreme poverty, this sum of money can pave the way towards financial independence. Firstly, from a short-term perspective, it would help the borrowers to meet their basic needs such as food, shelter or clothing (Asian Development Bank,2004). On a longer term, they can lead to a self-reinforcing positive cycle which allows borrowers to evade meager financial situations by building a business which generates profit and makes them independent of external financial aid (Sinclair, 2012 p. IX). Examples of such businesses can include anything from making and selling dolls[21] to buying a used car and turning it into a taxi or buying a cow and selling milk at the local market[22].

Traditionally, microlending processes were, and to a wide extent still are, very paper-based. In a standard setting, loan officers and field agents would travel with paper forms to villages and remote areas, gather information about potential borrowers, return the forms to the MFI, and after the MFI has reviewed the data, the officers return to the village either to bring the loans to the accepted borrowers, or to acquire more information which was missing or erroneous (Yeow et al., 2018). These practices are not only cumbersome and lengthy, but are also subject to external influences, such as floods, which could potentially destroy all of the MFI's records (Yeow et al., 2018).

21 https://muktiweb.org/saraswati%27s-hard-work-and-dedication-made-her-successful-entrepreneur
22 https://grameenfoundation.org/impact/personal-stories/jane-nyambura

Digitalization would evidently render the system less susceptible to safety hazards. Initial efforts towards this goal were mainly focused on the MFI's side, and included the digitalization of forms, ledgers and loan calculation (Yeow et al., 2018). These initiatives were followed by a focus on the borrower side facilitated by more recent advancements in platform technology and the wider availability of smartphones and the internet, enabling solutions such as peer-to-peer lending platforms (Mahajan & Srivastava, 2019).

It is important to keep in mind that the process of digitalization might be hindered by local conditions. It would be unreasonable to expect that people living in poverty will have the funds to purchase a smartphone. Also, in some rural areas, mobile network connections can be scarce, further impeding the breakthrough of such technology (Schuetz & Venkatesh, 2019). Another specificity of financial behavior in developing areas is the preference for direct peer-to-peer local lending rather than taking loans from an official entity (Larios-Hernández, 2017).

Traditional banking practices are poorly equipped for functioning in developing regions and serving unbanked individuals due to, amongst other factors, their rigid formality (Larios-Hernández, 2017). This segment of borrowers is especially difficult to serve due to their specific relationship to money and technology. It is a documented fact that people in rural and developing areas have a strong affinity for cash, which makes the introduction of any digital technologies in these communities a particularly problematic task (Larios-Hernández, 2017). From a purely economic standpoint, it might seem counterintuitive to provide a borrower with money without collateral and perhaps no immediate earning potential to secure the repayment of that loan (Morduch & Armendáriz de Aghion, 2005). In fact, the opposite is true. Microfinance organizations such as the Grameen Bank and FINCA have reported that, in over 95% of cases, the full sum of the loan is repaid in due time (Midlgey, 2008).

In the next paragraphs and chapters, we go more into depth as to how such models of financing can be beneficial to all the parties involved and how they can alleviate poverty in developing regions by helping people to become financially self-sustaining. Due to our choice of case-study company, we focus mainly on the landscape for microloans in India. Nevertheless, the movements within this field have been echoed worldwide in approximately the same pace and fashion, and can be considered to be representative of the development of the microlending field as a whole (Misra, 2006). In the next chapters, we go more into detail regarding the economic and operational aspects of microloans, as well as the problems associated with them.

Development and Classification

Development of microlending

The first official initiatives for rural financing were introduced by governments in the 1950's and included, among other measures, regulated development banks (Morduch & Armendáriz de Aghion, 2005), interest ceilings (Misra, 2006) and credit limits (Hartarska & Nadolnyak, 2007). These initiatives for rural financing are considered to have been more supply-led, and governed by Keynesian economic principles, according to which the government can actively and efficiently steer demand and improve failing markets (Misra, 2006). They were meant to support small business owners and help them avoid private moneylenders who asked for enormous interest of several hundred percent and hounded borrowers who were unable to repay their loans on time, sometimes even to the point of suicide (Hartarska & Nadolnyak, 2007; Sinclair, 2012, p. 203). However, these government-led actions exhibited certain insufficiencies which rendered most of the projects faulty, corrupt and generally unsuccessful (Misra, 2006; Morduch & Armendáriz de Aghion, 2005). One of the concerns related to the application of Keynesian principles in this context is the exclusion of borrowers with a higher risk of defaulting on their debt (Hudon & Sandberg 2011). For instance, interest ceilings meant that banks could no longer ask for higher interest from borrowers with a higher risk of repayment failure; this created an incentive for rural banks to favor wealthier borrowers when giving out loans, because that widely reduced the supervision and screening costs (Gonzalez-Vega, 1977 in Hartarska & Nadolnyak, 2007). Thus, the exact group which these measures sought to help once again became marginalized and financially excluded.

Furthermore, the highly regulated environment imposed by the state initiatives forced rural banks to refocus their energy and attention towards meeting government imposed standards, thereby not dedicating enough resources toward their core business (Dichter, 1997 in Hartarska & Nadolnyak, 2007). Consequently, a general failure of these measures to meet poverty reduction and income redistribution goals was observed (Gonzalez-Vega, 1977 in Hartarska & Nadolnyak, 2007).

As a result of increasing awareness regarding these problems, in the 70's and 80's, microcredits from non-governmental enterprises appeared as an alternative funding mechanism for the poor (Hartarska & Nadolnyak, 2007; Misra, 2006). Mirroring contemporary influences of emerging economic paradigms, the SBs that appeared as a solution to the ineffective government measures of rural financing began following a more market oriented approach (Jahan & Papageorgiou, 2014). In this time, microcredit innovations started appearing all over the world, leveraging group pressure and social norms, rather than collateralization or government expenditures, as a means for ensuring repayment (Misra, 2006). Microloans are considered to bypass the deficiencies of the government-led programs to some extent by allowing regulated and

unregulated financial entities to give out market-adjusted loans at lower interest than those given by development banks, and without collateral (Hartarska & Nadolnyak, 2007). Around 2002, microfinance started accelerating towards the over USD 70 billion that it is today (Sinclair, 2012, p.247). One of the reasons for which microloans are enjoying this success is that they are considered a win-win situation for all concerned stakeholders, including the government, the microfinance institution, and the people, because they do not require a massive shift in public policy or reorganization of institutions (Misra, 2006; Sinclair, 2012).

Naturally, as any social business, MFIs are on a thin line between operational continuity and social responsibility (Mcloughlin , 2013)The question arises as to how microloans can aid the poor while also allowing the MFI to continue its activity. To answer this question, we need to make the differentiation between profit- and non-profit oriented MFIs. With profit-oriented MFIs the answer is quite straightforward. Similarly to traditional loans, loans from profit-oriented MFIs generate revenue through interest, which can then be reinvested in the operations of the institution and in further loans. The interest is variable and depends on a number of factors, but the statistical average worldwide is somewhere between 27% and 35% (Kneiding & Rosenberg, 2008). As comparison, the Grameen foundation asks for approximately 20% interest on its loans (Nimal, 2006). Such high interest rates are the result of a combination between the need to cover operational costs of the MFI and the relatively small sum of the loans which would yield correspondingly low returns from interest (Kneiding & Rosenber, 2008). On the other hand, non-profit MFIs have to rely on donations for the continuation of their activity, as they do not make a profit on their loans. They can, however, indirectly lead to money generation in the community through new business creation, as well as the general improvement of people's living standard, spending power and their empowerment on the job market (Khan & Dewan, 2017).

Irrespective of whether the MFI is profit-oriented or not, the loan recovery rate is vital in its ability to continue giving loans and increase the sum and number of these loans (Khan & Kazi, 2016). It is therefore in the best interest of the MFI to ensure that the proper conditions are created to strengthen the ability of the borrower to repay the loan. This is a difficult problem to tackle when considering that there is no collateral and no guarantee given to the MFI by the borrower that would secure the loan. Interestingly, peer pressure and loan supervision have been proven to be more efficient in improving the repayment rate of microloans rather than the traditional collateralization (Khan & Kazi, 2016; Misra, 2006). This entails a grassroots approach by the microfinance institution which includes regular meetings between borrowers and the institution's advisors, where the borrowers receive guidance regarding the successful use of the loan money (Dorfleitner & Oswald, 2016; Khan & Kazi, 2016; Shastri, 2009). This routine supervision accompanied by financial and business advice helps ensure a high repayment rate of the loans, whereas the absence thereof has been linked to a lower repayment rate (Anichul Haque Khan & Kazi, 2016).

Furthermore, collateralized loans have been found to be associated with riskier borrowers (Berger & Udell, 1990). On the same train of thought, the prospect of more easily and quickly receiving future loans as a result of repayment of current loans (and subsequent improvement and documentation of the borrowers' creditworthiness) has also been found to discourage borrowers from taking on riskier projects with the borrowed money and to increase the rate of repayment (Giné et al., 2010).

Evidently, in order to find ways to avoid non-repayment, it is imperative for the MFI to understand the most common causes for borrowers defaulting on their loans.

Firstly, some studies have found that the ability to repay microloans is inhibited by the availability of other lending sources, such as private moneylenders (Anichul Hoque Khan & Dewan, 2017). Moneylenders tend to give out loans at predatory interest rates. As a result, the borrowers need to use up their savings or the money they received from other sources of financing, such as official microloans, in order to repay the interest to the moneylender, thus ending up defaulting on the loan (Sinclair, 2012). This results in a vicious debt circle. It is therefore argued that microlending has created a whole new platform for predatory lending practices to unfold. Even if the initial intent is not malicious and not seeking to exploit poor borrowers, if the MFI is a profit-oriented organization, it will invariably need to collect interest on the loans it gives out in order to finance its operations, since it will not be suitable to receive donations (Salomon, 2007). Such a necessity of collecting interest can easily become corrupted and the MFI will start introducing the very same high interest rates it had intended to render obsolete. The MFI therefore needs a sound financial strategy and good management of resources to ensure that it will not have to resort to putting a financial strain on its borrowers in order to finance its own activities.

Classification

We start by extending the definition of microloans and underlining the key differences to traditional loans. Three general characteristics of microloans can be enumerated that differentiate them from traditional loans (Loughran, 2018):

1. They are given for relatively short periods of time, somewhere around 6 and 12 months
2. The initial sum is quite low compared to traditional loans and lies somewhere between USD 100 and 500; this initial sum usually serves the purpose of testing the borrower's creditworthiness. Depending on the success rate for the repayment of the initial loan, the borrower then has the option of applying for larger sums.
3. The interest rate is relatively low (global average is 37%) compared to other alternatives, such as local moneylenders

With these aspects in mind, there are several criteria along which MFIs can be characterized. Firstly, from an administrative perspective, MFIs can be both regulated financial institutions and unregulated entities. Hartarska & Nadolnyak (2007) describe both concepts in detail. The authors explain that the difference lies in the ability of regulated institutions, stemming from their liability to prudential regulation, to offer deposits and thus increase the volume of their loans by reinvesting the money from the deposits (Campion & White, 1999). Non-regulated entities, not being subject to prudential regulation and thus not being allowed to accept deposits, rely on investors, donors and other external sources of financing in order to be able to meet their loan demand (Hartarska & Nadolnyak, 2007).

From the perspective of the MFI, there are two categories of microloans that have different consequences depending on their purpose (Khan & Kazi, 2016): productive and unproductive. Productive loans are given for something which has immediate profit generation potential, such as opening a new business. Unproductive loans, on the other hand, are given for more basic needs such as food, clothing or medical care. In the case of the latter, it is more probable that it will take a longer time for the loan to be repaid and the risk of defaulting on the loan is higher. Similarly, the nature of the loan can vary depending on the institution: NGOs and NPOs will most probably offer interest free loans, whereas other, more profit-oriented types of organizations, might offer loans at interest rates which are nonetheless lower than those of development banks or moneylenders (Shastri, 2009). In a European study by Lagoa & Suleman (2014), both profit- and non-profit-oriented MFIs have been shown to improve socio-economic conditions within the communities where they were given out. This last idea is a fairly important for this research the goal of most MFIs is not only to deliver microloans to people in need, but also to ensure that the community benefits from their activities (Sengupta, 2019). Most MFIs have a whole array of programs and products which encompass much more than microloans. For instance, the Grameen foundation[23] has, additionally to its group lending activity, a program called FarmerLink, which entails a simple system of sending SMS messages to subscribers containing reminders for specific events, weather forecasts, farming advice, and financial counseling.

23 https://grameenfoundation.org/tags/farmerlink

Description of the lending process

Frequently, MFIs act as intermediaries between social investors and borrowers. The investor sends the money to the MFI, and, in turn, the MFI takes care of the screening and supervision of potential borrowers, as well as loan recovery (Mukkamala et al., 2018). The latter part is crucial to the survival of the MFI: if the money does not get recovered, investors lose their trust in the company and might choose to discontinue their investments.

Furthermore, it has been observed that access to microloans can significantly increase the borrower's ability to repay larger loans at traditional banks. More specifically, a study made in Bangladesh found a negative correlation between the total sum in microloans that had been given out to a person (or family/group) and the percentage of a larger loan at a traditional bank which still needed to be repaid (Khan & Kazi, 2016). Moreover, the size of the loan has been shown to have a negative correlation to the repayment rate, meaning that smaller loans get repaid more often and in a higher percentage (Anichul Hoque Khan & Dewan, 2017). Dorfleitner & Oswald (2016) have also found that the repayment rate is negatively correlated to the duration of the microloan. The authors suggest that the duration has to be calibrated carefully, because demanding repayment too early might force the borrowers to seek other financing sources, such as high-interest informal loans from moneylenders, due to their business not yet having made profit. Conversely, demanding repayment after an excessive amount of time might lead to the borrowers spending the money earned from their business on something else before the loan has expired, leading to the impossibility of repayment.

One of the most successful microlending initiatives is unequivocally that of Muhammad Yunus, the founder of the Grameen Bank and one of the most impactful figures in this field (Sinclair, 2012, p. XIII). Morduch & Armendáriz de Aghion (2005, p.85) describe the Grameen model in detail. The process is as follows: in different villages of the country of operation, loan officers of Grameen participate in weekly meetings with groups of 40 people. Each group member's passbook is then submitted to the loan officer. The passbooks contain all the transactions of the holder, including loans, outstanding payments, fees and savings. All this information is inserted by the loan officer in his or her ledger. The loan officer then makes some calculations to see if the numbers match up, and to check if everyone is on schedule with their loan and interest payments. In this situation, the loan officer can also collect applications for new loans and forward them to the Grameen bank.

The Grameen Bank employs one of the most common forms of microlending, which is group lending. Group lending is the practice of giving out a loan to a group of people who share the liability for the loan, each person being responsible for the repayment of their own share (Bahng, 2013). The loan is only considered to have been successfully repaid if each member of the group has repaid their part. This creates a build-up of peer pressure, which has been observed to lead to higher loan repayment rates (Bahng, 2013). It is also a usual

practice to offer progressive lending models within the group, so that each member will be eligible to receive a higher sum only if all other members have repaid their parts (Bahng, 2013). From an economic standpoint, group lending can be regarded as a measure by MFIs for overcoming the absence of collateral and background information about borrowers through risk spreading and shared liability (Freixas & Rochet, 1997). Shared liability within a group can create a natural incentive for members to report honestly and reduce moral hazard. However, it might exacerbate it by having more dishonest members persuade the honest ones to refuse repayment altogether (Morduch & Armendáriz de Aghion, 2005, p. 86).

As an incentive mechanism for accelerating loan repayment in group lending or other forms of microlending, progressive loans were introduced (Kumar & Veerashekarappa (2011). A borrower who repays the initial sum according to the terms of the agreement with the MFI will have the chance of applying for a larger loan the second time, as their credibility has increased after the first repayment. If the second loan is also repaid in due time, the third one will be even larger, and so on (Kumar & Veerashekarappa, 2011).

Aside from the traditional microlending scenario where the MFI is an intermediary between social investors and borrowers, other lending models have sprung up as a result of technological developments such as digital platforms. These developments have led to alternative methods of money transfer between social investors and borrowers, such as peer-to-peer lending. Peer-to-peer lending entails partial disintermediation of the lending process and allows direct contact and transactions between lenders and borrowers (Dorfleitner & Oswald, 2016). This type of lending does not require any mediator such as an MFI or loan officer who manages the funds and the borrowers. Instead, the borrowers and the lenders are in direct contact with each other, usually over a digital platform. In such models, borrowers create an online profile and loan request, where they describe themselves and the reason they are applying for a loan[24]. A lender can browse on the microlending company's website through any number of projects and choose the ones she will want to give money to. After the borrower has accepted the loan, the money is sent directly to her account, and she can communicate directly with the lender through an online chat on the website. The repayment then happens on a weekly or monthly basis according to predefined conditions. We mentioned 'partial disintermediation' at the beginning of the paragraph because the MFI still maintains some of the obligations of a regular intermediary, such as in the case of group lending. The most significant of these is the screening of the loan applicant before they are allowed to participate in the platform. The company still needs to ensure that the borrowers are well-intended and will adhere to the loan contract by focusing their efforts toward repaying the loan.

24 https://www.zidisha.org/

A variation of the peer-to-peer model is the so called indirect peer-to-peer model (Dorfleitner & Oswald, 2016). Here, the MFI usually provides the platform for communication between lenders and borrowers, however, the money is intermediated by a local MFI which is part of the MFI's network[25]. Thus, private lenders can indeed choose to which borrower they wish to lend their money, but the local partner of the MFI makes the last decision as to whether that specific borrower will receive the money. In this way, the risk of non-repayment to the lender is alleviated by the partner MFI doing the background check and supervision.

Naturally, the financing models described above are mere summaries and generalizations of the most common practices in the field of microfinance. There are various possible combinations between the terms of the different lending contracts, and possibly more which are out of the scope of this paper.

Criticism and Challenges

Despite their strongly socially motivated background and their many benefits, microloans face their share of criticism and shortcomings, which we are addressing in the next paragraphs. We describe these issues from the perspectives of all the different participants in the microlending network. This distinction will help guide the conceptualization our blockchain design.

There are several points to be taken into consideration with respect to issues related to the MFI. Firstly, as already mentioned, as opposed to profit-oriented businesses, social enterprises rely on investor money to maintain their operations and to continue offering their services (Dorfleitner & Oswald, 2016). It is therefore crucial for social MFIs to be able to account for all the resources at their disposal and offer investors solid evidence regarding the utilization of their money. This can be a difficult task, since it requires strict reporting and accounting, which in turn necessitates human capital that is scarce and valuable in such enterprises. Moreover, two of the main mechanisms in place for ensuring the repayment of loans are financial trainings done in advance of granting the loan and close supervision and mentoring of the borrowers after they have received the loan, both of which require additional human resources (Sinclair, 2012). Thus, an evident conflict for the allotment of human resources arises, which can affect the level of trust of the investors and the repayment rate of loans. If the MFI had a trusted, incorruptible and transparent system of supervision in place to replace some of the manual labor needed in these instances, more human resources could dedicate their time toward the activities that actually serve the purpose of the MFI.

Secondly, rural areas tend to have a lack of financial infrastructure, rarely allowing easy access to ATMs or bank branches (Loughran, 2018; Misra, 2006). This also leads to a low savings capacity and general inability to

25 https://www.kiva.org/

be part of a larger financial system (Misra, 2006), which, in turn, creates information asymmetry between the borrowers and the MFI (Narayanan et al., 2016). The issue of information asymmetry is of major concern in the credit industry in general (Freixas & Rochet, 1997). Especially in cases where the creditworthiness of the borrowers and information about their business is barely accessible, the MFI is at a disadvantage. Not only is it incredibly difficult for the MFI to determine which borrowers carry the most risk, but the returns of the business of the borrowers are also difficult to assess (Morduch & Armendáriz de Aghion, 2005, p. 36). The borrower might be tempted to underplay their returns in order to not have to repay the loan in its entirety, in accordance with the limited liability discussed in the previous section. This could, at least partially, be overcome by the availability of MFI employees who do the grassroots work and are on location to supervise the borrowers and investigate their situation. However, it is very difficult for MFIs to send field officers on research and screening trips in rural and remote areas. This difficulty is aggravated by the unavailability of technology and lack of investment funds for digital solutions in these areas. The field officers need to do all the screening, supervision and loan management work by hand and on paper (Yeow, 2018). This highlights even more the need for a transparent and reliable solution for documenting loans.

Moreover, due to the lack of collateral and the impossibility to check the creditworthiness of borrowers, and despite high transaction costs, it is a routine practice among MFIs to require periodic installments even before the borrowers have had the opportunity to make the loan productive and make a profit (Dorfleitner & Oswald, 2016). This serves as a way of reducing the risk associated with loan repayment. Such partial repayment can be difficult to achieve in areas where bank transfers and online payments are not really an option and payments have high transaction costs. Nevertheless, this is seen as a measure for disciplining the borrowers while at the same time assessing their repayment capacity (Dorfleitner & Oswald, 2016).

Relevant business administration and economic theories

In this chapter, we identify relevant frameworks related to information systems and business administration, which we later use for the assessment of our proposed solution.

Information Asymmetry

The microlending process represents a form of contract, and can therefore be scrutinized with the help of contract theory in order to better understand the relationship between the participants. Contract theory is tightly linked to the concept of information asymmetry (Dawson et al., 2010). Information asymmetry is part of the agency theory (Dawson et al., 2010) and represents the imbalance in terms of amount and quality of information that makes a contractual situation more favourable to one party over the other (the agent over the principal), giving way to opportunism (Dawson et al., 2010).

Opportunism is considered to be a violation of the contract conditions due to knowledge that the other contract party may not possess (Wathne & Heide, 2000 in Dawson et al., 2010). Agency theory states that the principal can avert opportunistic behaviour by means of a contractual setting which reduces favourable information asymmetry on the part of the agent (Eisenhardt, 1989 in Dawson et al., 2010).

In a classical microlending setup, the information asymmetry between the investors and the social business is a compelling source of mistrust on the part of the investors, which is a typical exemplification of the agency problem (Mknelly & Kevane, 2002 in Jeon & Menicucci, 2006). Similarly, the information asymmetry between the social business and the borrowers can lead to their financial exclusion (Salampasis & Mention, 2017).

Two approaches have been suggested as a means of dealing with information asymmetry: screening and signaling (Akerlof, 1970 in Dawson et al., 2010). Signaling refers to the agent voluntarily supplying the principal with additional favourable information about themselves in the hope of receiving improved contract conditions (Spence, 1973 in Dawson et al., 2010).Conversely, screening refers to the effort undertaken by the principal to actively gather more information about the agent (Stiglitz, 1975 in Dawson et al., 2010).

Switching Costs

When a market is characterized by network effects, switching costs can arise which deter new entrants (Burnham, Frels & Mahajan, 2003). Switching costs represent any type of actual or perceived barriers for users of a product or service to move to another provider (Burnham et al., 2003).

Burnham et al. (2003) have identified three switching cost typologies: procedural, financial and relational. They explain procedural switching costs as appearing during the process of changing providers, including the financial uncertainty connected to switching (Klemperer, 1995 in Burnham et al., 2003), the resources spent by the user to gather the necessary information for the switching decision (Samuelson & Zeckhauser, 1988 in Burnham et al., 2003), the work dedicated to learning how to properly use the new provider's product or service (Wernerfelt, 1985), and the effort inherent in the adoption of this new product or service (Klemperer, 1995).

Financial switching costs, on the other hand, represent the monetary loss related to switching, both in terms of spending money to acquire the new provider's product, and in terms of losing the loyalty benefits from the old provider (Porter, 1980; Guiltinan, 1989).

And finally, relational switching costs are the costs incurred by the user due to their affinity to the brand of the previous provider, and the other users with which he or she interacted (Guiltinan, 1989; Porter, 1980).

IT Alignment

The idea that the IT systems and applications used by a company should be aligned with its chosen strategy and goals is not new (Bharadwaj et al., 2013). It is becoming increasingly acknowledged that, in order for a firm to succeed, its IT infrastructure should not be created as a support for its business strategy and goals, but rather be designed along with them (Bharadwaj, 2013). A suitable alignment between the IT and business strategy of a company have been linked to increased performance, and misalignment has often been detrimental to operations (Tallon, 2008). It is therefore vital for any organization introducing new IT systems to understand their place in the overall strategy and operations.

There are three main models of IT and business strategy alignment: functional, structural and temporal (Reynolds & Yetton, 2015). Functional alignment refers to the way in which IT capabilities are used as a support mechanism for business (Oh & Pinsonneault, 2007). Structural alignment is concerned with how decision rights are assigned between the business and IT departments, and between different organizational levels (Hodgkinson, 1996). And lastly, temporal alignment explains how strategic options in the future are affected by alignment decisions made in the past (Sabherwal et al., 2001).

Literature Review

The increased attention given to the benefits of blockchain for social businesses (SBs) and microlending has led to a higher necessity for transparency, accountability and oversight on the operations of the SB to ensure the trust of existing and potential investors and donors (Yeow et al., 2018). In this chapter we perform a literature review in order to establish the current state of research on our chosen topic and to provide the knowledge foundation for the further steps of this paper. Given the novelty of the technology and its late adoption in the social sector, the research on this topic is far from having matured, therefore not many academic bodies of literature exist that revolve around it. The choice of our review design was made based on several considerations.

First, after detailed investigation, the sample literature on which we could base our analysis was quite limited. Systematic reviews (Briner & Denyer, 2011) are praised for their strict, methodical and quantitative nature (Grant & Booth, 2009), however, they require a certain volume of rigorous studies (Grant & Booth, 2009). Therefore, we decided that a systematic literature review would not be the most suitable procedure to help us establish the state of current research and its relevance to our thesis. Variations in terms of rigor and process have been developed to cope with precisely these volume limitations (Grant & Booth, 2009).

Secondly, the decision of review design was influenced by our research question as suggested by Beecroft et al., (2006). Our study is of a qualitative and inductive nature and works with blockchain, a rapidly developing technology. Therefore, the literature review was aimed at selecting the most relevant and recent works on the selected topics, not for the purpose of drawing conclusions or forming theories, but for creating a foundation on which a solution can be built. Review designs based on quantitative procedures such as meta-analyses, syntheses, or any form of systematic reviews (Grant & Booth, 2009) were consequently deemed unsuitable.

And lastly, the purpose of the literature review was also an influencing factor in our decision. Depending on the goal of the research, the literature review can serve as a final work in itself, or it can have a supporting role in the overall development of a paper (Cronin et al., 2008). Our case is reflected in the latter situation. We therefore pursue a general literature review with a conceptual analysis approach (Grant & Booth, 2009). Generalized literature reviews do not have the purpose of maximizing the scope of extant literature, nor to deliberately provide an analysis or qualitative assessment of the reviewed papers (Grant & Booth, 2009). Their purpose is simply to create a background for the rest of the paper to build on.

In *Methodology*, we have described in detail the selection process of reviewed works. The papers, their findings and their relevance to our thesis are presented in Table 8.

Work/Authors	Focus and findings	Relevance to our thesis
Mukkamala et al. (2018). Converging Blockchain and Social Business for Socio-Economic Development	Conceptual design of a blockchain-based microlending solution	Serves as the basis for our initial conceptual design
Lane, Leiding & Norta (2017). Lowering Financial Inclusion Barriers With a Blockchain-Based Capital Transfer System	Presentation of a blockchain-based remittances and microlending platform using stablecoins and smart contracts	We extracted insights regarding financial inclusion and microlending, as well as technical aspects for our solution
Mahajan & Srivastava (2019). Holistic Credit Rating System for Online Microlending Platforms with Blockchain Technology	Architecture of a blockchain microlending system for tracking the borrowers' creditworthiness based on a naive bayes classifier	Support for understanding the technical aspects behind blockchain microlending systems
Schuetz & Venkatesh (2019). Blockchain, adoption, and financial inclusion in India: Research opportunities	Identification of blockchain-related issues and potential for future research on financial inclusion in rural India	The paper sets the context of our paper and helped us identify the critical points of discourse in the implementation of blockchain in the Indian microlending context
Larios-Hernández (2017). Blockchain entrepreneurship opportunities in the practices of the unbanked	Analysis of the current situation of financial inclusion and identification of various business models for entrepreneurs to use the blockchain technology to serve developing communities and unbanked individuals	We use the insights from the paper to better understand the communities we are trying to help and the characteristics of the blockchain technology which can be the most beneficial to our solution
Mukkamala et al. (2018). Blockchain for Social Business	Distinctive features of blockchain that can benefit social businesses	We transfer some of the core concepts to the design of our solution
Kshetri, N. (2017).Will Blockchain Emerge as a Tool To Break the Poverty Chain in The Global South?	Applications and benefits of blockchain for socio-economic development	We use the paper as a map for the current blockchain landscape, and as a support for assessing opportunities and challenges for the implementation of blockchain in developing regions

Table 8 The summary of the literature review

There are several key blockchain characteristics that can help create solutions which serve developing communities, and which (Larios-Hernández, 2017). The five high-level characteristics on which we focus are trust, transparency, auditability, decentralization and anonymity (Mukkamala et al., 2018). Several more concrete functionalities of the blockchain derive from these five characteristics.

Firstly, there is the inherent capacity of the technology to reduce transaction costs due to the elimination of the intermediary (Schuetz & Venkatesh, 2017; Stanley, 2017). This is a result of the characteristics of decentralization and trust. Whilst using electronic money would, in itself, be a large improvement compared to the initial, inconvenient cash-based microlending systems, digital money transfer can still carry high costs due to intermediation, especially for cross-border payments (Lane, Leiding & Norta, 2017). This is where blockchain brings an advantage. Blockchain-enabled transactions do not require manual processing and therefore happen almost immediately. As a consequence, blockchain reduces foreign exchange and international transfer fees, thereby alleviating the strain of making cross-border micro-transactions, for example for remittances (Lichtfous, Yadav & Fratino, 2018). In fact, the market for blockchain-based remittances is booming due to their enabling low-cost international money transfers (Kshetri, 2017).

Secondly, blockchain applications can help solve the issue of trust and documentation of creditworthiness (Larios-Hernández, 2017; Stanley, 2017). This is accomplished by means of the transparency and auditability brought by blockchain-based systems. Rural and developing communities prefer peer-to-peer cooperation mechanisms, therefore trust and the knowledge of past financial behavior are also strongly peer-based (Larios-Hernández, 2017). Due to the lack of documentation and background information of borrowers, it is a usual practice for loans to be given out based on spoken testimonies of a person's peers (Larios-Hernández, 2017). More than 2.4 billion people in the world lack official personal documentation (Dahan & Gelb, 2015), which is understandably a great hindrance for systems based on formal rules and strict reliance on personal identity, such as traditional banking. As a result, there are ongoing efforts for creating blockchain-based personal identification systems which often take the shape of peer-to-peer reputation networks.

An extension of this idea relates to the timestamping feature of blockchains. This feature can be used to track the ownership and existence of goods, which is beneficial in providing proof of collateral in case a person applies for a loan at a traditional financial institution (Burrell, 2016). Similarly to the lack of personal identification documents, the lack of ownership documentation is exceptionally common in developing regions, some studies estimating that over 20 million families throughout India are living in houses and work on lands for which they have no documentation (Kshetri, 2017). For instance, the country of Honduras initiated a blockchain-based property ownership registry which widely reduced notary and property transfer costs (Kshetri, 2017).

Most research papers reviewed by us mostly present elaborations on the benefits of blockchain for financial inclusion and microlending, yet do not present a holistic design of the actual system. The identified papers which delivered such designs are presented below.

In their paper titled "Converging Blockchain and Social Business for Socio-Economic Development", Mukkamala et al. (2018) present a solution for a blockchain-based microlending process on the MultiChain platform. The suggested scenario assumes that the SB plays the role of an exchange market for investors and borrowers to enable the transfer of digital assets and withdraw their cash equivalent. We describe this solution in detail in *Analysis: Blockchain Concept and Evaluation*.

Other research papers presenting similar solutions focus on the possibility for remittances (Lane, Leiding & Norta, 2017) and complementary functions, such as building creditworthiness through microlending (Mahajan & Srivastava, 2019). Remittances are small sums of money sent by expats back home to their families, which can be costly due to international money transfer fees (Lichtfous, Yadav & Fratino, 2018).

Lane, Leiding & Norta (2017) present an Ethereum-based solution using native coins and smart contracts to facilitate remittances, and to allow unbanked individuals to become part of formal financial systems. Since blockchain eliminates the need for intermediary parties such as banks to process and confirm transactions, it effectively reduces transfer and foreign exchange fees (Schuetz & Venkatesh, 2019).

Mahajan & Srivastava's (2019) design is based on the Hyperledger Fabric framework and has an additional module which enables lenders and borrowers to rate each other on the system based on their fulfilment of the contract details, such as the date and extent of loan repayment. Based on these ratings, the system calculates the credit rating of the borrower and the probability that they will repay in the future. Thus, through repeated borrowing and repayment, participants on the network can build credible proof to demonstrate their trustworthiness.

Case study: Mukti

Before we begin describing the company, we wish to underline that we do not treat Mukti as the sole subject of our paper, but rather as a model and source for our initial assumptions. We treat it as a sample of the population of social businesses, of which we analyse the characteristics, needs and challenges. Despite our focus on the Indian microlending context and financial infrastructure, we have attempted to design our research to be applicable to most situations for developing countries where microlending is involved.

In order to analyse in-depth and to understand the challenges in this field, the social activity of Mukti was treated as a case study. Mukti is one of the non-profit programmes of The Organisation for Empowerment (ORE) whose purpose is to "*help women, and their families, rise from the depths of poverty by giving them the means and guidance to be self-sufficient entrepreneurs through a micro-finance program*".[26] Despite being part of ORE, Mukti has its own organizational structure, goals and challenges, and is therefore seen as a separate entity for the purpose of this thesis. Due to our choosing Mukti as an example company, in this thesis we focus on social businesses which rely on donations and subsidies instead of revenue for operational continuity.

Mukti belongs to the six prong program called HEALER, which is an acronym standing for "health" (health, water, sanitation), "education and empowerment", "agriculture reforms", "livelihood and economic security", "environment and economy" and "rights to information and governance" (Sengupta, 2019). The services of Mukti which are focusing on microlending and the empowerment of women are assigned to the area of "livelihood and economic security" and are narrowed down to the specific sub-program called Mukti Community Development Fund (MCDF). MCDF operates in around 50 villages, where the program supports 400-500 self-help groups (SHG). Every SHG consists of 10-12 women entrepreneurs in rural areas. Mukti follows the practice of group lending, thus one loan is shared within one SHG. Within the program, the participants are provided with regular assistance and skill-based training to make the best use of the loans received. The focus on the women derives from the fact that they tend to look after their families and relatives more than men, which serves the purpose of the all-around development of the society (Sengupta, 2019). Taking this fact into consideration, women borrowers represent a relatively lower risk and higher chances of repayment. Furthermore, the societal benefits are substantial: for Mukti, it has been observed that around 60% of first-time borrowers become self-sufficient after the first loan, which spans two years, and a total of 80% become self-sufficient after the second loan (Sengupta, 2019). It is usual for Mukti to offer multiple subsequent loans to their borrowers, which is a practice known in the microlending community as progressive lending.

[26] *https://www.ore-mukti.org/*

Despite the successful social activity, like other social businesses, Mukti struggles with the issue of transparency of the transactions from the point of view of the investor. From the investor's point of view, it is impossible to track how exactly the financial means are managed and transferred. The upsurge of the trust between parties would possibly increase the number of investors, which. This, however, would be directly positively correlated with the number of people who received support.

Analysis: Blockchain concept and evaluation

In this chapter, we start by discussing the problem-solving potential of blockchain in the domain of microlending and continue by construing and analyzing the solution proposed by Mukkamala et al. (2018), which we treat as a starting point for further development. Basing on this analysis, we present four blockchain-related components which create the final conceptual design for our proposed microlending solution in the context of India. Each of them is analyzed and the suitability of their design is critically assessed. We follow this presentation by listing the challenges for the implementation of such technological solutions in the given context. Lastly, the final solution is scrutinized through the four business-related frameworks presented in Theoretical Background.

Problem-solving potential of blockchain for microlending

Recently, scholarly and practitioner attention has begun to converge towards more advanced solutions, such as the blockchain technology, which is considered to harvest great potential in providing financial services for unbanked groups (Schuetz & Venkatesch, 2019). Therefore, in this section we provide a presentation of relevant blockchain capabilities.

Reduction of information asymmetry

In a traditional microlending setup, investors do not have a direct point of contact with the borrowers, and the route of their money towards them is intransparent, creating information asymmetry between the investors and the microlending enterprise. Resulting from this are the cases of fraud and hidden predatory lending which can make investors hesitant towards giving money (Jeon & Menicucci, 2006). For non-profit companies which rely on investment and donations, such hesitancy can be detrimental. The enhancement of transparency and auditability brought by the blockchain would most assuredly reduce the number of such cases. This would provide the investors with irrefutable proof showing that their assets have reached the borrower in the intended amount, which would lead to the reduction of information asymmetry between the investors and the SB.

Moreover, information asymmetry between borrowers and the microlending enterprise is considered harmful in terms of financial inclusion (Salampasis & Mention, 2017). Borrowers are deterred from joining formal financial systems by their inability to prove their creditworthiness, identity or ownership of collateral (Kshetri, 2017). Through blockchain, these individuals can participate in online payment activities without the need for a bank account, and slowly build up a payments and ownership history which can serve as a proof of creditworthiness. Simply put, the use of blockchain-based payments will allow individuals who do not have a regular bank account to transact with digital money.

Reduction of operational costs

Most microlending enterprises currently have a manual, often paper-based ledger maintenance system. Field officers and volunteers at the business need to manually check the balance of each borrower and their repayment progress (Yeow et al., 2018). This process is resource-intensive and slows down other internal processes of the social business, such as accounting, auditing and even unrelated activities due to the need of volunteers and employees to spread their capacity. If the lending process were to happen on the blockchain, this manual work would be greatly diminished and would free up time for the volunteers to focus on financial trainings for the borrowers and performing background checks.

The addition of blockchain to these processes would ensure not only a much quicker overview on the current state of the borrowers' balance and repayment progress, but also faster auditing of the transactions, as, in theory, due to the incorruptibility of the blockchain ledger, they would not need to be re-verified by any auditors. This poses great opportunities for cutting regulatory supervision costs. Furthermore, the transaction costs of payments, local or international, would be greatly reduced if they were to happen on the blockchain by means of cryptocurrencies or similar assets (Kshetri, 2017). The elimination of the central regulating authority, or the intermediary, will inevitably lead to a reduction in transaction costs (Kshetri, 2017). In this way, receiving payments from international donors or investors, and sending money to impoverished people living abroad would not come at any significant additional cost to the social business or to the investors. Therefore, more funds remain at the disposal of the business for offering loans and financing its operations.

Conceptual designs

This section focuses entirely on the presentation of four different components, which serve as specifications and extensions to the paper of Mukkamala et al. (2018). Each component consists of its conceptual design and critical assessment revolving around its quality and suitability. The solution of the authors, for which we depict and address several points of enhancement, is analyzed at the beginning of this section. The combination of

proposals for each of these points should yield a holistic design which considers the perspectives of all the stakeholders through the lens of the business theories presented in *Theoretical Background*.

Description of the solution of Mukkamala et al

In their paper, Mukkamala et al. (2018) propose a conceptual design for a blockchain implementation for microlending in India.

Before the presentation of the solution, the presentation of stakeholders is needed. Four separate parties are involved in the solution. The borrowers – the female entrepreneurs or SHGs, are obvious beneficiaries of the project. On the supply side we find social investors, auditors and the SB. The role of social investors is self-explanatory. Auditors are external participants who are in charge of monitoring the operations of the CDF, checking its transparency and trustworthiness. The role of the SB comes down to the screening and selection of the female borrowers and the intermediation of the financial transactions in terms of the money exchange. Building on the statement of Sengupta (2019), the major strength of the SB is being very close to the ground reality of the borrowers, therefore having the ability to assess the local needs and the success rate of a given entrepreneurial idea. Hence, once the borrower's credibility is confirmed, the money from the investor is sent. The above described procedure seems to be very straightforward because it imitates the traditional money transfer between two actors, where a bank serves as an intermediary. However, the scenario assumes that both actors have full trust in the intermediary, which is not applicable in the case with SB and social investors. The issue of transitive trust needs to be considered and the lack of trust balanced by transparency ensured by the blockchain technology.

Conceptual design of Mukkamala et al. (2018)

The sequence diagram presented in Figure 6 shows the full finished process of blockchain-based microlending of Mukkamala et al. (2018) and should be interpreted as follows: solid purple lines indicate the blockchain framework transactions, where the dotted lines show the non-transactional communication messages or data transfers (Mukkamala et al., 2018). *Data Streams* depicted in Figure 6 represent a means for these non-transactional transfers to happen on blockchain.

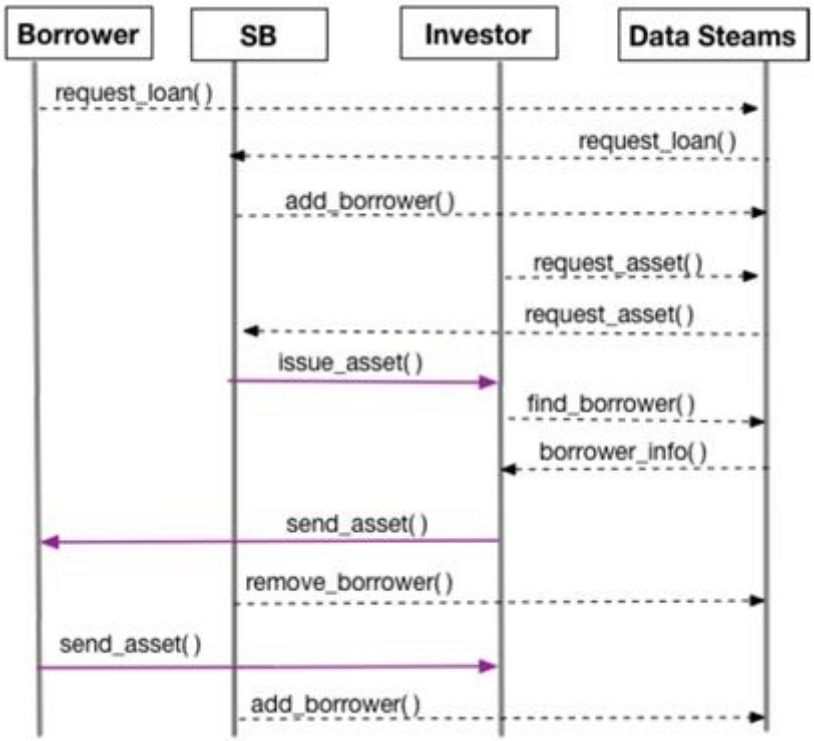


Figure 6 Sequence diagram of the use-case presented by Mukkamala et al. (2018)

The process of the blockchain- based microlending proposed by Mukkamala et al. (2018) is divided into four parts. In the first stage, the borrower requests a loan by sending a message to the data stream "loan_request", which is destined for the SB (Mukkamala et al., 2018). Thanks to the subscription to the stream, the SB receives the message. It contains all the meta information such as the desired size of the loan or the identification of the borrower to enable the further transfer of the digital assets. In this stage, the SB proceeds with the aforementioned background checks and assessment of the borrower's credibility and the repayment rate. Once the fulfillment of all the necessary conditions is approved, the public key of the borrower is added to the "borrowers_list", so the transfer of money to her is possible. The whole procedure is depicted by the first three top arrows in Figure 6.

The second step incorporates the social investor to the blockchain by assigning him the digital assets, which are an equivalent to the amount of the fiat money primarily transferred to the SB's bank account, regardless of the blockchain infrastructure. The SB serves here simply as a "currency" exchange intermediary, who exchanges fiat money for the given digital assets, so the transactions can be stored on the blockchain. In order to achieve this, the social investor sends the "asset_request" to the data stream and waits for the SB to "issue_asset()", which contains the public key of the social investor and the amount of digital assets transferred.

Once the social investor owns the equivalent of digital assets on the blockchain, the third step occurs – identifying a borrower and transferring the digital assets on blockchain. By sending a query "borrowers_list" to the data stream, the investor will be able to get the public key of the desired borrower and transfer the digital assets by "send_asset()" with the usage of his private key. Since only the borrower can consume the sent assets due to the application of asymmetric cryptography, the system ensures the transparency and security of the transfers.

Last but not least, the final stage revolves around the repayment of the loan. The schema of the repayment mirrors the mechanism of transferring the money from the investor.

Critical Assessment: Quality and Suitability of the solution

Despite the fact that the conceptual design is very well suited for microlending in developing areas, it needs to be underscored that the authors do not specify the further exact technical aspects of the solution. First of all, the endorsement schema lacks in-depth specification.

The authors indicated that the open-source blockchain framework, MultiChain was selected for the use – case due to its suitability for private blockchains building (Mukkamala et al., 2018). Moreover, they argued that a private blockchain with public visibility would be most suitable due to the inexpensiveness of the consensus mechanism and enabled verification of the content by all the stakeholders. Nevertheless, there are further technical considerations which require specification in order for the solution to be feasible and ready for actual implementation.

The considerations regarding the consensus mechanism highlight that the set-up of the ledger validation is crucial for the maintenance of transparency and trust within the network. The authors suggest the usage of the MultiChain validation schema for the presented settings (Mukkamala et al, 2018). In terms of blocks mining and transaction validation, Mukkamala et al. (2018) claim that miners should not be compensated in any manner for the ledger validation. Due to their incomparably lower complexity, private blockchains do not require such level of computational power in contrast to i.e. public blockchains on Proof-of-Work. Therefore the incentivization and the accumulation of the hashing power is not needed. Moreover, no "gold rush" should accompany the process of mining (Mukkamala, et al, 2018).

The ideal scenario, according to the authors, would be the assignment of the mining process to external parties such as volunteers or sponsors, which would indispose a potential monopolization of the mining by the SB (Mukkamala et al., 2018). On account of the major concern being the ensurance the relationship of trust between the SB and social investors, the assignment of the mining process to the SB to full extent would significantly jeopardize the underlying concept. The SB would be able to change the ledger by endorsing its

desired version, ultimately defeating the purpose of the blockchain implementation. Once the mining is delegated to external parties, the risk of manipulation is mitigated and the high level of trust ensured.

On the other hand, the MultiChain validation schema presented by Mukkamala et al. (2018) would allow the SB to become responsible for the validation procedure, but concomitantly diminish the threat of the aforementioned monopolization. The configuration of the "mining diversity" parameter available on MultiChain enforces the round-robin sequence of the mining nodes (Mukkamala et al, 2018). Therefore, a part of the validation activity is still assigned to the SB, which may not be preferable in case of mistrust between the investor and the SB. Nevertheless, as stated in *Delimitations*, we abstract from the selection of any particular blockchain framework, which raises the question of which consensus mechanism would be suitable for our general solution.

The second issue, which undoubtedly has to be taken into consideration when planning the feasible blockchain implementation, revolves around the identification of the digital assets proposed by Mukkamala et al. (2018). The authors operate with the vague term of a "digital asset", however they never specify what kind of digital asset that would be. In the presented environment, several options should be analyzed – a local cryptocurrency, an introduction of tokens or maybe operations based on an existing cryptocurrency. Each of these interpretations alters the way investors receive assets, and therefore causes different challenges and requires specific architectural set-ups. These variants will be covered in *Component 3: Digital Assets* and *Component 4: Cryptocurrency ATM*. In case of using an existing cryptocurrency, the social investors would be fully autonomous in terms of purchasing the assets, a scenario which would not happen in the case of tokenization, which would have to be distributed by SB. On the other hand, the usage of i.e. Bitcoin would make the infrastructure vulnerable to currency fluctuations, which could strongly jeopardize the social and help-oriented context of the project (Weaver & Neumann, 2018). The lack of specification regarding the digital assets disables the actual implementation of the scenario. This factor is too important and triggers the sequence of further design decisions once selected.

Lastly, we strive to highlight a practical vulnerability of the conceptual design. Taken that the SB is an autonomous middleman who is in charge of exchanging the fiat currency to digital assets and vice versa, for both parties - the investor and the borrower, the conceptual design of the blockchain solution does not fully preclude a potential trickery from the side of the SB. The party can "easily" pass an undermined value of the digital assets to the borrower motivating it by i.e. abrupt and unfavorable cryptomarket movements or unexpected costs connected with the loan. The borrower most likely would not have a means of evaluating this claim, nor is there any indication of them having the possibility to confirm the receipt of their money to the investor. Moreover, sometimes it is impossible to take action on this kind of events, even when fully aware of it. A similar phenomenon of information asymmetry can be observed at the point of the fiat and digital

assets exchange with the investor. A potential deceit is slightly more delicate considering the investor's relatively higher access to information and opportunities to constantly track and monitor the transactions. Evidently, we do not claim that this malicious behavior is a common practice amongst social businesses. Due to the critical assessment, we objectively stipulate possible threats. Our aim is to critically analyze the proposed solution and address potential points of failure.

Having analyzed the inaccuracies of the solution, in this section we address them to contribute to the academic domain of blockchain for microlending with the considerations regarding the blockchain solution as a complementary study to the work of Mukkamala et al. (2018). We will analyze the behavioral implications among the parties in order to eventually propose an alternative blockchain design focusing on the consensus mechanism and the characteristics of the blockchain network.

Component 1: Consensus Mechanism

Conceptual design

Despite the main premise of the blockchain implementation – the elimination of the necessity of mutual trust among the participating parties and the increase of the process transparency – we argue that the full neglection of the trust component is impossible and infeasible in the conceptual design of Mukkamala et al.(2018). The crucial factor deciding on the success of the scenario is the reputation and authority of the SB, due to its central meditative role in exchanging the money, auditing of borrowers and facilitating the operations. The potential lack or inability to create and maintain the relationship of trust (due to the information asymmetries) between the SB and the investors may strongly jeopardize the effectiveness of the social actions taken by the SB (Mukkamala et al., 2018). Simply, due to some actions taking place outside of the blockchain, the technology is not able to ensure a fully transparent process flow, despite its incontestable beneficial impact in facilitating it.
This characteristic needs to be remembered when establishing the technicalities for the solution and to keep our expectations realistic.

Building on the overall analysis and the specifications of Mukkamala et al. (2018), the indication that the blockchain-based solution should be permissioned is natural for these settings. The infrastructure is to serve a closed group of stakeholders, whose privacy needs to be kept within the blockchain. Therefore, it is crucial to control who has a right to read and write to the blockchain, which is a distinct feature of private blockchains (Sultan, Ruhl & Lakhani, 2018). We propose that *Proof-of-Authority* and *Proof-of-Publication* could be successfully implemented into our scenario, in contrast to Proof-of-Stake or Proof-of-Work. Their suitability is discussed in *Critical Assessment: Quality and Suitability.*

The investors do not necessarily need an external incentive to validate the ledger correctly, which is a characteristic of private blockchains (Kolisko, 2018). The "charity" spirit of the investment supports the enclosure of real identities behind the nodes in the blockchain. Nevertheless, we need to keep in mind that numerous investors strive to keep their anonymity, thus this feature would have to be incorporated into the blockchain set-up. Still, in order to keep the transparency and safety on the highest level possible, the identity of the borrowers would be disclosed.

Critical Assessment: Quality and Suitability

Proof of Work

First, the primal consensus mechanism for the blockchain infrastructure will be assessed from the perspective of its suitability and quality provision for our case. We argue that the solution would be highly inappropriate for microlending and present the reasoning supporting the claim as follows.

As presented in *Theoretical Background,* the successful validation process requires a random trial approach in order to solve the hash function (Jabbar & Bjørn, 2017). Due to this working of the mining scheme, the solution requires enormous computational power in order to add a new block to the chain. Considering the philanthropic nature of our project, none of the involved parties – SBs, investors, auditor nor borrowers - would have sufficient hardware and computational power to validate the ledger. We should not forget that borrowers hardly ever possess smartphone or similar devices.

For the sake of comparison, the current odds of solving a puzzle on a regular PC, in order to add the block to the Bitcoin blockchain, are infinitely small (Jabbar & Bjørn, 2017). Therefore, it shows that Proof-of-Work is absolutely not suitable for setups where parties do not possess heavy hardware.

Moreover, the wider implementation of this consensus mechanism, besides Bitcoin, to different sectors, would be fateful for the environment (as is Bitcoin itself). What is more, the biggest problem in mining Bitcoin and therefore using Proof-of-Work the tendency of locating the mining facilities in the regions (i.e. China) that are mostly based on "cheap", coal power, which is the worst choice in terms of environmental issues[27]. It shows that the strive to collect a sufficient level of computational power is already very desperate and insensitive to the ecological considerations.

The electrical burden strongly hampers the scalability of this consensus mechanism. The business and IT environments strive to avoid the usage of the Proof-of-Work, which gave rise to several new schemas like the aforementioned Proof-of-Authority, Proof-of-Stake and many others. They are characterized by incomparably lower electricity consumption since they do not require to randomly guess the hash values nor incentivize

[27] *https://digiconomist.net/bitcoin-energy-consumption*

nodes to create the mining farms in order to increase their computational power and upsurge the changes to be rewarded with a coin. They are based on different principles and different incentivization mechanisms.
Due to the significant computational requirements of Proof-of-Work, causing inability to effectively validate the ledger and the fateful environmental consequences, the consensus mechanism is rejected.

Proof of Stake

Taking into consideration that the implementation of blockchain to microlending has a strong *pro publico bono* underlining and is principally not oriented towards clear profit making purposes, the Proof-of-Stake as a consensus mechanism also does not seem to be perfectly suitable. As presented in *Theoretical Background,* the mechanism assigns the right to endorse the ledger basing on the stake's size "locked-up" by the parties, which is positively and proportionally correlated with the probability of becoming a validator. The settings in which the actor "mostly involved" into the transaction is responsible for the preservation of the ledger's credibility are suitable for purely business-oriented transactions, because it mimics in the most natural way the financial market mechanisms. This is not a major focus in our case. The borrowers are not trying to make the best "deal" possible. Their goal is simply to receive a loan so they are able to improve their own well-being and that of their families. One party (the social investors) just strives to do good, therefore it is unlikely that they would behave maliciously. The recipients (the borrowers) also do not have any incentive to cheat because they simply would like to get a chance to receive financial means and build a better life. Therefore, no regular money-generating, business perspective can be successfully applied here.
Moreover, the application of Proof-of-Stake makes it impossible for the auditors (suggested by Mukkamala et al. (2018)) to have any power in the blockchain due to their lack of stake. The solution does solve the problem of the potential mistrust of the investor towards SB, since it entitles investors the absolute power over the blockchain. The potential monopolisation of the validating power by investors would ultimately defeat the purpose of auditability and trustworthiness. The centralization of the database would happen, making the blockchain implementation pointless. Therefore, Proof-of-Stake is crossed out from the consideration.

Proof of Authority

Given the incontestable discrepancy in terms of technological development and accessibility of infrastructure among the network participants, an egalitarian approach to the validation right assignment would not be appropriate. The investors and the SBs have an incomparable technological advantage, considering that the borrowers are experiencing poverty, explained previously in *Context*. Therefore, the assignment of the ledger endorsement would be impossible for this party.
Secondly, the microlending activity for the given area is not basing on the assumption that the nodes are entirely trustless parties (i.e. like in Bitcoin), whose mutual trust or honest cooperation need to be fully

moderated by the technological solution. The assurance of full anonymity is irrelevant here since in the realm of microlending, the identification of the beneficiaries is a preliminary and crucial criterion for being considered as a credible borrower. Nevertheless, the issue of potential identity disclosure of the investors needs to be taken under discussion, because some cases can arise in which the donors would prefer to stay anonymous. Therefore, we suggest that Proof-of-Authority would be a suitable consensus mechanism which could leverage on this fact. The potential loss of this highly valued anonymity would encourage investors to preserve the ledger. Proof-of-Authority is appropriate when dealing with private blockchains, where full transparency and lack of any trade secret is present. The risk of losing money lies only on the side of the investor. Thus, they are the party which is mostly incentivized to preserve the ledger. Hence, we propose to assign the validation right to the investor within Proof-of-Authority.

Proof of Publication

As an alternative to Proof-of-Authority, we suggest that the application of Proof-of-Publication as a concept which would ensure the credibility of the ledger through the preservation of the chronological order of operations. It is a blockchain-based technology to confirm the authenticity of the given data input in terms of its publication time (Tokens 24, 2018). The concept of time-stamping was briefly introduced in the section *Theoretical groundings.* The idea of Proof-of-Publication bases on the process of secure time-stamping in the blockchain network - publication details are encoded into a secure hash chain enabled by the distributed time-stamping service (TSS) where the information is broadcasted to the involved parties (Clark & Essex, 2011). The algorithm verifies the events by sending a so-called *proof of entry*, which is followed by the true or false output confirming or declining the input's trustworthiness (Tokens 24, 2018). In our case, we propose that the validation of the ledger would be entirely dependent on time-stamping (chronological order of transactions), which would be fully automated in the distributed realm due to the blockchain infrastructure.
Moreover, the selection of Proof-of-Publication makes the schema a very environmentally-friendly solution, since it requires a low level of computational power. Therefore, the endorsement process would be possible from a regular PC enabling all the participating nodes to add blocks and validate transactions. The aforementioned schema with proof-of-entry would control the credibility of the entries.

Choice of blockchain accessibility

Public blockchains, such as the one of Bitcoin, operate under the assumption of anonymity and complete trustlessness between participants. To ensure the proper working of the system, all transactions are visible, but real identities are hidden (Cabianca, 2018). Public blockchains need cryptocurrencies in order to maintain the system by incentivizing participants to run full nodes, validate transactions and mine new blocks.

Permissioned blockchains, on the other hand, have no need for such incentivization. In permissioned blockchains there is internal visibility amongst participants, but there is no external transparency (Cabianca, 2018). In permissioned blockchains, only selected nodes are allowed to participate, and each node can have different permissions and visibility (Szymański, 2018). We therefore conclude that a permissioned blockchain would be the most suitable for our chosen setting, as the investor would be able to select their preferred level of anonymity, whereas the identity of each borrower would be known.

Component 2: Smart contracts

Smart contracts are implemented in a variety of sectors like maritime or transportation in order to i.e. monitor the location of the cargo or ensure the origin of the given products. They are enabled by the synergetic usage of blockchain and IoT, where IoT nodes, being smart devices with embedded sensors, actuators etc. are responsible for the communication with other nodes and the trackability of the cargo, while blockchain provides the full transparency and immutability of the register (Alam, 2019). The combination between blockchain (here, smart contracts) and real-world actions without the usage of such devices may be tricky, yet possible, which serves as a base for the incorporation of smart contracts in out solution.

Conceptual design

In the ideal and most efficient scenario for our solution, the encoded contract would be triggered by the traditional bank transfer of fiat currency from the social investor to the SB. The main goal of the concept is not only to effectively diminish the number of actions which need to be taken by the investor, but also to increase the transparency and credibility of the microlending process by blockchain-based loan repayment. The whole process will be presented in detail in this subsection.

We propose the design incorporating the smart contract, whose execution is triggered by the successful bank transfer sent from the investor to the SB**.** Figure 7 presents the sequence flow for the aforementioned scenario, which will be described in detail further. The logic behind the sequence flow is similar to the one presented in Scenario 1, enriched by two additional distinctions. The final division is as follows:

From Scenario 1

- dotted blue lines represent non-transactional message communication
- solid purple lines represent transactional operations on the blockchain framework

Our additions:

- solid orange lines represent all the actions which are encoded in the smart contract

- solid green lines represent all the steps, that are held entirely outside of the blockchain, requiring the usage of other (traditional bank transfer) or some physical action in the real world (i.e. background check)
- red solid line represents the execution of the smart contract

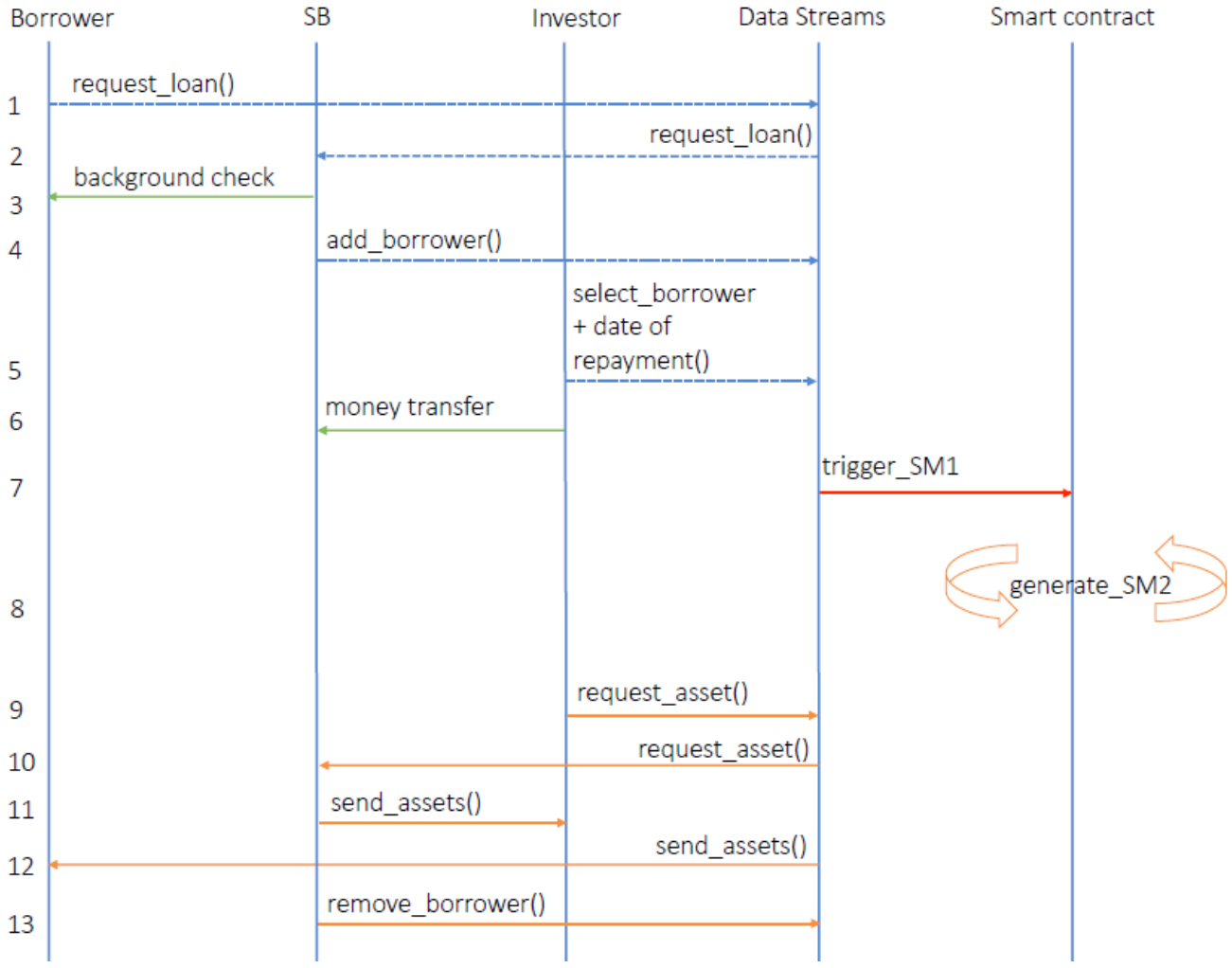


Figure 7 Sequence Chart for Smart Contracts (own elaboration)

Arrows 1-4 mirror the sequence of actions from the first solution incorporating the smart contract - the initial introduction of the borrower to the blockchain and her background check, the requests for the loan and eventually the addition to the borrower's list. Once the borrower is visible on the blockchain and has declared

her financial needs, the deviation to the previous sub-scenario is introduced. Due to the framework-agnostic nature of our research, the notion of Data Streams is used as a generalized term depicting non-transactional transfers in all of our scenarios. We suggest the design of a user-friendly interface to enable transactions.

Through the user-friendly interface, the investor would be able to select a borrower whom she would like to support and the date of repayment (arrow 5). We suggest that the date of repayment should not be sooner that i.e. 2 years in order to give the borrower a possibility to make effective use of the resources and generate sufficient profit. The amount of the donated financial means would be determined by the investor or by the aforementioned selection of the borrower (the whole amount requested by the borrower would be given).

Once the borrower, the amount and the repayment date are selected by the investor, the information is used to feed the first smart contract (SM1). Step 6 illustrates the transfer of fiat currency by regular bank operation, however in contrast to the previous solution, this action is a pre-programmed condition for the execution of SM1. The layer of the smart contract would be primarily encoded on the blockchain (ensuring the ease of the smart contract creation) and connected to the bank account, which would enable the incorporation of the transfer information to the blockchain. Therefore, arrow 7 indicates the triggering of SM1. All the following actions are performed due to their prespecification within SM1, therefore there is no need for any party to actively perform any of the steps. For the sake of clarity, the triggering of SM1 was marked in red (arrow 7).

After the successful money transfer by the investor, a "twin" smart contract (SM2) is created (arrow 8). SM2 stores the same set of information as SM1 (the investor, the borrower, the amount lent and the expected date of repayment), however it presents the repayment schema where the borrower sends the assets to the investor. The execution of SM2 would be time-constrained - after the termination of the repayment period, the contract would be automatically executed. In the case of lack of sufficient resources in the borrower's wallet, the remaining amount could be delivered later or even possibly taken from the SB. This matter, however, should be discussed further which will not be covered in this paper.

Arrows 9-12 incorporate the known schema where assets are requested and sent between the investor and the SB. The last step (arrow 13) removes the borrower from the list of borrowers.

Critical Assessment: Quality and Suitability

The execution of the smart contract by the transfer of fiat currency to the SB would give a meaningful advantage in terms of transparency and increased willingness of participation for the investors. First, due to the reduced effort required from the investor and the user friendly interface, the donor's level of satisfaction would increase, which is indirectly connected to her potential eagerness to re-donate. Moreover, this arrangement would enable the automated repayment of the loan, an action which is stored in the blockchain.

Our value proposition is the enhancement of the transparency of the repayment process. The execution of SM1 generates the creation of SM2, which is responsible for the repayment of the loan. SM2 would take the transaction details from SM1 in order to direct the process of repayment, which would give the investor a sort of guarantee that the money will be returned and easily traceable due to the use of blockchain. The engagement into the process of microlending will seem safer to the investor. Given the fact that the investor is a part of the blockchain, her right to validate the ledger ensures traceability and auditability, even in the case of her general reluctance towards automations such as smart contracts.

Despite the transactions' efficiency ensured by the smart contracts and their simplicity, Lee (2018) argues that the neglection of the bugs in smart contracts may lead to fateful consequences. The author brings up the infamous ICON June 2018 bug, which opened a way for manipulation within encoded transactions by allowing their free enabling and disabling (Lee, 2018). Certainly, the consequences of such an event would not be that inauspicious in terms of monetary value in our case. However, the unexpected and malicious modification of the smart contract would disable the successful transfer of financial means to the borrower. In order to avoid this threat, the correctness of the contract and constant technical support should be provided, which is connected with tremendous expenses. Therefore, it is essential to invest in development at the very early stages of the blockchain set-up in order to ensure the network's security.

Having established a suitable consensus mechanisms as complementary specifications to the solution of Mukkamala et al.(2018) - Proof of Authority or Proof of Publication -, in this section we have added an additional component to the blockchain network, with the purpose of the process optimization. We now proceed with the identification of the digital assets that would best supplement the hitherto determined architecture.

Component 3: Digital Assets

In their paper, Mukkamala et al. (2018) describe the lending process as supported with the help of a certain, unspecified "digital asset". Furthermore, Gora Sengupta mentioned in the interview that, at Mukti, they are unsure whether a cryptocurrency would be beneficial for their operations. We therefore investigate the possibility of this asset being either a native or existing cryptocurrency and propose the conceptual design of its implementation.

Before we delve into the analysis of a native cryptocurrency, we shortly discuss the possibility of using cryptocoins which are already on the wider market (such as Ether, Bitcoin or similar), as this poses some evident benefits. At this point we only discuss coins, because they can be used in much the same way as regular money, so any coin on the market would do. Tokens, on the other hand, are issued for a specific goal, therefore

they would need to be created in accordance to the requirements of our problem setting (Jafrey, 2018). As a result, the usage of already existing tokens would not suit our requirements and would therefore be pointless.

With regards to coins, if existing ones were to be used, investors could simply purchase them on a cryptocurrency exchange and then use the list of borrowers provided by the SB to choose to which group they wish to send funds. The fiat-to-cryptocoins exchange step between the SB and the investor would therefore not take place. This might dishearten the investors who are not familiar with the technology, or who simply wish to complete the process as quickly and simply as possible. Hence, it would be wise for the SB to still offer the purchase of the cryptocurrency for the investor, if the investor wishes to do so. Secondly, using an existing cryptocurrency would have the benefit of making it easier for the SB to exchange their existing balance for fiat currency. Every time a borrower approaches the SB to make an exchange between the coins sent to them by the investor and local fiat currency, the SB will end up with the coins. These can be either kept in a wallet and sold to the next investor wishing to make a donation, or sold on an external crypto-exchange for fiat currency. Depending on the cryptocoin and its volatility, holding it may turn into a financial risk for the SB.

There are also certain compelling downsides to using an existing cryptocoin. Because of the recent upsurge in popularity of these currencies, they are subject to high price volatility (Bird & Hunter, 2018; Mukkamala et al., 2018). Consequently, working with existing cryptocoins will create a certain devaluation risk for the SB, depending on how many coins it holds at any given time. Holding too many coins might lead to huge unpredictable losses, therefore a mechanism must be put in place through which the SB regularly exchanges coins for more stable currencies (Weaver & Neumann, 2018). Moreover there are at least two currency conversion steps happening: first when the investor exchanges fiat money for cryptocoins, and then when the borrower exchanges cryptocoins back to fiat. Thus, transaction costs can become quite high (Weaver & Neumann, 2018).

Local regulation is another point of consideration here. In India, as in many other countries, cryptocurrencies are not regarded as legal tender, meaning that they are not accepted by the government and they cannot be used to repay debt (Balaji, 2018). The Reserve Bank of India has declared it illegal for the entities that fall under its jurisdiction to trade or otherwise use cryptocurrencies (Leonard, 2018). Nevertheless, unlike in some countries such as Pakistan or, as of recently, China, cryptocurrencies in India are discouraged but not illegal (Goitom, 2018).

After careful scrutiny, we consider that the disadvantages of the implementation of existing cryptocoins in our solution overshadow the advantages, and do not pursue this line of thought. We therefore continue with an inquiry into the possibility of using native (self-developed) cryptocoins instead of existing ones.

Working with a native currency could provide an elegant solution to at least some of the problems related to existing cryptocurrencies. This is partly because the creation of a native coin is inevitably linked to the creation of an own blockchain, which has certain advantages (Shevchenko, 2018).

Firstly, this offers the possibility to temper the price volatility factor by defining a limit on the maximum number of coins which will ever be issued, or even pegging the value to an existing fiat currency (Shevchenko, 2018; Lane, Leiding & Norta, 2017), helping to avoid the phenomenon of inflation which has been catastrophic for many fiat currencies such as the Venezuelan bolivar (Mathis, 2018). This valuation concept is gaining traction in the cryptocurrency domain (Vilner, 2019). We will expand on these concepts in the *Critical Assessment* part of this section.

Secondly, designing an own blockchain allows for the alteration of specific parameters which can make it more suitable for our specific application. One of these parameters is a predefined limit in the number of coins which will ever be issued. Another important parameter are the identities of network participants. It is possible to define and govern the identities and permissions on a blockchain designed for a predefined application, such as is the case for Mukti, where the identities of the borrowers are known, but some investors might prefer to remain anonymous.

However, native coins could be challenging to implement in our solution. Unlike in the case of widespread cryptocurrencies such as Bitcoin, there is a certain level of trust in our chosen scenario. Generally, on public blockchains, the issuance of new coins is tied to incentivization and is often algorithmically capped (Koffman, 2019). Participants are rewarded with coins when they help maintain the ledger through validation and mining. The cryptocoin reward is needed in order to provide an incentive for anonymous, trustless parties to maintain the correct ledger and to discourage dishonest behavior, which is not necessary in our case.

In our case, there is partial trust between the nodes, and there is no need to incentivize them for validation. In permissioned blockchains, the identities of some participants can be known, and not anonymous or pseudonymous (Kolisko, 2018). The basic assumption of complete trustlessness is therefore not present in our case and the consensus mechanism can be designed accordingly. Nodes do not need to be rewarded with coins for validation. In *Component 1: Consensus Mechanism*, we have motivated our choice of a permissioned blockchain as our preferred network accessibility type and our consideration of using the Proof-of-Authority or Proof-of-Publication consensus mechanisms. These consensus protocols either rely on selected, pre-approved validators or on automation to maintain the ledger, and do not issue coins as rewards, as there is no block mining (Binance Academy, 2018).

Also, irrespective of the consensus mechanism or network permissions, there is the consideration of the coin's exchange rate. The fiat value of most cryptocoins is determined, amongst other factors, by network effects,

scarcity, and the supply-demand dynamic (Long, 2018; Tiwari, 2018). It is only possible to exchange cryptocoins for fiat currency due to their acceptance as a means of exchange for services and goods outside of the network. The exchange rate of a cryptocoin which runs on a private blockchain only used by a limited number of people, and which is not accepted as a means of exchange by other parties, would be difficult to evaluate. Therefore, a local native cryptocoin would not be of much help unless the entire local community accepts it as payment, or there are crytpocurrency ATMs which can exchange it for other cryptocurrencies or fiat currencies.

For this reason, we now continue by discussing the possibility of using cryptographic tokens. Tokens can be built on existing blockchains, and can be issued during an initial coin offering (ICO) or whenever needed (Shevchenko, 2018). Initial coin offerings are similar to the stock-market concept of initial public offerings (IPOs), only instead of stocks, tokens are issued to represent the value of their issuing company (Euler, 2018). They do represent a means of value exchange in a similar way as coins, but they should be seen more like vouchers which can only be used for a specific purpose, whereas coins can be used for any number of purposes (Shevchenko, 2018).

Based on the taxonomy of Euler (2018) in Appendices 7 and 8, we establish that for our chosen setting, a token with tokenized asset and token-as-a-share characteristics would most likely enable our solution. The value of tokenized assets is pegged to the value of an existing asset, making it easily translatable into a monetary amount. The similar functionality of tokens-as-a-share has further motivated their inclusion into our decision. Platform tokens do not share this characteristic, as they rarely have value outside of the platform on which they reside. our intention is to have a token which can easily represent a fiat currency, or anything that can be quantified in monetary value. Hence, we shift our focus away from platform tokens.

Based on these characterizations and our decision of pursuing token-as-a-share and tokenized asset principles, we can see in the taxonomy that only two token subtypes reflect this: investment tokens and security tokens. Investment tokens are only issued during ICOs, and are therefore not befitting to our setting. Consequently, security tokens seem to be the best solution.

Conceptual Design

According to the analysis above, security tokens seem to be a suitable solution for our problem setting. For this purpose, the SB would hold a bank account or vault with a specific amount of money or a given commodity, and would issue tokens which give their owners the right to claim a corresponding part of the assets held in the account or vault (Kokane, 2018). An alternative would be the use of stablecoins, whose value is linked to that of a fiat currency. Similar to the concept of security tokens, stablecoins are also underwritten by existing bank balances(Kokane, 2018). Stablecoins are a form of “payment tokens whose main purposes are store of

value, medium of exchange, or unit of account" (Koffman, 2019). Stablecoins are backed by a commodity or by a fiat currency, and their purpose is the avoidance of the volatility which generally characterizes the cryptocurrency market (Koffman, 2019)

With security tokens, the lending process would unfold as follows: the investor would first purchase the security tokens from the SB by means of a regular bank transfer to the SB's account. They would then send the desired amount of tokens to the selected borrower(s), who can, in turn, redeem from the SB the amount of fiat currency corresponding to the tokens they hold. This exchange step between investor and SB could also be done by means of a smart contract, which we discussed in detail in *Concept 2: Smart Contracts*. The SB could then withdraw the fiat amount from the account to which the investor made the initial transaction. In this way, the money and tokens would be completely recirculated and there would be no need for any of the parties to engage in transactions with external entities. Working with tokens has the additional advantage of being a cheaper and faster way to create and use a digital asset, as they do not need to be maintained on a separate blockchain (Long, 2018). They can be built on existing blockchains, minimizing the time and money investment that would be required in the case of the creation of an own blockchain. As we have mentioned in the introduction to this chapter, stablecoins are backed by a commodity or by a fiat currency, and their purpose is the avoidance of the volatility which generally characterizes the cryptocurrency market (Koffman, 2019).

As a result of the aforementioned considerations, we have to conclude that, unless the underlying blockchain is public, a native coin issued as a reward for validation and mining would not make much sense. Unless the suitable physical infrastructure (BTMs) were available that can exchange a native coin for fiat currency, or the currency were listed on exchanges and could be sold for fiat, a native coin would be difficult to use locally. It would need to either be accepted by the community as a local currency, or accepted and exchanged by existing financial institutions. Otherwise, the coin would need to be listed on public exchanges so that it can become part of a larger community and receive face value. However, creating a native coin that runs on a public blockchain and gets listed on exchanges will undermine our initial reticence towards using existing cryptocoins in the first place.

Critical Assessment: Quality and suitability

We have discussed in the previous paragraphs the possibility of using a native cryptocurrency in the microlending context, and analyzed the different considerations which would be needed in order to implement it. We concluded that security tokens would be the most suitable type of cryptocurrency to be used.

This has multiple benefits. First, tokens can be implemented on existing blockchains, and one can choose out of the numerous frameworks on the market. There is no need for a new blockchain to be created for this purpose, which significantly reduces the costs of its development. This also means that tokens can be implemented on both public and permissioned blockchains, which makes them more suitable to our suggested solution, as a permissioned blockchain would be preferable to a public one. Nevertheless, we would argue that building on an existing blockchain might increase the trust of investors, because using the technology of a company which has already made a name in the industry might attract investor trust easier than the creation of a completely new blockchain. We must remember that in our case, the investors will most probably not all be tech savvy and will not have the disposition and resources of understanding the technology well enough to make their own informed decision regarding the trustworthiness of the system. The alternative would be to create awareness and popularity through expert opinions and marketing, something which entails additional costs.

Secondly, the use of security tokens would allow for a complete recirculation of the fiat money given by the investors to the SB, and would not require any currency exchanges that could lead to additional costs.

The selection of security tokens as digital assets has now finalized the design of the internal architecture of the network, with the established consensus mechanisms of Proof of Authority or Proof of Publication and the incorporation of smart contracts.

Component 4: Cryptocurrency ATMs

One of the issues we have identified with the scenario of Mukkamala et al. (2018) is the last step of the lending process, namely the receiving of the loan money by the borrower. After the investor has sent the tokens to the borrower, the borrower has to approach the MFI and ask for fiat currency in exchange for the tokens in their wallet. Here, as with almost any cash-based transaction, there is playroom for the SB to keep some of the fiat currency for themselves. This last step happens outside of the blockchain, so the investor has no possibility to see what is happening with the funds. One option for disintermediating this last step and removing the SB's involvement are cryptocurrency ATMs.

Conceptual design

We operate under the principle that the "digital assets" mentioned in the paper of Mukkamala et al. (2018) are security tokens. The first steps of the process flow for a loan application would be similar to the ones described in *Component 1: Consensus Mechanism and Component 2: Smart Contracts*: first, the borrower requests a loan from the SB, after which the SB performs a background check and either confirms or rejects the loan application. In the initial scenario, the investor separately requests an amount of tokens from the SB

in exchange for fiat currency. After the regular bank transfer of fiat currency made by the investor, the SB generates security tokens representing claims to the amount of fiat which the investor has transferred and sends them to the investor. The investor can then send the tokens to one or multiple borrowers which they have chosen from the borrower list. After receiving the assets, the borrower needs to approach the SB and ask for the tokens to be exchanged for local currency. For this, the SB can simply take from their bank account the initial amount which was sent by the investor.

We have described in why this last step, as well as the repayment process, can be exploited by a non-honest SB. Unfortunately, the step of exchanging the tokens for fiat currency is unavoidable, because the borrower would not be able to perform any transactions locally otherwise (Sengupta, 2019). Local economies in developing regions are still very cash based, and cryptocurrencies have not become generally accepted as a payment method, especially not in such regions (Larios-Hernández, 2017). By introducing a BTM in the blockchain network, this step can become more trustworthy for investors, as it would eliminate the risk of the SB retaining some of the loan money. Instead of the borrower approaching the SB to exchange the funds for them, they can go to the BTM themselves.

At this point we wish to highlight that, to the best of our knowledge, it is not yet possible to cash out security tokens on such BTMs. Nevertheless, due to the high programmability of most BTMs, it is reasonable to assume that such a functionality could be implemented. The literature on which we based our research mainly focuses on Bitcoin ATMs. In the following paragraphs, we refer to tokens and coins as a generic cryptographic assets, or crypto-assets.

Critical assessment: Quality and suitability

We consider it necessary to add here that this component of the blockchain network is idealistic and would require widespread acceptance by SBs and regulatory authorities. With the necessary funding and support, multiple SBs could form a blockchain federation and offer a region- (or even country-) wide network of BTMs. Adding to this is the environmental situation in areas such as the Sunderbans where Mukti operates, where floods and other calamities are regular occurrences (Sengupta, 2019), which might further hinder the installation of such machines.

Firstly, it would increase the trust of possible and existing investors, as it would bypass the last step of the borrower having to approach the SB in order to get cash in exchange for their tokens. The system would be more reliable to external observers. Giving borrowers the possibility to withdraw the funds that were sent to them would increase the overall trustworthiness of the lending system and would also take some work away from the SB, as it would not have to handle the trading of the cryptocurrency and the exchange to fiat currency

on its own. Nevertheless, other costs arise if the SB is the BTM operator and issues a native cryptocurrency. The costs for installation and maintenance, as well as for the development of the blockchain, smart contracts and tokens, are considerable.

Infrastructural considerations

Another consideration is the physical infrastructure, and whether existing ATMs should be converted, or if new BTMs should be installed. Some companies are developing software that makes it possible to convert regular ATMs into hybrid BTMs (ATMmarketplace, 2018). This would seemingly be the simplest solution, as it does not entail additional costs for installation and maintenance of BTMs since the network would run on the old infrastructure. The initial costs for this solution would be reduced to the software and installation costs for connecting the ATMs to various blockchains. This might prove to be a challenge as the number of regular ATMs in India is decreasing. In August 2018, there were an estimated 205.000 regular ATMs, a number which has fallen by 3.000 since 2017[28]. As a result of recent regulatory changes, it is estimated that up to 50% of those ATMs might be closed down this year (PTI, 2018). The changes in regulation include much stricter KYC (know-your-customer) and AML (anti-money-laundering) processes that entail expensive and laborious software and hardware updates, rendering it infeasible for smaller operators to continue hosting ATMs (PTI, 2018). Most of the planned shutdowns are in rural areas, so they will predominantly affect individuals who are already in a meager financial situations and who need the ATMs not only for regular withdrawals, but also to receive state subsidies (PTI, 2018). This measure would also cause a job loss of half a million people who operate, maintain or otherwise work with ATMs (Anand, 2018).

In light of these events, using the old infrastructure to give people access to BTMs could prove problematic. Another option would be for the SBs to purchase new BTMs. The price of these machines can vary depending on functionality and build, but most of them average at around 5.000 $ (Lamassu, 2019; General Bytes, 2019). The lighter versions, which do not get installed on outside walls, but can be put on a table or any support inside, can be bought for around 3.600 $ (Lamassu, 2019). Installing a new fleet of BTMs can therefore turn into an expensive endeavour. Even if the funds were available, there is still the issue of network connectivity. The BTM needs to be connected to the internet in order to participate actively in a blockchain network, and as we have seen, some rural areas do not have a strong network coverage (Sengupta, 2019). This would undoubtedly need to be considered during the physical implementation of such devices, along with the decision of whether the machine should run its own node or a hosted one.

[28] *https://www.rbi.org.in/Scripts/ATMView.aspx?atmid=90*

Regulatory considerations

Irrespective of the challenges related to the physical infrastructure, there are also regulatory concerns to be considered. The landscape for BTMs in India is extremely scarce, the first one having been opened in October 2018 in the Kemp Fort Mall of Bengaluru (Anand, 2018). This scarcity is partly a result of efforts undergone by the Reserve Bank of India and other regulatory entities to suppress the use and circulation of cryptocurrencies, actions which are motivated by the anonymity and potential for illegal activity that most cryptocurrencies provide (Leonard, 2018). This is a legitimate concern, especially considering that BTMs tend to be praised as the most secure and anonymous way of trading cryptocurrencies, as they often do not require identification if the user is working with small sums (Khatwani, 2018), thereby making it impossible for law enforcement to track these transactions.

However, operators of BTMs have certain obligations regarding the functionalities of their machines, as they need to ensure that they are compliant with the legislation of their respective countries (Lamassu, 2019). For compliance purposes, operators can decide on the specific KYC processes that users need to undergo in order to perform transactions on the BTM. This depends on what the producer has integrated in the hardware of the machine, be it a video camera or ID scanner for identity confirmation. Additionally, for the business purpose, operators can decide upon transaction fees and withdrawal limits (Lamassu, 2019). Each operator can determine how much they will charge for the buying or selling of cryptocoins, as well as which transaction amount will require users to identify themselves. This custombizability is extremely convenient for our situation, as the security parameters can be tuned to comply with any local regulation, and it is not in the interest of our solution to provide the users of the BTMs, so the borrowers, with anonymity.

It needs to be underlined here that our case is distinct from that of most existing cryptocurrencies, owing to the different purpose and design of our solution. In our selected case, the network is permissioned and selected nodes (the ones representing the borrowers, and perhaps some investors) are known. There is no inherent need or interest for anonymity, except perhaps for some of the investors. The implementation of such devices should therefore, at least in theory, be less difficult to perform from a regulatory perspective.

Challenges for the blockchain implementation

No technological infrastructure in place

Although India became the second largest smartphone market in the world in 2018 (Tripahi, 2018), the uneven distribution of the wealth and access to technology impairs the implementation of the blockchain-based solutions. Basing on the data presented by Statista (2018)[29] every fourth Indian has access to a smartphone, which is clearly not sufficient in order to ensure the transparency of the transactions and the node identification. Moreover, the statistics is calculated for the whole country without any inclusion of the consequences deriving from the massive social discrepancies. Therefore, the situation in rural areas is even more serious.

Taking into consideration that the context of our paper revolves around the poor, mostly located away from urban areas and infrastructure, we will shift the focus to this group. In 2017, 66,4 % of the whole population of India[30] lived in the rural areas, where the vast majority goes on using feature phones (Tripathi, 2018). We can speculate about the reasons for this phenomenon. It can derive from a lack of financial resources to invest in a smartphone or no clear purpose for which activities it should be used. What is more, the hesitancy may also be caused by general reluctance to dealing with an unknown technology or initial inability to benefit from its functionalities. On the other hand, taking into consideration the needs of this social group (some of the people are illiterate due to the limited access to education and lack of financial resources), the benefits of feature phone like affordability, long battery life and no requirement of technological proficiency can simply meet their preferences (Baxi, 2018).

Baxi (2018) highlights the fact that the sales of feature phones in India are flourishing – according to Counterpoint Research the overall mobile sales increased by 37% at the end of 2017, while the growth rate for the feature phones reached the level of 55% (Verma, 2018). JioPhone, the top-selling feature phone of 2017 boosted the ratio. What is more, according to Sengupta (2018), the 2G network connection in rural areas strongly impairs the feasible usage of the blockchain. It clearly indicates that the implementation of the blockchain-based solution for this specific group may be challenging hardware-wise. However, the emergence of KaiOS, a web-based operating systems that gave birth to internet-enabled feature phones (Baxi, 2018), could be a first step to considering a blockchain implementation.

[29] *https://www.statista.com/statistics/467163/forecast-of-smartphone-users-in-india/*
[30] *https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=IN*

Assignment of multiple borrowers to one node

Another challenge for the blockchain implementation is the assignment of multiple borrowers to one node, which is fateful in terms of the identification of the borrowers' real identities and assignment of the responsibility of the loan. Taking into consideration the lack of the necessary infrastructure, namely the inability for each individual to own a smartphone which could serve as a separate node, multiple people need to be assigned to one node. In case of the situation which Mukti is dealing with, these groups (SHGs) consist of ten to twelve female entrepreneurs, on which we will elaborate in the following section (Sengupta, 2019). This circumstance disregards the blockchain's premise of the full transparency of the operations and it strongly undermines the creditworthiness. When more people, with equal rights, are represented by only one node, it is infeasible to indicate who exactly is responsible for the proceedings or decisions made by the node.

Nevertheless, the assignment of a number of people to one node, may have beneficial consequences when scrutinising the behavioural patterns of credit takers. As mentioned in *Theoretical Background*, the mutual responsibility for the loan gives rise to a feeling of peer-pressure, which can increase the repayment rate (Morduch & Armendáriz de Aghion, 2005). The awareness that the failure of one individual may jeopardize the financial situation of the others serves as an incentive to put their best effort in the development of their business and the ability to return their share of the donated sum. Taking into consideration this aspect of the lending process, the assignment of multiple individuals to the one node has a very positive side effect.

Assessment of final solution through relevant business frameworks

In the previous sections, we proposed and analyzed from a technical perspective the final solution for the implementation of blockchain in microlending. In order to provide a holistic perspective on the feasibility of this solution, in this section we analyze them through the lens of relevant economic and managerial theories.

Information Asymmetry

We observed the risk for information asymmetry in two phases of the microlending process. It is found in both the relation between the SB and the borrowers, as well as between the investors and the SB. For the sake of comparison, we consider that, in the first relation, the investor is the principal and the SB (or, in our case, Mukti) is the agent, whereas in the second one, the SB becomes the principal and the borrower is the agent. There are, of course, clear disparities between our example and the cases to which agency theory typically applies, however, the situations are comparable in terms of contractual dynamics and the effects of information asymmetry on the behaviour of the involved parties.

The SB is at a clear informational advantage in terms of borrower selection and fund management, as it is difficult for outside investors to see its internal processes and to observe its relation to the borrowers. This can encourage opportunistic behavior on behalf of the SB. For instance, as in most microlending contracts, there is a liability insurance for the borrowers (Bahng, 2013), so the SB could simply receive the money back from the borrowers and tell the investors that the borrower was unable to repay the loan. Since we are speaking of a social business, investors know from the beginning that this is a risk, so they would probably not question this statement. With the use of blockchain, this could not happen, as the borrowers and investors are transacting directly with each other. Additionally, the ledger is immutable by default, adding to the trustworthiness.

Correspondingly, there is also information asymmetry in the contract situation between the SB and the borrower, where the asymmetry favours the latter. As in any lending process, the borrower may be tempted to misrepresent some information pertaining to themselves or their business in order to position themselves more favourably in the screening process (Freixas & Rochet, 1997). It is also quite difficult for the SB to assess whether the loan has indeed become productive and produced enough revenue for the borrower to be able to repay it.

With our solution, the information asymmetry between the borrower and the other stakeholders is reduced and the chance for financial inclusion is increased. Assuming that the borrower manages to repay her loans in accordance with the predefined contract conditions, her creditworthiness would be positively correlated to the number of loans she takes. Considering that her credit history would be stored on the blockchain, its legitimacy could not be refuted, providing solid evidence regarding her trustworthy behavior. Her participation on the blockchain would therefore help to build her creditworthiness and lead to increased trust from the other stakeholders.

Furthermore, with regards to the two suggested means of reducing information asymmetry: signalling and screening (Akerlof, 1970 in Dawson et al., 2010), it can be considered that in our case the utilization of the blockchain technology is an indirect means of signaling. This is because, through the blockchain, the SB allows the investors complete transparency towards the transactions made on the blockchain network, thereby providing them with additional relevant information. This exposure serves as a trust-building factor that encourages more investors to give money. The second suggested mechanism for reducing information asymmetry is screening. Undoubtedly, this is reflected in the background check done by the SB on the borrower, as this action helps to reduce the information insufficiency of the SB. The blockchain-based microlending process therefore follows the two key approaches which are used to deal with information

asymmetry. As long as it is ensured that these activities are continued and optimized, opportunistic behavior will be diminished.

However, even with our solution, if no suitable tracking setup (such as a dashboard or similar) is provided for the investor, there is a potential for information asymmetry. In this case, the information asymmetry stems from the inability to access the minimally required information for the creation of a complete contract (Rosenblat & Stark, 2016).

Switching Costs

Ideally, as Mukti operates in the realm of social business, our concept would come at no financial cost to the borrowers or investors. Therefore, we do not see the risk for financial switching costs to occur in this situation. Similarly, as we are working with an emerging market and a completely novel product, it is difficult to imagine relational switching costs on the borrower side. On the investor side, however, it is possible that some donors might already be cooperating with other microlending companies in their area and experience loyalty and trust to them. Their satisfaction in these partnerships is positively correlated with relational switching costs. Moreover, if the investors are from distant countries, they might be reluctant towards giving money to small social businesses who operate on the other side of the globe, as they might be afraid of the unknown, which might invite all types of switching costs. These factors could render the investors reticent towards switching to another company. SBs could try to overcome this by providing a convincing value proposition about the increased transparency and auditability brought by the implementation of blockchain in the microlending system. This promise would be supplemented by the provision of a user-friendly experience which further serves to reduce various switching costs.

Also, there is the distinct possibility for procedural costs to impede stakeholders from joining the network. A new application, especially using a new technology, will inevitably create uncertainty and might discourage investors or borrowers from adopting it. Some borrowers might already be part of an informal lending system, or have agreements with family members to borrow money from time to time. Such social and community ties might be hard to break, as we have discerned in the *Literature Review* chapter that inhabitants of rural communities tend to favour informal, peer-to-peer systems over official relations with legal entities. Similarly, investors might already be cooperating with another SB and, even if they do not perceive any loyalty to that particular company, they will hesitate to switch merely because of the additional effort that this action entails.

IT Alignment

For Mukti and other similar SBs, the strategic goals are not related to profit or competitiveness. Instead, their strategy is aimed at fulfilling their mission (Meehan & Jonker, 2017), which is the socio-economic advancement of their communities (Sengupta, 2019). Nevertheless, they are still organizations whose internal structures have much in common with profit-seeking companies, and which should be treated in the same way (Meehan & Jonker, 2017). It is therefore reasonable to assume that social businesses are seeking the optimization of their processes, especially in terms of financial resources. Scaling is also amongst the long-term strategic goals of Mukti: in our interview with him, Gora Sengupta mentioned that they are planning to grow the borrower base in order to attract funding from larger organizations (Sengupta, 2019). The achievement of these goals is not measured by financial performance, but rather by how well they succeed in achieving the mission of the SBs (Collins, 2005). Due to the selection of characteristics and the suitable consensus mechanism, our solution is easily scalable in terms of the participants involved, which makes strongly support the goal of Mukti. Evidently, for social businesses such as Mukti, the strategic goals differ from regular, profit-oriented enterprises. In social businesses, strategic goals are defined around the mission statement (Collins, 2012), which in our case is the socio-economic empowerment of women in rural areas of India (Sengupta, 2019).

Structural alignment refers to the assignment of decision rights between different strategic business units and corporate levels (Reynolds & Yetton, 2015). Mukti, however, represents a single business unit working with microloans, and we therefore consider that an analysis of structural alignment would not yield significant results at this point, and we therefore abstract from inquiring into this topic. Of course, if we were to study other, more complex organizational structures, the reasoning would be different.

Likewise, temporal alignment works with the premise of changes in the competitive environment and the creation of new business capabilities in order to deal with these changes (Reynolds & Yetton, 2015). In a social business setting, competitiveness and the creation of new capabilities for the future are not as prioritized as operational improvement and fostering of existing capabilities (Collins, 2005). Furthermore, we are doing a cross-sectional study, which only regards the current state of a phenomenon in a given point in time, which invalidates further considerations on temporal alignment in this paper. Therefore, it is out of the scope of our current state of research.

Despite the two above named limitations, investigating how our proposed solution aligns with the business goals and mission statement of Mukti, will provide valuable insight into its capacity for success and adoption. Functional alignment implies the creation of IT capabilities which can support business capabilities (Reynolds & Yetton, 2015). The business capabilities of Mukti and other SBs in the microlending sector are related to their closeness to their borrowers and their ability to offer loans to groups which are difficult to reach for

external entities. As we have mentioned in previous sections, the implementation of our conceptual design would automate certain internal tasks. This, in turn, would ease the workload off of loan agents and other Mukti volunteers, who could focus more on field work (Sengupta, 2019) and provide guidance and support to the borrowers instead of handling paperwork. The introduction of our proposed solution would therefore help Mukti to dedicate more resources to core business processes supporting its mission.

Another goal of Mukti is the enlargement of their borrower base. After adopting our proposed solution, Mukti will become a double-sided digital market, and will consequently have great scaling potential (Bharadwaj et al., 2013). The initial effort and resources dedicated to starting the blockchain based microlending application will be quite significant, but after the system will have been put in place, scaling will not be an issue. Any participant with a digital, internet-connected device will be able to join the network without additional effort on the part of the SB. We therefore conclude that our suggested solution design will create functional alignment with the purpose of Mukti.

Findings and recommendations

Basing on the in-depth scrutiny of the separate blockchain-related components aiming to address the unspecified details of the solution presented by Mukkamala et al (2018), we now present our final holistic blockchain-based conceptual design for the microlending in developing countries. We start with an overall description of our conceptual design while including the implementation of smart contracts, which is our own addition, and not a specification for the scenario of Mukkamala et al. (2018). We then present the permission settings of the network and move to the specification of the undetermined details of the solution of Mukkamala et al. (2018), namely the consensus mechanism and the digital assets, which served as a starting point for our research. Lastly, we consider the addition of cryptocurrency ATMs as a feature supporting this infrastructure.

Our considerations and analysis regarding the characteristics of the blockchain infrastructure led to the conclusion that the accessibility of the blockchain solution needs to be permissioned and the blockchain per se private. The domain of microlending requires a high level of transparency and meticulous access management in order to keep the data secured and the network honest. The access to the network needs to be limited to ensure its manageability.

Component 2: Smart contracts presents the overall modus operandi of our solution, to which we incorporated smart contracts. In our proposal, the smart contract triggered by a regular fiat money transfer, could effectively automate the steps of distributing and transferring the digital assets from the investor to the borrower and therefore streamline the process. In order to increase the repayment rate, we designed the

automatic creation of the second smart contract, whose construction is embedded within the main smart contract. The introduction of a smart contract layer on top of the blockchain would enable its easy creation, without the constant involvement of external developers, therefore it would not cause any significant rise of operational costs.

In *Component 1: Consensus* mechanism, we have discussed the usage and suitability of distinct consensus mechanisms and furtherly concluded that two validation schemas would be in alignment with the needs and challenges of a blockchain solution for microlending in developing countries – Proof-of-Authority and Proof-of-Publication.

In blockchains based on Proof-of-Authority, the validators of the network risk them own identity, which refrains them from any malicious behavior. In case of the attempt of incorrect ledger validation, the real identity of the node is revealed to the network, which may have obvious adverse consequences. Nevertheless, it can be argued that the schema incentivizes the node as expected only if the owner of the node values his or her anonymity. Since investors are the only party who may value the protection of their identity and have a strong preference of staying anonymous, we argue that this stakeholder should have the authority to validate the network. Moreover, it needs to be remembered that even if some investors are comfortable with a potential disclosure of their identity, they are the party who physically introduces financial means to the system, exposing themselves to a potential loss if the borrower cannot manage to repay. Additionally, their intention of investing most probably stems from an honest desire to help, and not to make financial gains. Thus, irrespective of the importance of their anonymity, the investors still would be incentivized to preserve the valid ledger for the sake of tracking and protecting their money and accomplishing their wish to support those in need.

Proof-of-Publication is a second recommended consensus mechanism which we consider suitable for supporting our settings. Thanks to the usage of Proof-of-Publication, the validation of the ledger would base on the concept of timestamping. The condition to add the transaction to the blockchain would simply depend on the chronological order of the events, whose immutability would be ensured by the blockchain infrastructure.

Despite the above considerations, the assignment of the validation of the ledger to only one party (the investors) resembles a traditional centralized database, which defeats the purpose of the blockchain implementation. Hence, we highlight that the blockchain pre-specification needs to include the allowance for external parties (auditors) to validate the ledger as well. Lastly, due to potential discrepancies in the level of technological proficiency and the lack of required technological architecture, we suggest that assigning the validation rights to the borrowers would not be effective.

The last reason supporting the selection of the aforementioned schemas is the fact that both of the consensus mechanisms are computationally efficient, requiring a minimal amount of electricity. This not only makes the solution environmentally friendly and scalable, but also is strongly advantageous for our settings. As a result of low CPU requirements, the validation of the network can be performed from a regular computer, which is highly advantageous in our case, where the block validators are individuals who might not have the most advanced technological means at their disposal.

In terms of network infrastructure, the borrowers would run light nodes which are connected to the network for the sole purpose of making transactions and keeping a balance of tokens. Due to the dire circumstances in which they live, we operate on the assumption that most of them will not have the necessary means for running full nodes on laptops or other more powerful devices. On the other hand, investors, auditors and other interested parties should have more comprehensive permissions and roles, such as transaction validation. With regards to visibility, the borrower nodes would not necessarily have to be anonymous. Since they already undergo a background check, their real-life identities are known by the SB and possibly by the investors as well. The allocation of node permissions would happen when a node tries to connect to the network. The node would send a request to the network stating its access preferences - whether it wants investor, auditor or borrower access in user-friendly interface mentioned in *Component 2: Smart Contracts*. Based on these requests, the permissions and level of anonymity of the respective node are determined. Borrower nodes would have the authority to make transfers and send loan requests, and investor nodes would have the permission to validate transactions, make transfers and send asset requests. Auditor nodes would most likely have the permission to view all transactions and also to validate them. To sum up, the network will have a restricted number of nodes, the majority of which will be light clients.

And lastly, as part of our conceptual design we have specified the digital assets mentioned in the solution of Mukkamala et al. (2018). We found that security tokens would be the digital asset which would most equitably support our designed solution, as they can be used to represent underlying assets held by the issuing entity. They would give the holder the right to claim a specified amount of, in our case, fiat money held in a bank account of the SB. Therefore, the tokens would represent the real value of the money contributed by the investors, and would have value outside of the blockchain network. This would effectively eliminate the issues related to determining the exchange rate of coins, and would enable a recirculation of the funds within the organization. The need to purchase and exchange coins on public exchanges is also be erased.

As an augmentation of the final design, we discussed the possibility of incorporating cryptocurrency ATMs in the overall infrastructure to enable borrowers to become independent of the SB in the fiat - to-token

exchange. This scenario would diminish the implication of the final business to the vetting of the borrowers and the maintenance of the blockchain system.

Furthermore, the implementation of the above presented blockchain-based solution proved to effectively reduce the information asymmetries amongst stakeholders in terms of the trackability of the assets. Though this increased transparency, social investors would deem the system as more trustworthy, and possibly increase their donations. The adoption of the solution by borrowers and investors was found to not be significantly hampered by switching costs. Additionally, we found that the resulting scalability and operational efficiency would create functional alignment to the goals set by Mukti.

In Table 9, the first column shows the previously discussed challenges of microlending in developing countries along with points of improvement of the solution of Mukkamala et al. (2018). In the second column, we present the summary of our recommendations on how to address these issues with the blockchain-based solution (based on Mukkamala et al., 2018) in order to support the process of microlending and eventually contribute to the poverty reduction.

Challenges	Findings and recommendations
Lack of the direct specification of consensus mechanism in the paper of Mukkamala et al. (2018)	Suggestion of: Proof of Authority with the validation right assigned to the investors and auditors, or Proof of Publication basing on the timestamping schema
Lack of specification of digital assets in the paper of Mukkamala et al. (2018)	Proposal of usage of security tokens as they can be created at any time, and do not have to be minted or mined. They represent a claim on real assets held by the issuer (the SB) and their functionality resembles that of a bank check
Information asymmetry - Lack of trust from investor towards SB	Smart contracts enabling the full automation of the lending process and ensuring the repayment of the loan. The blockchain would ensure the trackability and immutability of the ledger, so the investor can transparently trace the assets. The introduction of the smart contract ensures that any action which is not pre-coded in the smart contract, will simply not happen.
Information asymmetry - Lack of trust between SB and borrower caused by potential transfer of lower amount of digital assets	Overall implementation of the blockchain technology and specifically smart contracts in *Concept 2: Smart contracts.* The borrower's trust would be increased by the pre-specification of the actions in the smart contract. SB would not have a flexibility for any potential malicious behavior, because the assets would sent directly to the borrower through the smart contract.
Lack of trust between SB and borrower caused by the fiat-digital assets exchange	To tackle the trust issue deriving from the fiat- digital exchange between SB and the borrower, we propose the augmentation of the solution by connecting the blockchain network to the crypto ATMs. However, we treat it as a future prospect since current infrastructure would make this augmentation difficult.
Difficulties to gain new investors	Implementation of the blockchain solution with smart contracts (*Component 2: Smart contracts)* would increase the repayment rate of the loans, and therefore investor's satisfaction. We hope that this positive experience and the promise of the transparency and immutability ensured by blockchain would indirectly help to gain new investors.
Insufficient human resources	The implementation of our solution would reduce the amount of work done by the loan officers and volunteers to manually validate the loan register. As a consequence, they could focus their resources more on performing background checks more efficiently and dedicating more time to financial trainings for the borrowers.

Table 9 Table of challenges and recommendations

Discussion

Having presented our solution and analyzed its multiple aspects, we now proceed to summarize our efforts in order to answer the initially formulated research question:

How should a blockchain-based solution for microlending in developing countries be designed in order to ensure trust, transparency and auditability to positively impact poverty and financial inclusion?

In order to ensure the coherence of our study and give a comprehensive answer to the research question, we have used theoretical groundings on blockchain and microlending separately, as well as business-related theories of information asymmetry, switching costs, and IT alignment. The combination of these theories helped us to analyse the case from the perspectives of all the stakeholders and to incorporate technological and business aspects to our thesis. The subject is in alignment with the composition of our study program. This gave us the possibility to employ our previous knowledge to the paper and to understand the more deep-rooted concepts in order to thoroughly assess the proposed solutions' suitability and shortcomings.

This knowledge was supplemented by the insights we gathered through our literature review, which gave us the technical notions and implications of blockchain which were required for the design of our own solution and the subsequent answering of our research question. Academic literature in the domain of blockchain-based microlending to fight poverty in developing countries is still relatively scarce. Most of the publications we found neither presented a comprehensive design from the perspective of all stakeholders, nor provided a discourse regarding the stakeholders' perspectives by means of academic notions from the domain of business studies. Therefore, we consider our thesis as a meaningful contribution in this area.

Aiming to answer the research question, we conclude that the blockchain-based network, once properly designed, can be highly useful for microlending in developing countries by increasing the transparency of transactions and supporting their auditability, which eventually leads to the establishment of trust among parties. Combined with the inherent characteristic of immutability and decentralization of the blockchain, this can lead to greater financial inclusion and proximate contribution to poverty reduction. We have argued for this by designing a holistic blockchain-based design for microlending. We resolved that a network architecture which best meets the various pre-specified requirements demanded by our context is a permissioned blockchain with a Proof of Authority or Proof of Publication as a consensus mechanism with known block validators, smart contracts functionality and security tokens support. The visibility of the blockchain should be private due to the non-public character of the network and general focus on the protection of the stakeholders' proceedings. The infrastructural particularities in rural India, where Mukti operates, have been

considered for the derivation of these conclusions, as well as the individual needs and preferences of the different network participants.

In our solution, we leveraged on the intrinsic characteristic of the blockchain technology, immutability, which ensures a lack of any possibility to change the ledger once validated. This straightforwardness by default increases the ease of its auditability by internal and external parties. The validation right is assigned to nodes whose potential malicious behavior is in any scenario hampered by the logic behind our selected consensus mechanism. This factor yields a stronger feeling of trust between the network participants. Moreover, investors and external auditors are allowed to endorse the ledger, which decentralizes the decision-making power and allows the external party to monitor the proceedings of the investor. The auditability of the process is significantly supported by this setup. We argue that the blockchain enables an increase in trust also through the identity management within the network. The borrowers are fully identified before they join it. The investors, however, have a right to select to which extent they want to keep their anonymity.

The transparency of the process is further ensured by the use of a digital asset which is trackable on the blockchain. We chose security tokens as a manifestation of this digital asset, since they convey the necessary functionality for our context. Security tokens enable a complete circulation of the investor's funds within the microlending flow of Mukti and similar companies, without the need of exchanging them for other currencies. The previously mentioned information asymmetry in the fiat-digital exchange among stakeholders is therefore diminished, leading to higher transparency and trust. An additional feature to this are crypto-ATMs, where the borrower can retrieve the fiat money represented by their tokens without any interference by the SB. This addition contributes to the overall trust of the system by eliminating any cash-based transactions through the SB.

There are numerous advantageous implications in the area of trust, transparency and auditability deriving from our components and the decreased information asymmetries which they create. The incorporation of smart contracts to the blockchain-based network would enable a seamless and actionless process of microlending for the investors. This would lead to a significant enhancement of the process' transparency and immutability, and balance the information asymmetries among stakeholders. Due to the pre-specified actions encoded in the smart contracts, the investor has a clear overview of what will happen with her donation. Moreover, being embedded in the blockchain, the smart contract is nearly impossible to be manipulated once triggered. It indisposes the SB from any potential interference in the blockchain, which is directly positively related to the level of trust from the perspective of the investor. Such an intangible factor directly translates into the increased interest in microlending,potentially attracting new investors. All these efforts and enhancements eventually translate into the contribution for the poverty reduction and financial inclusion.

It is worth noticing that our findings are in alignment with alternative solutions proposed in the academic domain. The use of smart contracts was presented by Lane, Liding & Norta (2017) in their whitepaper about the cross-border blockchain payments platform Everex as a means of enforcing payments in a similar way to our approach. The concept also works with stablecoins, a form of cryptographic token which is very similar in functionality to the security tokens proposed by us. Another solution, presented by Mahajan & Srivastava (2019), points out the benefits for creating blockchain-enabled creditworthiness to increase financial inclusion, which is strongly relevant to the motivation for our paper. Through our conceptual design, unbanked individuals can build their creditworthiness and become financially included.

As mentioned in *Introduction* and *Context*, financial inclusion is one of the main challenges that prevents many people from escaping poverty. In 2017, only 94% of the households did not have any dweller with a health insurance and 74% of women in general did not possess saving accounts (NAFIS, 2017). The further lack of access to basic financial instruments like credits with affordable interest rate, insurance products or regular bank accounts, creates the necessity of storing the savings in households where the assets are highly susceptible to theft, which strongly adds to their hardship (Schuetz & Venkatesh, 2019).

Due to the inability to build their creditworthiness, these individuals are not considered by the regular banks as potential clients, which consequently aggravates their material situation. They are forced by circumstances to get multiple microloans from SBs or questionable moneylenders which eventually may lead to a vicious debt circle. The wide usage of the blockchain-based network by distinct entities would provide the creation of the trustworthy credit history of each borrower. It would enable the manageability to the "debt circle" phenomenon by controlling the number of loans taken by the borrower.

Furthermore, despite their harmless and honest intentions, people experiencing poverty cannot participate in any larger network of online payments due to the lack of initial funds or collateral. With the implementation of the blockchain-based solution, these constraints may become invalid, since neither a bank account nor any other type of official registration would have to be created. The solution would help these people to finally receive the financing they need, use the assets to become financially independent on a long term perspective and become part of the mainstream banking system. However, the investment in the technological infrastructure and the efforts to reduce financial exclusion lie at the very core of the process of poverty reduction. Referring to the statement of Yunus (2007) presented in *Context*, the first of the reasons to the social business emergence was a lack of sufficient engagement from the side of authorities. Therefore, we underscore that without appropriate attitude from governmental bodies and constructive support for the regions in need, our solution would not be much of use.

Poverty is a problem of a worldwide reach and the way how it is addressed needs to be scalable. Due to the framework-agnostic blockchain design, the findings of our thesis and the final solution are generalizable, as

this was one of the main focuses of this papers. The design of the blockchain-based network was created to meet the challenges and conditions of any developing area of the world, where a structured and transparent process of microlending could be a real enabler of poverty reduction. There are numerous companies such as Mukti which operate in other areas of the world like Zidisha[31] in Africa or Uulala[32] in Latin America, who have similar infrastructural characteristics and could easily benefit from our conceptual design like Mutki.

Despite the significant benefits deriving from the implementation of the solution, there are noticeable drawbacks and obstacles, which are difficult to address and may be a subject of further research.

We mentioned that the assignment of a self-help group (SHG) consisting of 10-12 women to a single network node might bring some evident disadvantages in terms of accountability, and it might also induce despotic behavior in the phone holder. We have not inquired into these details in-depth, as we lacked sufficient information. Nevertheless, the group is liable as a whole with or without a blockchain implementation, thus we do not consider this to be an impassable obstacle. It is possible that, in an initial stage, the individual contributions to the loan might still need to be tracked manually. With sufficient funds, alternative implementations can be imagined which will allow each individual borrower to carry their own node (or cold wallets). We believe that these options show great promise and would be a great contribution to future research.

Lastly, from a wider perspective, there has been criticism on the societal benefits of microloans, as these are a less direct and less measurable effect compared to the rate of repayment (Mader and Winkler, 2013). Some researchers argue that access to microloans can lead to an improper prioritization of the business created with the help of the borrowed money, by forcing children to neglect their education in order for them to contribute to the business activity at home (Emerson, 2018). On the long term, if not correctly supervised, this can lead to a decrease of general education level within a community, which has been linked to lower living standards and earning potential (Emerson, 2018).

Further research

Blockchain frameworks

In *Analysis: Blockchain concept and Evaluation*, we gave a detailed description of the functionality and technical aspects of each component of our solution. For the purpose of generalization, we abstracted from specifying any one blockchain framework to be used. We now shortly discuss some possibilities which invite the need for future research. After some preliminary research, we found multiple blockchain frameworks

[31] *https://www.zidisha.org/*
[32] *https://uulala.io/*

which would support the creation of our solution. Of course, the list is not exhaustive and many other frameworks could be successfully used in this setting.

The Hyperledger Fabric framework was used for the only other blockchain-based microlending solution (Mahajan & Srivastava, 2019) which we reviewed beside the one of Mukkamala et al. (2018). If this framework were used for the implementation of our blockchain concept, Proof-of-Authority would not be the preferred consensus. In Hyperledger Fabric, the consensus is permissioned and voting-based (Kumar, 2018). Using this algorithm would inevitably slow down the rate of transactions with every increase in the number of nodes (Kumar, 2018). Nevertheless, unless a large number of SBs all use the same network with thousands of borrowers, we expect the number of nodes to remain relatively low, so it is improbable that scalability will become a problem.

Multichain, the framework used by Mukkamala et al. (2018), is an open platform designed specifically to build private blockchains, since it allows the easy management of the shared ledger's openness according to the network owner's preferences (Baliga, 2016). It has clear restrictions regarding asset creation which also makes it suitable for our solution (Greenspan, 2015).

In case of the actual implementation of our solution, one would have to keep in mind that the selected blockchain framework would have to enable the creation of smart contracts. Therefore, Ethereum (presented in *Component 2: Smart contracts*), Rootstock or Codius could be taken into consideration (Baliga, 2016). Each of them is characterised by different specifications and technical configurations i.e consensus mechanism. Moreover, once our solution develops and expands, multiple other blockchain frameworks would be of use and provide a suitable base for consortium creation like Corda, OpenChain and BlockStack (Baliga, 2016). Nevertheless, these remarks just scratch the surface of this broad topic. The in-depth scrutiny should be performed as future considerations.

Security of the network

Referring to the presented technicalities, our solution deals with the financial flows among different parties, the infrastructure of the network must ensure the security of the assets. Despite having presented the selected aspects of the blockchain and comprehensively analyzed their suitability, we could not provide the full security analysis of the network. First of all, it was not the main objective of our study. Secondly, the lack of purely software engineering background and limited timeframe made it impossible to cover this aspect of the solution to a satisfactory level. The specification of the security restrictions of the network would be a valuable complementary contribution for our study.

Prototype of the solution

The specification of the aforementioned aspects could lead to the delivery of a prototype, enabling the actual implementation of our conceptual design. Due to the time and space limitations of this thesis, we were unfortunately not capable to deliver a prototype. The actual implementation would allow for the evaluation and also further application of our research strategy - action approach. The steps of the action research spiral could be iterated, according to its initial assumption, and lead to improvements of the solution. We would strongly support that kind of development of our project in future research.

Complementary blockchain-based solutions

In order to support the promises of our solution, several complementary blockchain-based services could be proposed. Assuming that the majority of people in a community would be part of the blockchain system, the mechanism of mutual support in providing creditworthiness could be implemented. In small, tight-knit rural communities, the villagers know each other better than the SB can ever determine by looking at ownership and identity documents, which might be missing in the first place (Larios-Hernandez, 2017). Thus, an inherent, informal reputation system would be already in place within the community. A borrower who has received a loan for herself might have a trusted peer who, for various reasons, has not passed the screening. She might decide that she wishes to lend her friend a part of her assets through the blockchain. The "secondary" borrower would have her own phone, thanks to which she would be able to connect to the blockchain. The transfer of the assets from the "primary" borrower to the "secondary" one would be stored on the blockchain, thus the credit history would be automatically created for the latter. This is also applicable to groups instead of individual people. When the time for loan repayment comes, the peer repays the borrowed sum, and the initial borrower returns the full sum to the investor. Thus, the reputation system becomes slowly digitalized and can help to create a provable history of creditworthiness for the peer to receive an official loan by herself. The concept is a general idea which would require a proper design, analysis and evaluation. Nevertheless, undoubtedly it would help broaden the reach of microloans.

The second complementary blockchain based solution which could be taken into consideration is the idea of blockchain-based property management. It is being discussed broadly in numerous circles, giving birth to several conceptual designs. Nevertheless, only three countries, Sweden, Honduras and Georgia have so far taken some concrete steps towards its employment (Rangaraju et al., 2017). The solution is very promising when considering the realm of microlending. Thanks to the immutable ledger for the property management, the establishment of the ownership would be much easier and more trustworthy. According to Kshetri (2017), in some developing areas, people often do not run the records to track ownership transitions, and even if that kind of proceedings take place, the records cannot be accessed or provide conflicting data. The legitimate

owners of a property do not have the means to prevent themselves from the infringements or thefts (Kshetri, 2017). Moreover, they cannot deliver any documentation proving the legitimacy of their possessions, thus no base for the collateral can be delivered, indisposing a potential loan. Blockchain-based property management would provide the “single version of truth”, giving the means to prove the property ownership, which could eventually lead to financial inclusion due to microlending. Rangaraju et al. (2017) propose a possible design of such blockchain-based proof of ownership. (Burrell, 2016) also supports this idea by mentioning the feature of timestamping. Considering the future development of our contribution by other researchers, the synchronizations of both networks (our solution and the “proof-of-ownership” blockchain) would be a very interesting and valuable study supporting our research.

Conclusion

"*Poverty is not only about income poverty, it is about the deprivation of economic and social rights, insecurity, discrimination, exclusion and powerlessness*" — Irene Khan, former Secretary-General of Amnesty International, 2010.

Although immense efforts towards poverty reduction and financial inclusion have been made by governments and businesses alike, poverty is still considered one of the most urgent of the Sustainable Development Goals defined by the United Nations[33]. Financial exclusion is often mentioned as one of the reasons for the continuing prevalence of poverty and its overbearing influence on disadvantaged groups (Salampasis & Mention, 2018). However, the current development of technology allows for an innovative approach to address familiar problems. Applications of blockchain in the field of microlending have been shown to pose great promise for increasing financial inclusion and contributing to poverty reduction. Thus, our work has acknowledged the challenges associated with providing financial inclusion to the underprivileged and presented a blockchain-based microlending solution for addressing them.

In this thesis, we have presented the conceptual design for a blockchain-based microlending solution with the purpose of increasing trust, transparency and auditability and contributing to the growing body of research dedicated to confronting issues related to financial inclusion and poverty. Our research primarily focused on rural parts of India and the social activity of Mukti, while also setting an emphasis on the generalizability of our findings to other regions.

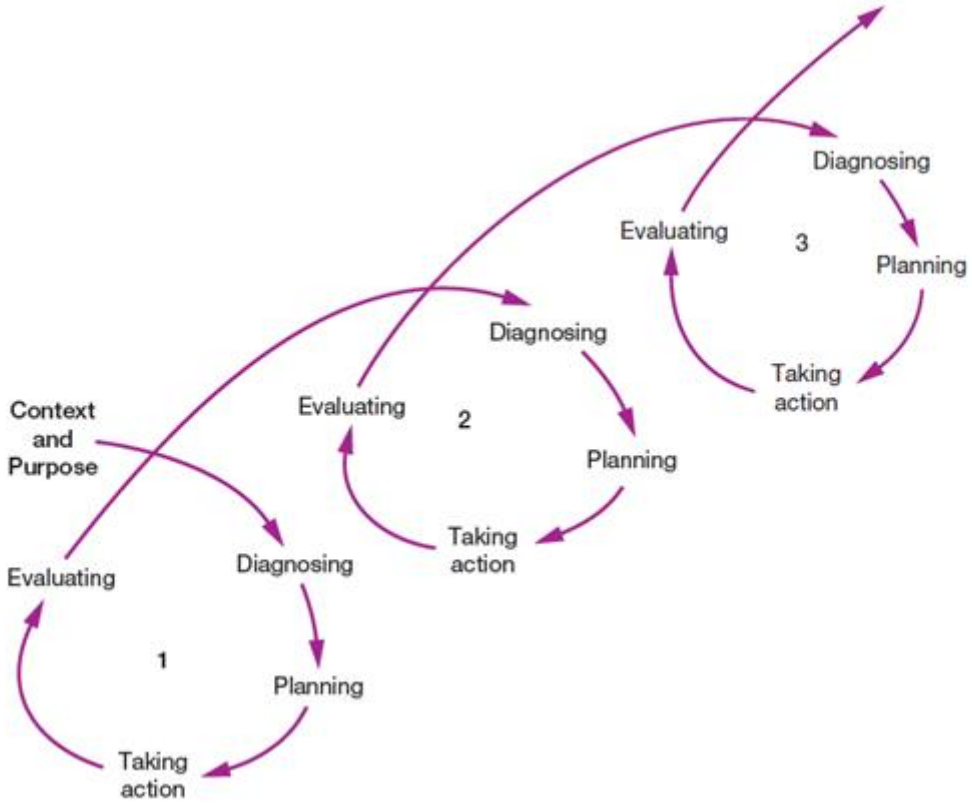
Through the use of several business administration and economic concepts such as information asymmetry and switching costs, we have proven that their successful application helps to analyze the ecosystem of the technology-enabled phenomena, while IT alignment supported the analysis of the internal organization of the social business. The combination of these fields may lead to significant mutual enhancements.

The blockchain technology is garnering increasing attention for the multiple benefits it can bring to developing communities, its opportunities reaching far beyond the sphere of microlending (Kshetri, 2017; Larios-Hernández, 2017). Having contributed to the field, we hope that such applications will amass increasing attention in the following years, leading to more thorough and widespread adoption of wide range of the technologies by social businesses and resulting in higher financial inclusion and fighting poverty.

[33] *https://www.un.org/sustainabledevelopment/*

Appendices

Appendix 1 - Action research spiral by Saunders at el. (2006)



Appendix 2 - Template of the questionnaire for the interview with Gora Sengupta

Interview with Gora Sengupta (Mukti) run by Agnieszka Turkiewicz & Silvana Marinescu from Copenhagen Business School.

No.	Category	Questions	Details
1	INTRODUCTORY QUESTIONS	What is your position in Mukti and what lies in the scope of your responsibilities? How would you describe the business activity of Mukti?	
2	INTRODUCTORY QUESTIONS	How would you describe the microfinance industry in India and worldwide?	
3	MICROFINANCING	Could you highlight major differences between profit oriented and non-profit oriented MFI? What are the major challenges in these two areas?	
4	MICROFINANCING	What were the key success factors for Mukti? What kind of critical resources were crucial ones (human, technology etc.) for Mukti's success?	
5	MICROFINANCING	What are the sources of financing in Mukti and do the company accept the deposits?	

6	MICROFINANCING	Would you consider Mukti an intermediary between investors and borrowers? Do you have any other source of revenue/ profit?	
7	MICROFINANCING	Do you think for-profit MFIs can be as useful and socially responsible as SBs?	
8	MICROFINANCING	In your own experience, what is/are the most crucial aspect(s) that need improvement in an MFI?	
9	MICROFINANCING	Could you please specify, if possible, at least one key challenge on the operational level and at least one on the strategic level?	
10	MICROFINANCING	What kind of challenges is Mukti facing now in terms of widening the concepts of microloans?	i.e. Trusted intermediary?
11	TECHNOLOGY & BLOCKCHAIN	How blockchain could help spread of microloans? What kind of problems could it solve?	
12	TECHNOLOGY & BLOCKCHAIN	What kind of challenges need to be handled in order to implement blockchain to microfinancing?	i.e. Lack of sufficient technology owned by borrowers?

13	TECHNOLOGY & BLOCKCHAIN	What kind of technology (hardware in particular) would have to be in place in order to enable blockchain solutions for MFI?	
14	TECHNOLOGY & BLOCKCHAIN	What kind of blockchain design would you find suitable for microloans in India? Which consensus mechanism, blockchain framework would be the most suitable in your opinion?	In relation to the paper *"Converging Blockchain and Social Business for Socio-Economic Development" by* R. Rao Mukkamala, R. Vatrapu, P. K. Ray, G. Sengupta & S. Halder
15	TECHNOLOGY & BLOCKCHAIN	Can you elaborate on the technical details of the blockchain solution?	Anonymity, scalability (no of blocks), permissioned/ permission-less, transparency, governance model of the blockchain
16	TECHNOLOGY & BLOCKCHAIN	What is your opinion about the introduction of the cryptocurrency for Social Businesses? What advantages and challenges would it bring?	

Backup questions

1	TECHNOLOGY & BLOCKCHAIN	Would there be any incentive system in place for the nodes to take part on the blockchain?	

Appendix 3 – Transcripts of the interviews (coded by two coders)

Coder 1:

Agnieszka Turkiewicz: we are writing master thesis with Raghava Rao Mukkamala in CBS. Im Agnieszka and Silvana. Since we have limited period of time we'll just go through the questions and of course if you have any questions for us, just go for it. We are totally open for conversation.

Gora Sengupta: ok, so I just want to know what the background of your work is, so that I can give it a proper perspective. And then I will also let you know what my perspective of this one is. Thanks a lot for sending a questionnaire, that really helps, so yeah you want to know from… are you doing some particular type of research or you are just doing a thesis or what is the …?

Agnieszka Turkiewicz: So, we are writing our master thesis and we are studying information systems and business administration, so basically our goal is to write a master thesis about the implementation of the blockchain to the social businesses especially in microfinancing. So basically we would like to focus (like about the how) on the industry of microfinancing and also blockchain solutions particularly for these settings.

Silvana Marinescu:yes

Gora Sengupta: ok, so just to make you aware that you know this particular paper that we wrote jointly, you made a reference to, this is actually, we use, we are the microfinancing company as such is not our main goal – our main goal is social development in certain needy areas and we use the microfinancing as a just a tool to do social development. So we are more inclined towards this, I can give you more information about this aspect than I can, because I am not a microfinancing sort of a prime expert on that, but I can tell you to which extend we use microfinancing for doing this social development. So I see you got a lot of questions on microfinancing, now just to let you know that we are, we use it only as a tool for, do you know, main goal, which is development of societies. Now so if I go to the first question there, what is your position in Mukti and what lies in the scope of your responsibilities? How would you describe a business activity of Mukti?

Ok, what I can do is I can share a screen with you correct?, and just to let you know what the overall activities of Mukti organization is and where I fit into it.

So, I just shared a screen with you, let me know if you don't receive the screen.

Agnieszka Turkiewicz:ok, perfect we have it.

Gora Sengupta: you've got the screen? Ok, is it large enough or just make it ..?

Silvana Marinescu: Maybe a little bit… now it is perfect.

Gora Sengupta: ok, so Mukti uses [...] 6 prong program which is called HEALER. Healer stands for "health" which includes health, water and sanitation, then education and empowerment, agriculture reforms, livelihood and economic security , environment and economy and rights to information and governance. So that's the 6 pronged Healer approach that Mukti provides for social development and where we fit in in microfinance and microloans and woman empowerment is in this area which is called livelihood and economic security, project MCDF, MCDF stands for Mukti Community Development Fund and that is the area I look after specifically MCDF program, which is reasonably large program but it is not a very large program. What we work on this scope of our work in our livelihood and economic security, project MCDF, encompasses currently about 50 villages and we have about 400 to 500 self help groups, each of these groups consists of about 10 to 12 women entrepreneurs, rural women entrepreneurs and we have about total membership of all 5000 women entrepreneurs that we regularly assist with providing them with the skills-based training to do what they want to do and then providing them with microcredit to run their micro businesses so the reason why we do it this way is that there have been some passages in our experience as well as that is been some past experience with the lights of Grameen bank in Bangladesh which was started off by a professor Muhammad Yunus, you may have heard of him, he is a Nobel laureate. So all that activity ensure that for the rural women it's a very low risk to provide them with the low capital which is micro loan and the rate of them/ the chances of them paying back the loan is very high so effectively the risk is lower so I am also because in the traditional setting the women look after their families it leads to an all-around sort of development of the society in that region where we built these systems.

So the first question is, that is where is basically fit in livelihood and economic security, in this MCDF.

So, the next question is about Describing the microfinance industry in India worldwide. I am not the person to consult for that as basically we use as I said we use the micro finance only the micro credit part of micro finance we don't have any other financial products so we can call our operation a micro credit operation and that's what we do and we use this microcredit only as a tool for the social development and if I combine the second and the third question "could you highlight major differences between profit oriented than non-profit oriented MFI? besides the interest what are the major challenges in these two areas?

Yeah, So simply it's more microcredit than micro finance and our operation is not profit driven at all so there is no online profits that the Board of Directors take home from this operation. So I guess if you ask me if you highlight the major differences between non-profit and for profit oriented MFIs, their policies, their operational policies and at strategic goals is what does the difference between the profit oriented and non-profit oriented.

Like our policies will clearly state that, you know things like that the interest level will be such that it is affordable in that region depending on the capacity, economic capacity of the women entrepreneurs there and it would also say that there is no part of that interest which will be coming into the Mukti organization as such because the interest that is paid is returned within the self-help groups which makes them, in effect after those collections are made, they become self-reliant with a fix time frame and that is aimed for two years. So when Mukti gives a loan to a woman entrepreneur, it is expected that she will repay that loan and become self-sufficient with two year time frame.

So that's the way we work. If anything I say requires clarification, just raise your hand and I clarify that

Agnieszka Turkiewicz & Silvana Marinescu: Thank you.

Gora Sengupta: So our old walls are not driven by profit but our boats are driven by the capability of being able to provide a sustainable service that means we don't want to put ourselves into a situation where we will not be able to provide any sustainable service this means that we have to watch our funding levels all the time, and if that funding level becomes too low then we cannot issue for the loans because we will not be able to sustain love the effect of that loan giving so that is that sort of thing. Now leaves us into what challenges we have

This is very definitely a challenge that the funds we have to operate with, they don't come to us very consistently because our funding is dependent entirely on the donors. So we rely on donors who keep us, keep our operation funded. So some of these donors are regular in the sense that they put a monthly amount or a six-monthly amount, but the other doors are worn off/ one off (?), so it is all this funding is all what we have to keep our operations going and if the one of donors don't necessarily come back again, or some of them may come back some of them may not, so this leads to inconsistency in the funding. And this is one of our major challenges.

And therefore, there is a fundraising aspect where we go out and try to attract donors. We hold programs, we hold information sessions and things like that which then maybe 100 people maybe 20 people will show some interest and start donating, so it's very important for us for the donors to trust us. because the doors are giving us money on the assumption that we will pass on that money to the eligible borrowers, who will use the funds for the purposes that they have told us that they will use it for and not for any other purpose.

Silvana Marinescu: I am sorry, can I interrupt shortly? Would you say that the donor's trust is the biggest issue while gathering funds? Like, that, because you said that the funds are not coming on a consistent basis, do you have 1 or 2 points, which you would say are the biggest impediments towards giving the money?

Gora Sengupta: Yes if there is any case in which the donor, against the perception that the money was not passed on to the borrower in time, or the borrower has not progressed sufficiently with that money in doing what they want are, yes there will be an impact on the amount of trust that the donor has on the organization and then that they may not come back or they may not decide to give a further donations. Now the way how we have to overcome that is we have to ensure that we are ourselves very timely in passing on the funds and we have to ensure that the borrower is an eligible borrower that means we have to verify that the borrower is saying what she is saying what she going to do with the money and if she is actually going to do that and she is using these funds for this purpose, not for anything else.

Now, the reason why I mentioned this point is that you must see the environment we operate in; we operate in a very tricky environment in which we are dealing with a lot of poor people.

And their environment is very hard in the sense that the Sundarban area where we do this work.

Have you heard of the Sundarban area?

Agnieszka Turkiewicz & Silvana Marinescu: Yes

Gora Sengupta: Sundarban is UNESCO world heritage, is the largest man growth slumps in the entire world and there are floods and there are cyclones and there are problems of health and disease and in that sort of environment a family is very vulnerable. So they might they might have a shed or a hut in which they live but this hut is blown away by a cyclone and cyclones are very frequent in that area of the word. So, you know the money that is given for a specific purpose,

in case of some kind of emergency there is a high likelihood of that money being spent, you know, for a more basic purpose, like for an emergency. No, that is not something new which we want to prevent or which we would like to prevent specifically because that money was allocated for business but we have to understand that the field in which we operate and the plate(?) of the people there as well, because we are mainly at the social development organization. So when that sort of thing happens we have to take extra set of steps to alert the donor that "look here, this place was affected by it by an emergency like this like one or a flood and the funds that you have donated may not have been, you know, the borrower might not be able to use these funds for the business purpose that she took it, and it was used for a temporary relief, are you ok with that or are you not ok with that? If you're not ok with than we have to return you the money".

So we have to be very frank and upright with the donor and report very regularly to the donor. Otherwise, over a period of time, the whole system doesn't, you know, doesn't function in the way it was intended. So we've got basically, among the challenges, what I mentioned here, was we have to look at 360° in this kind of

situation. The risk come from all angles and we've got to see how best we can match those impacts of those risks with what is actually happening in the micro business and what is happening to their microcredit.

The other challenges are a local infrastructure, local infrastructure that is nowhere near what we are used to. It's a village area, it's an area where there are a lot of small islands and the sea comes and basically it is salty water. The drinking water is not safe so the local infrastructure like in terms of communications. Well there are mobile phones and electricity has just reached, maybe six months ago, but the mobile phone, it's not something that someone can easily use a smart phone, where there was lots of data. We cannot do that, it is 2G connections and in some places 3G and if you're lucky 4G is slowly coming but it's sort of smart phones operates somewhere between 2G and 3 G. Affordable technology, if we suddenly say we want only the women entrepreneurs that are working there to have smart phones and we put block chain on that and then start working, it won't happen like that. Because they can't afford smart phones at the moment.

The other challenge, sort of indirect challenge, is size. Now Mukti doesn't have the depth, this size level which allows us to going to large scale funding like a Go For You and Development Program or World Bank or International Monetary Fund. All those very large organizations, funding organizations to get funding from them you have to reach a certain critical mass, a certain level, certain size, we are not in that size, we are about 75% of that size, but we are targeting to reach that size. Therefore till the time we reach the critical mass, we cannot attract a lot of funding which allows us to freely implement the technology that we need, so that also is a challenge.

A: and do you think, maybe it will be quite a jump, but it is just as a side note, do you think that somewhere in this particular domain there is a place for blockchain? At some point at least, or maybe in some kind of different settings? In general, is there any place for blockchain per se?

Yes there is actually. The way you know when we when we worked on that paper, one of the things is we will try to see the way how we best can implement blockchain solution. So one of the questions I think I saw somewhere, it leads to the lack of sufficient technology owned by borrowers. We can have some temporary workarounds to that problem in that where the Mukti structure is, let me share another screen with you.

So this is the model diagram of Mukti. As you see on the right there are SHG1, SHG 2, so those are self-help groups, each self-help group consists of between 10 and 12 of women.

Now, they all report into something called a branch, so each branch should have up to 150 SHGs reporting to them. So we can maybe share of the cost of the smart phone inside the SHG so 10-12 women together, they operate the smart phone from one self-help group, which then allows them to go into a blockchain system which the rest of the people use , or in the worst case a MCDF branch would have a node, which is a blockchain more [...] that the SHG step in through that.

So we are sort of, I know that we are diluting the system, in a sense that when one of these investors, these are groups of social investors, when one of these investors want to transfer a digital asset, from one of these borrowers, Directly but that will not happen in that fashion because it will go basically to a node which is shared. But then yes, it is the training we have to give SHG to do that amount of the local service given the fact that each may be too expensive for each person to buy a the smartphone or buy a smartphone.

Agnieszka Turkiewicz: So in this particular case, if we assume that in these SHG groups we have, each SHG group is a node, so at the end of the day, what kind advantage die it have to implement blockchain to this setting? Because, the only thing we are doing is crossing out these 4 parties in between.

Gora Sengupta: yes, so what it means, the investor does not need to put so much trust into Mukti. It can work directly with the SHG. So now what happening is, the investor is placing the trust in Mukti, in order to be able to pass on this money in the timely manner to the borrower directly. The putting the blockchain will eliminate Mukti from that, maybe not 100%, maybe only 70% but still it is a good amount of change.

Agnieszka Turkiewicz: but also it would leave Mukti this task to validate the borrowers, wouldn't it?

Gora Sengupta: Absolutely, yes. So Mukti, currently what it does is, before admitting any person to SHG there is a validation which is done. And the next level of validation is when there is application for a loan. At that time also another validation is done whether the loan is justified whether the items information declared in the loan application form are correct or they are not correct. Or perhaps, a particular borrower already has outstanding loans to her credit and then we don't give multiple loans to single borrower, because the government regulation doesn't allow that.

Agnieszka Turkiewicz: IT was a side note about the blockchain.

Gora Sengupta: we are discussing challenges and in some cases government regulations are also a challenge. You know, a very simple example, I am not talking about Mukti, but some countries may block some applications – for example China is blocking Facebook and Whatsapp etc, so that is just an example when governments must allow specific applications to be available on the internet service. Now, remember that we rely a lot on the donors from outside of India, and in general case SMG may be in one country, but the majority of the donors may be in another country. So it is a question of international transactions and these international transactions fall into the scope of governmental regulations. And that is another challenge. We always need to be careful that we are not violating any regulations in the country of the operation.

Agnieszka Turkiewicz: but then, maybe I am focusing a lot on this blockchain, but its like taking into consideration that the majority of donors is international and the borrowers are from India, also the blockchain here would significantly increase this trust to this intermediary, because there would be no intermediary, there

would be simply a technology because if we have investors from country A and borrowers from country B, the investors would not be so willing to invest and give money to intermediary from country B.

Gora Sengupta: Absolutely.

Agnieszka Turkiewicz: So that also would be an advantage of the blockchain solution in this particular setting.

Gora Sengupta: Yes, yes, largely remote, but not totally remote but they still have to vet because they are very close to the ground reality and they can assess the borrowers much better than any agency can. Even banks, in these regions there is not many banking services, so in turn the banks don't go on too much into these regions because they don't have local access. They don't understand the local situation that well as some organization like Mukti. So yeah that's a strong point for Mukti or any similar NGO and donors and other interested stakeholders who like that sort of service from an organization which is very close to the ground reality.

Agnieszka Turkiewicz: Okay, so we have challenges. What are the key success factors for Mukti? What kind of critical resources are crucial (human, technology) for Mukti's success. I think it's a quite broad question...

Gora Sengupta: Yes it's a broad question but, for Mukti, the critical success factors/key success factors, we call it the vital fuel, because we have very few, but reasonably experienced and good people with the correct attitude (?) for such type of service. So it's very important for us to grow that vital fuel which means we are governed and operated mainly by some thinker volunteers that are widespread across the world and also in India. So we have the vital fuel, people, ahem the non-profit attitude towards social development, that's a very critical success… critical factor. We have access to the deep interior regions where we operate and good knowledge and understanding of the environment. The ability to communicate with the, with the ground, you know with the persons there is a very important factor because all the organizational training is required when they form the self-help groups. You know those 10-12 rural women, you know someone is a president, someone is a secretary, someone is a treasurer, and they should be able to counsel also at times a group that they are in. So it involves a little bit of management kind of training, so the ability to communicate is important. Then, improvements in networks and information technology certainly allows us to expand our services. So these are all critical resources and success factors. Hmm is there anything else, I'm just trying to remember. Yeah one of the success factors that comes to mind is we have to understand their problems and work jointly on a solution. It's not that we understand their problem and just offer them a solution and then go away. Because many times that solution does not work because we do not understand fully because we are not part of the environment. So I'm based in Sydney and I'm offering a solution to an SHG which is based in the Sunderbans villages, I can't provide them 100% solution, right? I have to work on that solution jointly with them, and stick enough time so that they are removed of their problem. Then I take my learnings and they

take their learnings. So this has to be the solution, strategy has to be there. And that is the only way that solutions will be a success. So that is another crucial factor.

Silvana Marinescu: And, I'm sorry, do you have local sort of branches in all the regions where Mukti operates, or how do you recruit volunteers and workers who actually are in contact with the beneficiaries or the people that profit from the Mukti services?

Gora Sengupta: Yes that's actually a good question and there is obviously a lot of difficulty with that aspect. We generally go for places, we already have an existing base of SHGs and we take guidance from them as well. So we have a person in the role of, we just call that role 'friend', we call that MCDF friend. And it's the person who gives us leads on where we might be able to successfully enlist more people and form new SHGs. So the job of the friend is to form SHGs in a specific area where we think we will be able to operate. So it is a very important aspect and we have to incentivize the friends based on the number of SHGs that they can form within a prescribed period of time.

Agnieszka Turkiewicz: Ok, and what are sources of financing in Mukti and does the company accept deposits?

Gora Sengupta: So, financing yes, but deposits no. We are not, the regulation does not permit us to accept public deposits. And that is a regulation in India. Only designated non-banking financial companies can accept deposits from the public. So we are not in that category, Mukti is a trust and as such cannot accept deposits. The only thing we can accept is donor funds, funds that are donated. And the relationship with the donor is that we take the money for a period of two years and the terms is interest free. The donor does not charge us interest and the agreement with the donor is that that money given is for a period of 2 years. And at the end of the two year period we again request the donor whether they want their money to be paid back to them or if they want to reinvest the money in another borrower. And we have seen that in 90% of the cases they don't want the money back, they just want to reinvest it with another borrower. And the borrower and the terms are, you become, if you take a loan you pay back in 2 years and then you become, within that, you target to become self-reliant. So that money can be passed on to another…

Silvana Marinescu: I just wanted to ask, do you have any concrete numbers as to how many of the loans lead to long-term self-sufficiency?

Gora Sengupta: How many of the loans lead to long term self-sufficiency. Yes we have a monitoring system in place, and with that trigger every branch is not the same. There are branches which are doing very well and some branches which are not doing so well, so we will estimate maybe something around 60% would be able to be self-reliant in 2 years. But maybe around 80% or 85% become self-reliant in 3 years or so. That's the reason why we keep requiring more and more funds. Because everybody, their performance level is different.

Agnieszka Turkiewicz: And for example, just speaking of these figures and numbers, could you somehow estimate what was the amount, or the annual amount, of funds gathered by Mukti?

Gora Sengupta: Ah yes, I don't have that off the shelf, but I can give you an indication. I need some time for that.

Agnieszka Turkiewicz: Of course, no worries, we can figure it out later. It just popped into my mind, it would be very nice if you could provide this information, but it can be absolutely later, no problem. And, I think question no.6 was kind of answered already, whether you consider Mukti an intermediary between investors and borrowers. And do you have any other source of revenue, you mentioned that there is no revenue because Mukti is a non-profit so that leaves that question out.

Gora Sengupta: Another thing which I might add to that is you remember this diagram that I shared some time back and that MCDF is this category of livelihood, now sometimes when the, this is regarding the question on source of funds for the MCDF project. Sometimes, when we run short, there are some major projects in these other areas, if there is money that they can provide, then they provide that to MCDF. So that is also another sort of internal sourcing, that major programs within all these areas, they sort of look after each other in terms of funding.

Silvana: Yes so, in your experience, what would be the crucial parts of a social business, or in this case more specifically of Mukti, that need improvement? Is there, are there any areas where you know there is a possibility of improving processes or, yeah, making the business better?

Gora Sengupta: It actually depends on its strategic goals. Each organization will probably be different, so the crucial aspects that would need improvement would also be different depending on the strategic goals. In general in [...] is better knowledge of the field where it's, where our borrowers operate requires improvement. Because it is quite difficult to gather that information from the field on a sustained basis. For example, that particular place as I said, the seawater comes deep into the land through these various creeks and passageways, and the soil becomes salty. Now there is a lot of impact when the soil becomes salty, the ground water becomes salty as well and the drinking water becomes sort of, it could lead to disease, it could lead to loss of pregnancy, it could lead to all kinds of complications. So, suppose you have made a plan to do something in that area and then the salty water is not allowing us to do that. You know some plants don't grow in salty water at all. So if the plan was for the borrower to grow and cultivate those particular types of crops, then he's going to go in for disaster. So we don't have that kind of detailed knowledge, or what may be available in more developed places, which gives us a better knowledge and understanding and, so we would have to guide the people appropriately. Or even the poorer appropriately. So, better knowledge of the fields is required. And, of course, better communication and understanding within the industry sector. So, by that I mean there may be other NGOs that operate in that area. There may be other government parties that operate in that area. So there has to be a bit of understanding and information sharing between these agencies which may lead to a better outcome for everyone. So we don't currently have that sorted out. So, you know, work needs to be

done. Even the things like maintaining compliance with regulations, for instance the Indian government regulation is that a borrower cannot take loans from us, as well as another NGO. How do you monitor such things, unless you have a shared database or something like that? So the reason is understandable because if the borrower, if a poor borrower borrows too much money, then she may not be able to return that. Because her earning capability is not there. But how do you monitor if someone comes to Mukti and asks for a loan, and we vet, and we find that it seems to be fine. We don't necessarily know that she'd borrowed from other NGOs. So that kind of knowledge sharing is probably an area of improvement.

Agnieszka Turkiewicz: That's actually a very good point. Shall we, we kind of went through question number 9 so I think it's quite sufficient.

Silvana Marinescu: Yes, for nine I think yes. But maybe 10. So, is it a goal for Mukti to grow the number of borrowers in this Microfinance part, or do you have a cap of people that you are able to serve at one time due to human resource constraints or other factors?

Gora Sengupta: Yes, it is our plan to grow. And we would like to grow and reach that critical mass that I mentioned some time back so that we can attract funding from major development funds. Right now we are quite small, and we would like to expand our social development portfolio so that a better service and more additional development can be done. So, yes, very definitely it's our goal to increase the number of borrowers. Because, after all, people are becoming self-reliant within a 2 year timespan, which means that families are being lifted out of poverty, which is quite a big thing for something like that to happen in that region of the world. I see that the question continues and says 'What challenges is Mukti facing now in terms of growing the number of borrowers?'. Challenges are quite, quite a lot. You can grow something probably if you can analyze the existing state and month to month you can track everything, but there are quite a few problems in doing that. You know, natural calamities is something that I mentioned. There are political issues from time to time. Then, some SHGs, because of some issues, certainly close. Not many, but there are some. And we would like to understand the reasons why the SHG closes and how we could prevent that. So, these reasons are often complex. They may not be obvious. Unless we go very deep into it, we may not understand why the SHG closed. Sometimes the members don't go along well with each other, and they could close because of some incident. But if we understand those things properly and if we analyze them, then we will be able to create situations or have administrative help in time so that SHG doesn't close. Quantitative analysis of branch performance, of poor branch performance, is also something which we are working on. We already have some 7 or 8 parameters which we are able to measure a branches' performance. But we are working on that, it's something which is an area of interest and additional work for us. So the goal for that is we should be able to detect a branches' performance. Yes?

Agnieszka Turkiewicz: I just wanted to ask just a very small question, just for the record for clarification, SHG groups, of course there are groups of borrowers who get the money for their own, let's say, purposes, but do they cooperate anyhow together? Because if, like you said, an SHG group breaks down, we want to prevent it. What kind of cooperation is between the participants of the given group?

Gora Sengupta: Good question. They do not work together in the sense of running the business. Each person runs their own micro-business. But what they do is, the nature of the SHG is when one person takes a loan, the group as a whole is responsible for repaying the loan. [We create an area for] discussion and cooperation between them, and also at the monthly meetings they interact and discuss various things like what should be done [and other things like that]. So I think we are, I don't have a lot of time unfortunately, maybe 9 minutes or so.

Agnieszka Turkiewicz: Sure, we'll speed up.

Gora Sengupta: What is the priority, where do you want to go?

Agnieszka Turkiewicz: About blockchain, we said that blockchain could help in the sense that, to increase the trust between the donors, and let's say this intermediary which would be crossed out in terms of money, in terms of transfer of funds. That would be an advantage of the blockchain. Would you indicate any other advantage of the blockchain in this setting?

Gora Sengupta: Ahemm… quite a few advantages. Trust is of course one of them, the main one. But then if you see our paper, we have listed a few in there. So, compliance, auditability, visibility of transactions, you know all the standard […]. Those are definitely, and besides, the other thing is, some of the donors, maybe some of the large donors, they often donate anonymously. Because they don't want the name to be known for privacy reasons. So this allows for that anonymity.

Agnieszka Turkiewicz: So basically we also said that the challenge for implementation of blockchain is definitely the hardware. So the solution for it somehow would be this, let's say collective smartphone for a given group but it still would be represented as one node. So that would be a tricky part which has to be taken into consideration definitely.

Gora Sengupta: Yes, yes. And, of course, availability of proper network infrastructure.

Agnieszka Turkiewicz: Okay, what kind of blockchain design would you find suitable for microloans? So basically certainly it wouldn't be open blockchain, it wouldn't be public blockchain.

Gora Sengupta: No, a private permissioned blockchain. It could be this PBFT type of, with known block validators. Simple BFT with known block validators. And we also have proof of authority. And Multichain is the one we used while doing the paper. We could also do Chaincore and other blockchain platforms like that. The thing is, we have to transfer digital assets with the social business performing the role of digital currency exchange. Because we have not talked about doing a cryptocurrency. And, certainly it could be done, it's a

new area for us and we are also trying to understand whether the native cryptocurrency will have any benefits. But for the moment, in the initial first phase we would like to transfer digital assets. That is another idea where Mukti has a role at the moment, but it's just the operation is not large enough to warrant cryptocurrency as such. There are other complications like some regulation aspects also come into play. So, the consensus will be provided by some nominated nodes. And those nodes can very well be with some of the large donors or willing donors like volunteers in the donor space. Because the number of transactions is only very few. They are crucial to the sustainability of the organization, but the number of transactions in terms of, you know if you compare it with a banking institution etc. it's very low. Or even something like Ethereum or Bitcoin or Onecoin or any one of those, the number of transactions here will be very low.

Agnieszka Turkiewicz: I just wanted to clarify that, so basically for the validation the biggest donors would be responsible. And hence it would be proof of authority, and at some point it could be forced kind of proof of stake if designed in that way. Because most likely they will be holding the biggest stake. Okay, I think questions number 15 and 16, 15 we can skip because we kind of talked about it in between and it's very generic at some point. And 16 you also answered because you said that you wouldn't go for any cryptocurrencies per se.

Gora Sengupta: We're trying to understand if cryptocurrencies will benefit in any way. We could have a native cryptocurrency, but then again where is the cash exchange because the borrowers will need, you know, solid funds, so they are not in a position to use cryptocurrency directly. If we have to understand what are the benefits of a cryptocurrency.

Agnieszka Turkiewicz: Okay, Gora Sengupta we don't want to take any more of the time that you devoted to us, because we have two minutes left.

Gora Sengupta: Feel free if you want to catch up for a quick, some time later, for another call, as your work progresses, feel free to send me an email and we can talk.

Both: Thank you very much.

Agnieszka Turkiewicz: And thank you very much for this Skype, it was very helpful and informative. A lot of insights

Gora Sengupta: Of course. I wish you all the best for your master's.

Agnieszka Turkiewicz: And just one more thing, we should have saif it at the very beginning, but for the sake of the master's thesis we recorded this interview.

Gora Sengupta: Yeah no problem.

Coder 2:

Agnieszka Turkiewicz: we are writing master thesis with Raghava Rao Mukkamala in CBS. Im Agnieszka and Silvana. Since we have limited period of time we'll just go through the questions and of course if you have any questions for us, just go for it. We are totally open for conversation.

Gora Sengupta: ok, so I just want to know what the background of your work is, so that I can give it a proper perspective. And then I will also let you know what my perspective of this one is. Thanks a lot for sending a questionnaire, that really helps, so yeah you want to know from… are you doing some particular type of research or you are just doing a thesis or what is the …?

Agnieszka Turkiewicz: So, we are writing our master thesis and we are studying information systems and business administration, so basically our goal is to write a master thesis about the implementation of the blockchain to the social businesses especially in microfinancing. So basically we would like to focus (like about the how) on the industry of microfinancing and also blockchain solutions particularly for these settings.

Silvana Marinescu:yes

Gora Sengupta: ok, so just to make you aware that you know this particular paper that we wrote jointly, you made a reference to, this is actually, we use, we are the microfinancing company as such is not our main goal – our main goal is social development in certain needy areas and we use the microfinancing as a just a tool to do social development. So we are more inclined towards this, I can give you more information about this aspect than I can, because I am not a microfinancing sort of a prime expert on that, but I can tell you to which extend we use microfinancing for doing this social development. So I see you got a lot of questions on microfinancing, now just to let you know that we are, we use it only as a tool for, do you know, main goal, which is development of societies. Now so if I go to the first question there, what is your position in Mukti and what lies in the scope of your responsibilities? How would you describe a business activity of Mukti?

Ok, what I can do is I can share a screen with you correct?, and just to let you know what the overall activities of Mukti organization is and where I fit into it.

So, I just shared a screen with you, let me know if you don't receive the screen.

Agnieszka Turkiewicz:ok, perfect we have it.

Gora Sengupta: you've got the screen? Ok, is it large enough or just make it ..?

Silvana Marinescu: Maybe a little bit… now it is perfect.

Gora Sengupta: ok, so Mukti uses [...] 6 prong program which is called HEALER. Healer stands for "health" which includes health, water and sanitation, then education and empowerment, agriculture reforms, livelihood and economic security , environment and economy and rights to information and governance. So that's the 6 pronged Healer approach that Mukti provides for social development and where we fit in in microfinance and microloans and woman empowerment is in this area which is called livelihood and economic

security, project MCDF, MCDF stands for Mukti Community Development Fund and that is the area I look after specifically MCDF program, which is reasonably large program but it is not a very large program. What we work on this scope of our work in our livelihood and economic security, project MCDF, encompasses currently about 50 villages and we have about 400 to 500 self help groups, each of these groups consists of about 10 to 12 women entrepreneurs, rural women entrepreneurs and we have about total membership of all 5000 women entrepreneurs that we regularly assist with providing them with the skills-based training to do what they want to do and then providing them with microcredit to run their micro businesses so the reason why we do it this way is that there have been some passages in our experience as well as that is been some past experience with the lights of Grameen bank in Bangladesh which was started off by a professor Muhammad Yunus, you may have heard of him, he is a Nobel laureate. So all that activity ensure that for the rural women it's a very low risk to provide them with the low capital which is micro loan and the rate of them/ the chances of them paying back the loan is very high so effectively the risk is lower so I am also because in the traditional setting the women look after their families it leads to an all-around sort of development of the society in that region where we built these systems.

So the first question is, that is where is basically fit in livelihood and economic security, in this MCDF.

So, the next question is about Describing the microfinance industry in India worldwide. I am not the person to consult for that as basically we use as I said we use the micro finance only the micro credit part of micro finance we don't have any other financial products so we can call our operation a micro credit operation and that's what we do and we use this microcredit only as a tool for the social development and if I combine the second and the third question "could you highlight major differences between profit oriented than non-profit oriented MFI? besides the interest what are the major challenges in these two areas?

Yeah, So simply it's more microcredit than micro finance and our operation is not profit driven at all so there is no online profits that the Board of Directors take home from this operation. So I guess if you ask me if you highlight the major differences between non-profit and for profit oriented MFIs, their policies, their operational policies and at strategic goals is what does the difference between the profit oriented and non-profit oriented.

Like our policies will clearly state that, you know things like that the interest level will be such that it is affordable in that region depending on the capacity, economic capacity of the women entrepreneurs there and it would also say that there is no part of that interest which will be coming into the Mukti organization as such because the interest that is paid is returned within the self-help groups which makes them, in effect after those collections are made, they become self-reliant with a fix time frame and that is aimed for two years. So when Mukti gives a loan to a woman entrepreneur, it is expected that she will repay that loan and become self-sufficient with two year time frame.

So that's the way we work. If anything I say requires clarification, just raise your hand and I clarify that.

Agnieszka Turkiewicz & Silvana Marinescu: Thank you.

Gora Sengupta: So our old walls are not driven by profit but our boats are driven by the capability of being able to provide a sustainable service that means we don't want to put ourselves into a situation where we will not be able to provide any sustainable service this means that we have to watch our funding levels all the time, and if that funding level becomes too low then we cannot issue for the loans because we will not be able to sustain love the effect of that loan giving so that is that sort of thing. Now leaves us into what challenges we have

This is very definitely a challenge that the funds we have to operate with, they don't come to us very consistently because our funding is dependent entirely on the donors. So we rely on donors who keep us, keep our operation funded. So some of these donors are regular in the sense that they put a monthly amount or a six-monthly amount, but the other doors are worn off/ one off (?), so it is all this funding is all what we have to keep our operations going and if the one of donors don't necessarily come back again, or some of them may come back some of them may not, so this leads to inconsistency in the funding. And this is one of our major challenges.

And therefore, there is a fundraising aspect where we go out and try to attract donors. We hold programs, we hold information sessions and things like that which then maybe 100 people maybe 20 people will show some interest and start donating, so it's very important for us for the donors to trust us. because the doors are giving us money on the assumption that we will pass on that money to the eligible borrowers, who will use the funds for the purposes that they have told us that they will use it for and not for any other purpose.

Silvana Marinescu: I am sorry, can I interrupt shortly? Would you say that the donor's trust is the biggest issue while gathering funds? Like, that, because you said that the funds are not coming on a consistent basis, do you have 1 or 2 points, which you would say are the biggest impediments towards giving the money?

Gora Sengupta: Yes if there is any case in which the donor, against the perception that the money was not passed on to the borrower in time, or the borrower has not progressed sufficiently with that money in doing what they want are, yes there will be an impact on the amount of trust that the donor has on the organization and then that they may not come back or they may not decide to give a further donations. Now the way how we have to overcome that is we have to ensure that we are ourselves very timely in passing on the funds and we have to ensure that the borrower is an eligible borrower that means we have to verify that the borrower is saying what she is saying what she going to do with the money and if she is actually going to do that and she is using these funds for this purpose, not for anything else.

Now, the reason why I mentioned this point is that you must see the environment we operate in; we operate in a very tricky environment in which we are dealing with a lot of poor people.

And their environment is very hard in the sense that the Sundarban area where we do this work.

Have you heard of the Sundarban area?

Agnieszka Turkiewicz & Silvana Marinescu: Yes

Gora Sengupta: Sundarban is UNESCO world heritage, is the largest man growth slumps in the entire world and there are floods and there are cyclones and there are problems of health and disease and in that sort of environment a family is very vulnerable. So they might they might have a shed or a hut in which they live but this hut is blown away by a cyclone and cyclones are very frequent in that area of the word. So, you know the money that is given for a specific purpose,

in case of some kind of emergency there is a high likelihood of that money being spent, you know, for a more basic purpose, like for an emergency. No, that is not something new which we want to prevent or which we would like to prevent specifically because that money was allocated for business but we have to understand that the field in which we operate and the plate(?) of the people there as well, because we are mainly at the social development organization. So when that sort of thing happens we have to take extra set of steps to alert the donor that "look here, this place was affected by it by an emergency like this like one or a flood and the funds that you have donated may not have been, you know, the borrower might not be able to use these funds for the business purpose that she took it, and it was used for a temporary relief, are you ok with that or are you not ok with that? If you're not ok with than we have to return you the money".

So we have to be very frank and upright with the donor and report very regularly to the donor. Otherwise, over a period of time, the whole system doesn't, you know, doesn't function in the way it was intended. So we've got basically, among the challenges, what I mentioned here, was we have to look at 360° in this kind of situation. The risk come from all angles and we've got to see how best we can match those impacts of those risks with what is actually happening in the micro business and what is happening to their microcredit.

The other challenges are a local infrastructure, local infrastructure that is nowhere near what we are used to. It's a village area, it's an area where there are a lot of small islands and the sea comes and basically it is salty water. The drinking water is not safe so the local infrastructure like in terms of communications. Well there are mobile phones and electricity has just reached, maybe six months ago, but the mobile phone, it's not something that someone can easily use a smart phone, where there was lots of data. We cannot do that, it is 2G connections and in some places 3G and if you're lucky 4G is slowly coming but it's sort of smart phones operates somewhere between 2G and 3 G. Affordable technology, if we suddenly say we want only the women

entrepreneurs that are working there to have smart phones and we put block chain on that and then start working, it won't happen like that. Because they can't afford smart phones at the moment.

The other challenge, sort of indirect challenge, is size. Now Mukti doesn't have the depth, this size level which allows us to going to large scale funding like a Go For You and Development Program or World Bank or International Monetary Fund. All those very large organizations, funding organizations to get funding from them you have to reach a certain critical mass, a certain level, certain size, we are not in that size, we are about 75% of that size, but we are targeting to reach that size. Therefore till the time we reach the critical mass, we cannot attract a lot of funding which allows us to freely implement the technology that we need, so that also is a challenge.

A: and do you think, maybe it will be quite a jump, but it is just as a side note, do you think that somewhere in this particular domain there is a place for blockchain? At some point at least, or maybe in some kind of different settings? In general, is there any place for blockchain per se?

Yes there is actually. The way you know when we when we worked on that paper, one of the things is we will try to see the way how we best can implement blockchain solution. So one of the questions I think I saw somewhere, it leads to the lack of sufficient technology owned by borrowers. We can have some temporary workarounds to that problem in that where the Mukti structure is, let me share another screen with you.

So this is the model diagram of Mukti. As you see on the right there are SHG1, SHG 2, so those are self-help groups, each self-help group consists of between 10 and 12 of women.

Now, they all report into something called a branch, so each branch should have up to 150 SHGs reporting to them. So we can maybe share of the cost of the smart phone inside the SHG so 10-12 women together, they operate the smart phone from one self-help group, which then allows them to go into a blockchain system which the rest of the people use , or in the worst case a MCDF branch would have a node, which is a blockchain more [...] that the SHG step in through that.

So we are sort of, I know that we are diluting the system, in a sense that when one of these investors, these are groups of social investors, when one of these investors want to transfer a digital asset, from one of these borrowers, Directly but that will not happen in that fashion because it will go basically to a node which is shared. But then yes, it is the training we have to give SHG to do that amount of the local service given the fact that each may be too expensive for each person to buy a the smartphone or buy a smartphone.

Agnieszka Turkiewicz: So in this particular case, if we assume that in these SHG groups we have, each SHG group is a node, so at the end of the day, what kind advantage die it have to implement blockchain to this setting? Because, the only thing we are doing is crossing out these 4 parties in between.

Gora Sengupta: yes, so what it means, the investor does not need to put so much trust into Mukti. It can work directly with the SHG. So now what happening is, the investor is placing the trust in Mukti, in order to be able to pass on this money in the timely manner to the borrower directly. The putting the blockchain will eliminate Mukti from that, maybe not 100%, maybe only 70% but still it is a good amount of change.

Agnieszka Turkiewicz: but also it would leave Mukti this task to validate the borrowers, wouldn't it?

Gora Sengupta: Absolutely, yes. So Mukti, currently what it does is, before admitting any person to SHG there is a validation which is done. And the next level of validation is when there is application for a loan. At that time also another validation is done whether the loan is justified whether the items information declared in the loan application form are correct or they are not correct. Or perhaps, a particular borrower already has outstanding loans to her credit and then we don't give multiple loans to single borrower, because the government regulation doesn't allow that.

Agnieszka Turkiewicz: IT was a side note about the blockchain.

Gora Sengupta: we are discussing challenges and in some cases government regulations are also a challenge. You know, a very simple example, I am not talking about Mukti, but some countries may block some applications – for example China is blocking Facebook and Whatsapp etc, so that is just an example when governments must allow specific applications to be available on the internet service. Now, remember that we rely a lot on the donors from outside of India, and in general case SMG may be in one country, but the majority of the donors may be in another country. So it is a question of international transactions and these international transactions fall into the scope of governmental regulations. And that is another challenge. We always need to be careful that we are not violating any regulations in the country of the operation.

Agnieszka Turkiewicz: but then, maybe I am focusing a lot on this blockchain, but its like taking into consideration that the majority of donors is international and the borrowers are from India, also the blockchain here would significantly increase this trust to this intermediary, because there would be no intermediary, there would be simply a technology because if we have investors from country A and borrowers from country B, the investors would not be so willing to invest and give money to intermediary from country B.

Gora Sengupta: Absolutely.

Agnieszka Turkiewicz: So that also would be an advantage of the blockchain solution in this particular setting.

Gora Sengupta: Yes, yes, largely remote, but not totally remote but they still have to vet because they are very close to the ground reality and they can assess the borrowers much better than any agency can. Even banks, in these regions there is not many banking services, so in turn the banks don't go on too much into these regions because they don't have local access. They don't understand the local situation that well as some organization like Mukti. So yeah that's a strong point for Mukti or any similar NGO and donors and other

interested stakeholders who like that sort of service from an organization which is very close to the ground reality.

Agnieszka Turkiewicz: Okay, so we have challenges. What are the key success factors for Mukti? What kind of critical resources are crucial (human, technology) for Mukti's success. I think it's a quite broad question...

Gora Sengupta: Yes it's a broad question but, for Mukti, the critical success factors/key success factors, we call it the vital fuel, because we have very few, but reasonably experienced and good people with the correct attitude (?) for such type of service. So it's very important for us to grow that vital fuel which means we are governed and operated mainly by some thinker volunteers that are widespread across the world and also in India. So we have the vital fuel, people, ahem the non-profit attitude towards social development, that's a very critical success… critical factor. We have access to the deep interior regions where we operate and good knowledge and understanding of the environment. The ability to communicate with the, with the ground, you know with the persons there is a very important factor because all the organizational training is required when they form the self-help groups. You know those 10-12 rural women, you know someone is a president, someone is a secretary, someone is a treasurer, and they should be able to counsel also at times a group that they are in. So it involves a little bit of management kind of training, so the ability to communicate is important. Then, improvements in networks and information technology certainly allows us to expand our services. So these are all critical resources and success factors. Hmm is there anything else, I'm just trying to remember. Yeah one of the success factors that comes to mind is we have to understand their problems and work jointly on a solution. It's not that we understand their problem and just offer them a solution and then go away. Because many times that solution does not work because we do not understand fully because we are not part of the environment. So I'm based in Sydney and I'm offering a solution to an SHG which is based in the Sunderbans villages, I can't provide them 100% solution, right? I have to work on that solution jointly with them, and stick enough time so that they are removed of their problem. Then I take my learnings and they take their learnings. So this has to be the solution, strategy has to be there. And that is the only way that solutions will be a success. So that is another crucial factor.

Silvana Marinescu: And, I'm sorry, do you have local sort of branches in all the regions where Mukti operates, or how do you recruit volunteers and workers who actually are in contact with the beneficiaries or the people that profit from the Mukti services?

Gora Sengupta: Yes that's actually a good question and there is obviously a lot of difficulty with that aspect. We generally go for places, we already have an existing base of SHGs and we take guidance from them as well. So we have a person in the role of, we just call that role 'friend', we call that MCDF friend. And it's the person who gives us leads on where we might be able to successfully enlist more people and form new SHGs. So the job of the friend is to form SHGs in a specific area where we think we will be able to operate. So it is a very

important aspect and we have to incentivize the friends based on the number of SHGs that they can form within a prescribed period of time.

Agnieszka Turkiewicz: Ok, and what are sources of financing in Mukti and does the company accept deposits?

Gora Sengupta: So, financing yes, but deposits no. We are not, the regulation does not permit us to accept public deposits. And that is a regulation in India. Only designated non-banking financial companies can accept deposits from the public. So we are not in that category, Mukti is a trust and as such cannot accept deposits. The only thing we can accept is donor funds, funds that are donated. And the relationship with the donor is that we take the money for a period of two years and the terms is interest free. The donor does not charge us interest and the agreement with the donor is that that money given is for a period of 2 years. And at the end of the two year period we again request the donor whether they want their money to be paid back to them or if they want to reinvest the money in another borrower. And we have seen that in 90% of the cases they don't want the money back, they just want to reinvest it with another borrower. And the borrower and the terms are, you become, if you take a loan you pay back in 2 years and then you become, within that, you target to become self-reliant. So that money can be passed on to another…

Silvana Marinescu: I just wanted to ask, do you have any concrete numbers as to how many of the loans lead to long-term self-sufficiency?

Gora Sengupta: How many of the loans lead to long term self-sufficiency. Yes we have a monitoring system in place, and with that trigger every branch is not the same. There are branches which are doing very well and some branches which are not doing so well, so we will estimate maybe something around 60% would be able to be self-reliant in 2 years. But maybe around 80% or 85% become self-reliant in 3 years or so. That's the reason why we keep requiring more and more funds. Because everybody, their performance level is different.

Agnieszka Turkiewicz: And for example, just speaking of these figures and numbers, could you somehow estimate what was the amount, or the annual amount, of funds gathered by Mukti?

Gora Sengupta: Ah yes, I don't have that off the shelf, but I can give you an indication. I need some time for that.

Agnieszka Turkiewicz: Of course, no worries, we can figure it out later. It just popped into my mind, it would be very nice if you could provide this information, but it can be absolutely later, no problem. And, I think question no.6 was kind of answered already, whether you consider Mukti an intermediary between investors and borrowers. And do you have any other source of revenue, you mentioned that there is no revenue because Mukti is a non-profit so that leaves that question out.

Gora Sengupta: Another thing which I might add to that is you remember this diagram that I shared some time back and that MCDF is this category of livelihood, now sometimes when the, this is regarding the question on source of funds for the MCDF project. Sometimes, when we run short, there are some major projects in these

other areas, if there is money that they can provide, then they provide that to MCDF. So that is also another sort of internal sourcing, that major programs within all these areas, they sort of look after each other in terms of funding.

Silvana: Yes so, in your experience, what would be the crucial parts of a social business, or in this case more specifically of Mukti, that need improvement? Is there, are there any areas where you know there is a possibility of improving processes or, yeah, making the business better?

Gora Sengupta: It actually depends on its strategic goals. Each organization will probably be different, so the crucial aspects that would need improvement would also be different depending on the strategic goals. In general in [...] is better knowledge of the field where it's, where our borrowers operate requires improvement. Because it is quite difficult to gather that information from the field on a sustained basis. For example, that particular place as I said, the seawater comes deep into the land through these various creeks and passageways, and the soil becomes salty. Now there is a lot of impact when the soil becomes salty, the ground water becomes salty as well and the drinking water becomes sort of, it could lead to disease, it could lead to loss of pregnancy, it could lead to all kinds of complications. So, suppose you have made a plan to do something in that area and then the salty water is not allowing us to do that. You know some plants don't grow in salty water at all. So if the plan was for the borrower to grow and cultivate those particular types of crops, then he's going to go in for disaster. So we don't have that kind of detailed knowledge, or what may be available in more developed places, which gives us a better knowledge and understanding and, so we would have to guide the people appropriately. Or even the poorer appropriately. So, better knowledge of the fields is required. And, of course, better communication and understanding within the industry sector. So, by that I mean there may be other NGOs that operate in that area. There may be other government parties that operate in that area. So there has to be a bit of understanding and information sharing between these agencies which may lead to a better outcome for everyone. So we don't currently have that sorted out. So, you know, work needs to be done. Even the things like maintaining compliance with regulations, for instance the Indian government regulation is that a borrower cannot take loans from us, as well as another NGO. How do you monitor such things, unless you have a shared database or something like that? So the reason is understandable because if the borrower, if a poor borrower borrows too much money, then she may not be able to return that. Because her earning capability is not there. But how do you monitor if someone comes to Mukti and asks for a loan, and we vet, and we find that it seems to be fine. We don't necessarily know that she'd borrowed from other NGOs. So that kind of knowledge sharing is probably an area of improvement.

Agnieszka Turkiewicz: That's actually a very good point. Shall we, we kind of went through question number 9 so I think it's quite sufficient.

Silvana Marinescu: Yes, for nine I think yes. But maybe 10. So, is it a goal for Mukti to grow the number of borrowers in this Microfinance part, or do you have a cap of people that you are able to serve at one time due to human resource constraints or other factors?

Gora Sengupta: Yes, it is our plan to grow. And we would like to grow and reach that critical mass that I mentioned some time back so that we can attract funding from major development funds. Right now we are quite small, and we would like to expand our social development portfolio so that a better service and more additional development can be done. So, yes, very definitely it's our goal to increase the number of borrowers. Because, after all, people are becoming self-reliant within a 2 year timespan, which means that families are being lifted out of poverty, which is quite a big thing for something like that to happen in that region of the world. I see that the question continues and says 'What challenges is Mukti facing now in terms of growing the number of borrowers?'. Challenges are quite, quite a lot. You can grow something probably if you can analyze the existing state and month to month you can track everything, but there are quite a few problems in doing that. You know, natural calamities is something that I mentioned. There are political issues from time to time. Then, some SHGs, because of some issues, certainly close. Not many, but there are some. And we would like to understand the reasons why the SHG closes and how we could prevent that. So, these reasons are often complex. They may not be obvious. Unless we go very deep into it, we may not understand why the SHG closed. Sometimes the members don't go along well with each other, and they could close because of some incident. But if we understand those things properly and if we analyze them, then we will be able to create situations or have administrative help in time so that SHG doesn't close. Quantitative analysis of branch performance, of poor branch performance, is also something which we are working on. We already have some 7 or 8 parameters which we are able to measure a branches' performance. But we are working on that, it's something which is an area of interest and additional work for us. So the goal for that is we should be able to detect a branches' performance. Yes?

Agnieszka Turkiewicz: I just wanted to ask just a very small question, just for the record for clarification, SHG groups, of course there are groups of borrowers who get the money for their own, let's say, purposes, but do they cooperate anyhow together? Because if, like you said, an SHG group breaks down, we want to prevent it. What kind of cooperation is between the participants of the given group?

Gora Sengupta: Good question. They do not work together in the sense of running the business. Each person runs their own micro-business. But what they do is, the nature of the SHG is when one person takes a loan, the group as a whole is responsible for repaying the loan. [We create an area for] discussion and cooperation between them, and also at the monthly meetings they interact and discuss various things like what should be done [and other things like that]. So I think we are, I don't have a lot of time unfortunately, maybe 9 minutes or so.

Agnieszka Turkiewicz: Sure, we'll speed up.

Gora Sengupta: What is the priority, where do you want to go?

Agnieszka Turkiewicz: About blockchain, we said that blockchain could help in the sense that, to increase the trust between the donors, and let's say this intermediary which would be crossed out in terms of money, in terms of transfer of funds. That would be an advantage of the blockchain. Would you indicate any other advantage of the blockchain in this setting?

Gora Sengupta: Ahemm… quite a few advantages. Trust is of course one of them, the main one. But then if you see our paper, we have listed a few in there. So, compliance, auditability, visibility of transactions, you know all the standard […]. Those are definitely, and besides, the other thing is, some of the donors, maybe some of the large donors, they often donate anonymously. Because they don't want the name to be known for privacy reasons. So this allows for that anonymity.

Agnieszka Turkiewicz: So basically we also said that the challenge for implementation of blockchain is definitely the hardware. So the solution for it somehow would be this, let's say collective smartphone for a given group but it still would be represented as one node. So that would be a tricky part which has to be taken into consideration definitely.

Gora Sengupta: Yes, yes. And, of course, availability of proper network infrastructure.

Agnieszka Turkiewicz: Okay, what kind of blockchain design would you find suitable for microloans? So basically certainly it wouldn't be open blockchain, it wouldn't be public blockchain.

Gora Sengupta: No, a private permissioned blockchain. It could be this PBFT type of, with known block validators. Simple BFT with known block validators. And we also have proof of authority. And Multichain is the one we used while doing the paper. We could also do Chaincore and other blockchain platforms like that. The thing is, we have to transfer digital assets with the social business performing the role of digital currency exchange. Because we have not talked about doing a cryptocurrency. And, certainly it could be done, it's a new area for us and we are also trying to understand whether the native cryptocurrency will have any benefits. But for the moment, in the initial first phase we would like to transfer digital assets. That is another idea where Mukti has a role at the moment, but it's just the operation is not large enough to warrant cryptocurrency as such. There are other complications like some regulation aspects also come into play. So, the consensus will be provided by some nominated nodes. And those nodes can very well be with some of the large donors or willing donors like volunteers in the donor space. Because the number of transactions is only very few. They are crucial to the sustainability of the organization, but the number of transactions in terms of, you know if you compare it with a banking institution etc. it's very low. Or even something like Ethereum or Bitcoin or Onecoin or any one of those, the number of transactions here will be very low.

Agnieszka Turkiewicz: I just wanted to clarify that, so basically for the validation the biggest donors would be responsible. And hence it would be proof of authority, and at some point it could be forced kind of proof of stake if designed in that way. Because most likely they will be holding the biggest stake. Okay, I think questions number 15 and 16, 15 we can skip because we kind of talked about it in between and it's very generic at some point. And 16 you also answered because you said that you wouldn't go for any cryptocurrencies per se.

Gora Sengupta: We're trying to understand if cryptocurrencies will benefit in any way. We could have a native cryptocurrency, but then again where is the cash exchange because the borrowers will need, you know, solid funds, so they are not in a position to use cryptocurrency directly. If we have to understand what are the benefits of a cryptocurrency.

Agnieszka Turkiewicz: Okay, Gora Sengupta we don't want to take any more of the time that you devoted to us, because we have two minutes left.

Gora Sengupta: Feel free if you want to catch up for a quick, some time later, for another call, as your work progresses, feel free to send me an email and we can talk.

Both: Thank you very much.

Agnieszka Turkiewicz: And thank you very much for this Skype, it was very helpful and informative. A lot of insights

Gora Sengupta: Of course. I wish you all the best for your master's.

Agnieszka Turkiewicz: And just one more thing, we should have saif it at the very beginning, but for the sake of the master's thesis we recorded this interview.

Gora Sengupta: Yeah no problem.

Appendix 4: E-mail correspondence to social businesses sent in order to get additional contacts

Esafbank:

14.05.2019 Poczta — agtu17ab@student.cbs.dk

Interview for Copenhagen Business School

Agnieszka Katarzyna Turkiewicz

So 23.02.2019 15:49

Do:customercare@esafbank.com <customercare@esafbank.com>; ho@esafbank.com <ho@esafbank.com>;

DW:Silvana Marinescu <sima17aj@student.cbs.dk>;

Dear all,

We are two master students representing Copenhagen Business School on the field of Business Administration and Information Systems. With the supervision of Raghava Rao Mukkamala (CBS profile), we are currently working on our master thesis, in connection to which we are contacting you.

The purpose of our thesis is to investigate the implementation and potential design of the blockchain technology to facilitate microfinancing in developing countries.

Taking into consideration the scope of your business activity in the field of the micro-financing in developing countries, we consider you as a very knowledgeable and experienced partner, with who we would like to cooperate.

We would like to get insights about practical aspects and current challenges of micro-lending *per se* and investigate how the technology can support it. Hence, we would appreciate the opportunity to run a short interview with your specialists.

We expect the interview to last 30/45 minutes. Taken our location (Copenhagen, Denmark), we would suggest Skype interview, however we are open to any other digital communication channel. We can entirely adjust to your schedule. Nevertheless, we would appreciate holding the interview as soon as possible.

Of course, the interview questions can be sent to you in advance, if needed.

Please let us know if you are interested in the opportunity and thank you in advance for your time.

Looking forward to hearing from you.

Kind regards,

Agnieszka Turkiewicz & Silvana Marinescu

Everex:

14.05.2019 Poczta — agtu17ab@student.cbs.dk

[Everex] Re: Interview for Copenhagen Business School

Everex Team (Support) <team@everex.io>

Pn 25.02.2019 06:18

Skrzynka odbiorcza

Do:Agnieszka Katarzyna Turkiewicz <agtu17ab@student.cbs.dk>;

##- Please type your reply above this line -##
Your request (5461) has been updated. To add additional comments, reply to this email.

Everex Team (Everex)
Feb 25, 12:18 +07

Hi Agnieszka,

Thanks for reaching out!

We appreciate you taking the time sending your offer. We're forwarding your info to the team responsible for these contacts. They will be getting back to you soon if there is interest.

Have a great rest of your day!

Sincerely,
Everex support team.

Join us on Facebook, Twitter, Reddit, LinkedIn, and Telegram.

Agnieszka Katarzyna Turkiewicz
Feb 23, 19:58 +07

Dear all,

We are two master students representing Copenhagen Business School on the field of Business Administration and Information Systems. With the supervision of Raghava Rao Mukkamala (CBS profile<https://www.cbs.dk/en/research/departments-and-centres/department-of-digitalization/staff/rrmdigi>), we are currently working on our master thesis, in connection to which we are contacting you.

The purpose of our thesis is to investigate the implementation and potential design of the blockchain technology to facilitate microfinancing in developing countries.

Taking into consideration the scope of your business activity, we consider you as a very knowledgeable and valuable partner, with who we would like to cooperate.

We would like to get insights about practical aspects of the implementation and usage of blockchain in the realm of the private finance management. Hence, we would appreciate the opportunity to run a short interview with your specialists.

We expect the interview to last 30/45 minutes. Taken our location (Copenhagen, Denmark), we would suggest Skype interview, however we are open to any other digital communication channel. We can entirely adjust to your schedule. Nevertheless, we would appreciate holding the interview as soon as possible.

Of course, the interview questions can be sent to you in advance, if needed.

Please let us know if you are interested in the opportunity and thank you in advance for your time.

Looking forward to hearing from you.

Kind regards,

Agnieszka Turkiewicz & Silvana Marinescu

FincaUK:

Interview for Copenhagen Business School

Agnieszka Katarzyna Turkiewicz

So 23.02.2019 15:50

Do: info@FINCAUK.org <info@FINCAUK.org>;

DW: Silvana Marinescu <sima17aj@student.cbs.dk>;

Dear all,

We are two master students representing Copenhagen Business School (Denmark) on the field of Business Administration and Information Systems. With the supervision of Raghava Rao Mukkamala (CBS profile), we are currently working on our master thesis, in connection to which we are contacting you.

The purpose of our thesis is to investigate the implementation and potential design of the blockchain technology to facilitate microfinancing in developing countries.

Taking into consideration the scope of your business activity in the field of the micro-financing in developing countries, we consider you as a very knowledgeable and experienced partner, with who we would like to cooperate.

We would like to get insights about practical aspects and current challenges of micro-lending *per se* and investigate how the technology can support it. Hence, we would appreciate the opportunity to run a short interview with your specialists.

We expect the interview to last 30/45 minutes. Taken our location (Copenhagen, Denmark), we would suggest Skype interview, however we are open to any other digital communication channel. We can entirely adjust to your schedule. Nevertheless, we would appreciate holding the interview as soon as possible.

Of course, the interview questions can be sent to you in advance, if needed.

Please let us know if you are interested in the opportunity and thank you in advance for your time.

Looking forward to hearing from you.

Kind regards,

Agnieszka Turkiewicz & Silvana Marinescu

Grameen:

Interview for Copenhagen Business School

Agnieszka Katarzyna Turkiewicz

So 23.02.2019 15:01

Do: mdsecretariat@grameen.com <mdsecretariat@grameen.com>; g_iprog@grameen.com <g_iprog@grameen.com>;

DW: Silvana Marinescu <sima17aj@student.cbs.dk>;

Dear all,

We are two master students representing Copenhagen Business School (Denmark) in the field of Business Administration and Information Systems. With the supervision of Raghava Rao Mukkamala (CBS profile), we are currently working on our master thesis, in connection to which we are contacting you.

The purpose of our thesis is to investigate the implementation and potential design of the blockchain technology to facilitate micro-financing in developing countries and to encourage entrepreneurship.

Taking into consideration the scope of Grameen's business activity and its very meaningful impact in the field of the micro-financing in developing countries, we consider you as a very knowledgeable and valuable partner, with who we would like to cooperate.

We would like to get insights about practical aspects and current challenges of micro-lending *per se* and investigate how the technology can support it. Hence, we would appreciate the opportunity to run a short interview with your specialists.

We expect the interview to last 30/45 minutes. Taken our location (Copenhagen, Denmark), we would suggest Skype interview, however we are open to any other digital communication channel. We can entirely adjust to your schedule. Nevertheless, we would appreciate holding the interview as soon as possible.

Of course, the interview questions can be sent to you in advance, if needed.

Please let us know if you are interested in the opportunity and thank you in advance for your time.

Looking forward to hearing from you.

Kind regards,

Agnieszka Turkiewicz & Silvana Marinescu

Uulala:

Interview for Copenhagen Business School

Agnieszka Katarzyna Turkiewicz

So 23.02.2019 13:52

Do: contact@uulala.io <contact@uulala.io>;

DW: Silvana Marinescu <sima17aj@student.cbs.dk>;

Dear all,

We are two master students representing Copenhagen Business School on the field of Business Administration and Information Systems. With the supervision of Raghava Rao Mukkamala (CBS profile), we are currently working on our master thesis, in connection to which we are contacting you.
The purpose of our thesis is to investigate the implementation and potential design of the blockchain technology to facilitate microfinancing in developing countries.

Taking into consideration the scope of your business activity, we consider you as a very knowledgeable and valuable partner, with who we would like to cooperate.

We would like to get insights about practical aspects of the implementation and usage of blockchain in the realm of the private finance management. Hence, we would appreciate the opportunity to run a short interview with your specialists.
We expect the interview to last 30/45 minutes. Taken our location (Copenhagen, Denmark), we would suggest Skype interview, however we are open to any other digital communication channel. We can entirely adjust to your schedule. Nevertheless, we would appreciate holding the interview as soon as possible.
Of course, the interview questions can be sent to you in advance, if needed.

Please let us know if you are interested in the opportunity and thank you in advance for your time.
Looking forward to hearing from you.

Kind regards,

Agnieszka Turkiewicz & Silvana Marinescu

Appendix 5:The population growth of Brazil, Russian Federation, China, Indonesia and India in 2000-2017

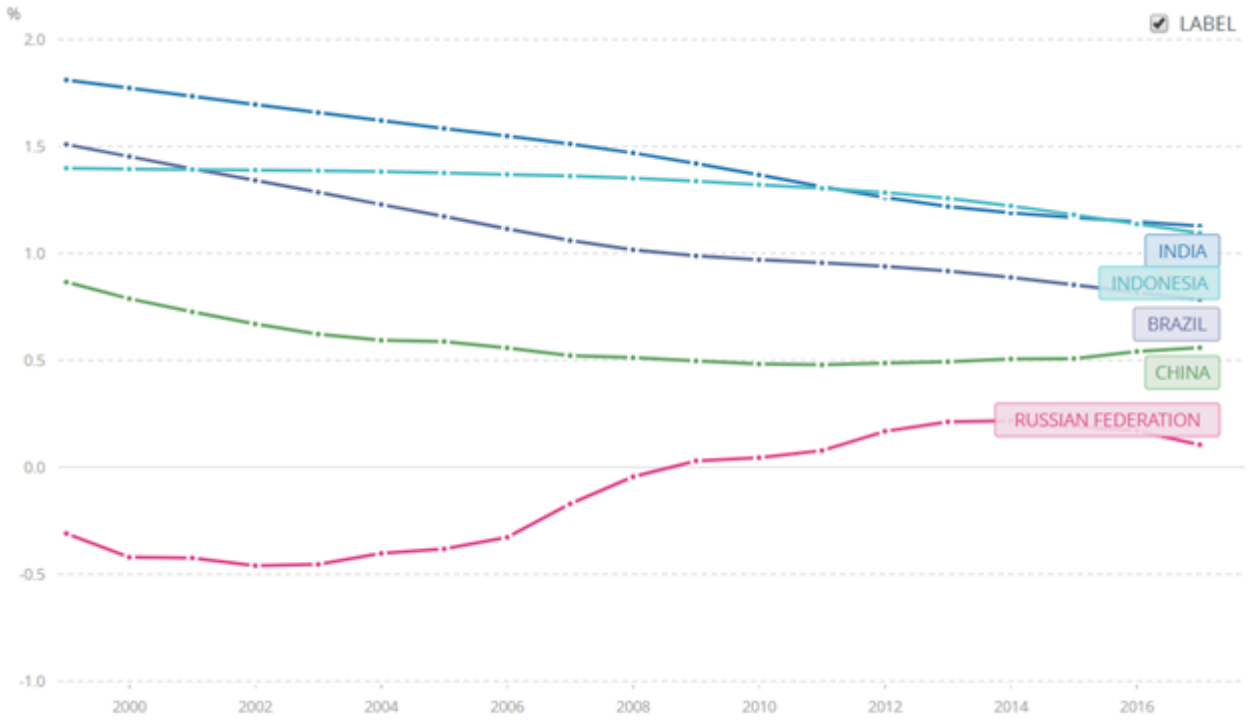
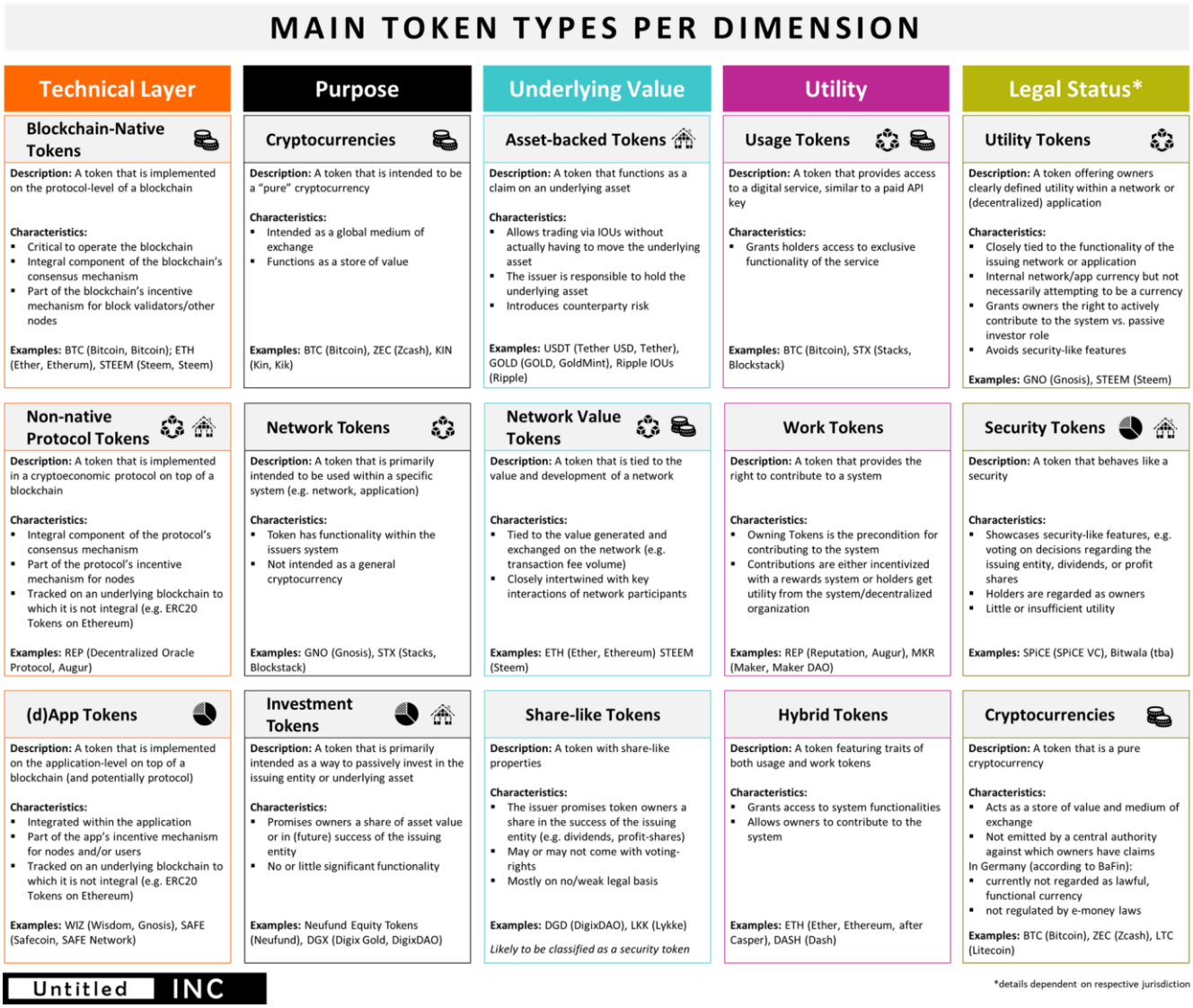


Figure 1 Source: *https://data.worldbank.org/indicator/SP.POP.GROW?end=2017&locations=IN-CN-BR-RU-ID&start=1999&view=chart&year_high_desc=true (*visited 12.02.2019)

Appendix 6: The poverty rate as a percentage of the population

Source: https://data.worldbank.org/indicator/SI.POV.DDAY?end=2015&locations=IN-ID-CN-BR-RU&start=2000&view=char (visited 12.02.2019)

Appendix 7 - The taxonomy of cryptographic tokens, Euler (2018)



Source: http://www.untitled-inc.com/the-token-classification-framework-a-multi-dimensional-tool-for-understanding-and-classifying-crypto-tokens/

Appendix 8: The archetypes of the cryptographic tokens

Source: http://www.untitled-inc.com/the-token-classification-framework-a-multi-dimensional-tool-for-understanding-and-classifying-crypto-tokens/

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