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Abstract

Smart contracts are one of the business and organizational areas where blockchain technology is thought to have a major potential impact. Smart contracts can be a secure method to technologically ensure that a certain action is followed by other agreed-upon transactions. Payment transactions for contract bindings might be the first go-to thought in this regard, also considering that blockchain technology's most significant impact until now has been through cryptocurrencies. And yet, so many other aspects of organizational processes rely upon transactions between different organizational units. There might not be a flow of currencies, and the value driver might be the flow of correct, on-time information. Such is the case when patients are released from a hospital to the organizations that provide home care in the Norwegian health care system. The health care professionals in home care need the right information to be able to provide the necessary care and medication. There is an ongoing IT-program in the Norwegian health care system called AKSON, with the goal of *one patient – one journal*. This article sheds light on opportunities regarding the potential use of smart contracts-technology in the Akson program, for information sharing when patients are transferred from hospital to home-care.

Keywords: blockchain, healthcare, smart contract

1. Introduction

In Home health care, health care professionals provide care in recipients home. They provide care to many different patients' groups, from elderly people, need assistance at home, medicine handling, to patients discharged from hospital with complex health conditions. The recent decade, home health care (HHC) have experienced increased expenses and demand. In addition to ageing in population the coordination reform, enacted in 2012, caused a shift in demand from hospitals to primary care. This has led to changes in group of patients, that need short-term and more specialized care in their homes than earlier (Helsedirektoratet, 2016).

Health records systems contain information about patients' diseases and conditions, medication list, care plans and consecutively report done by health professionals working with the patient. It is information about the patient provided by health care professionals like doctors, nurses, assistants and others. In addition to serve as a communication platform between health care professionals, it could also secure that patients' rights. It is necessary that when the patient is discharged from hospital and transferred to home health care, health records are accurate and

efficiently exchanged between the units. Good information about the patients' health condition are necessary for health care professionals to provide patients high-quality care. Accurate information and aligning documentation with the nursing process are mentioned to be one of the important factors of providing documentation of high quality(De Groot, Triemstra, Paans, & Francke, 2019; Gjevjon & Hellesø, 2010), means that the information should to be accurate and according to patients care plans.

Today health care institutions and units use different platforms when doing health records, which could be challenging when exchanging information when patients are being discharged. Akson is a project that concerns a common health record solution in Norway which will also aim to solve some of these problems. For recipients' and patients, Akson mean better and safer treatment, and it would facilitate a more comprehensive and coordinated health service with one medical record across municipal health service and hospitals. This means that health care professionals working in the municipalities – GPs, emergency service, home health care and other health institution work on the same medical record solution, and can interact with each other on platforms adapted their needs. Patients and residents can also take a more active part in their treatment and get better access to information about their health.

The research project concern especially about blockchain technology and the use of smart contracts when exchanging health records, after patients are discharged from hospital and transferred to home health care.

Research question: *What are the opportunities in using smart contracts to ensure the needed information flow when transferring patients from hospitals to home-care?*

The research is scoped to the Akson-program and the Norwegian health care system. The research looks into the merging point between technology and health care professionals, and the possible practical handling of information flow, and is grounded in the field of Supply Chain Management and the focus on processes and flow. The technological depth will not encompass programming of possible solutions but will evolve around the actual use of smart contracts in information sharing. Of course, grounded in actual possibilities and limitations that the technology provides.

The article will first present a literature review of the possibilities that lie in smart contracts, especially related to information flow and securing transactions. The research methodology will then be presented in more depth before the findings of the research are presented and then discussed. The article ends with a distilled conclusion and pointers towards possible future research.

2. Literature Review

There has been a growing interest in the use of smart contracts in health care the recent years. Azaria et al. (2016) use smart contracts for data sharing with different goals. One is mapping patient identification number to their public signing key in blockchain. Second is about patients who can manage the access rights of providers about their medical data. The last one is a summary of contracts that contain a history of all signed contracts. Xia et al. (2017) use smart contracts for sharing medical data among medical and research organizations and cloud providers, and to encrypt medical records, identify actions performed on sent data, and invalidating access to violated data. Further, Benchoufi and Ravaud (2017) have studied the integrity and transparency of medical trials with smart contracts. They use two smart contracts and the first one ensures the irrevocability of the trial protocol and second is the trial monitoring, patient enrolment data, and data analysis. Dubovitskaya et al. (2017) believe that smart contracts contain two types of blocks. One is about patients that allow doctors to have access to their health data and they can decide which type of data and for which period they find access. Second is clinical metadata that has all information for accessing the corresponding data file.

Dagher et al. (2018) tried to design a blockchain framework for electronic health record management. They used six smart contracts. Consensus contract that maintain blockchain mining and registration of users, classification contract that classifies different nodes of the system as patients, providers, or third parties, service history contract that defines the relationships between users, ownership contract that is responsible for medical records, permissions contract specifies the access permissions for records, and re-encryption contract shares symmetric encryption keys. They finally noted that their employed framework, which include smart contracts, are still under development and require more focus in future studies.

Giordanengoa (2019) shows that smart contracts could be used in healthcare in different situations, from data sharing to the improvement of clinical trials, but that the small numbers of studies included (n=9, omitting a literature review) and the fact that none of them were at a

commercialization or production stage raise questions about the usability of this technology in real-life situations. Parts of this research gap is aimed to be filled with this article, by giving the research a practical approach through the Akson-program in Norwegian health care system.

3. Research methodology

As mentioned the scope is narrowed down to actual information flow-processes in a certain part of the Norwegian health care system. There is a goal to provide research that brings conceptual thoughts and ideas together with actual processes, concerning actual health care professionals and information sharing. The framework for the research is the actual possibilities and limitations that smart contracts, as part of blockchain technology (BT) can provide. This framework, or rather technological base, will be examined and discussed in connection with real life processes.

The research has a qualitative, intensive approach, with semi-structured interviews of relevant persons working in the Akson-program. A literature review provides ground for developing the interview guide and for a pre-interview information package that was sent to the interviewees before our meetings. The analysis of the collected data follows the methods of sense-making theory, which provides a structure for sorting and structuring qualitative data.

A literature review provides grounds for developing an interview guide and a pre-interview information package that will be sent to the interviewees before our meetings. The literature review will be conducted through database searches with relevant keywords. Relevant authors will be contacted directly for advice.

We will consider using Iris-AI as a search tool. (Tool that is about to be tested at the Norwegian Defence University College.) Secondary data is process mapping that provide detailed information on the processes of transferring patients, both regarding the physical flow of patients and the flow of information.

The research methodology is inspired by Wang et al. (2019) and is chosen because the researchers are from the field of Supply Chain Management and not computer science, and because of the motivation towards bridging the gap between conceptual technological possibilities and real health care processes. Case study; specific organization, specific processes. The combination of literature review and following interviews has strong deductive

aspects, and there is an underlying hypothesis or puzzlement regarding the opportunities of BT. At the same time, the research is explorative and prospective, which belongs to a more inductive approach. In this sense, there is a strong claim in describing the research project as being abductive.

4. Findings and analysis of data

The prospective and hypothetical aspects of this research make it quite open. The findings have a strong possibility to drive the research in new directions, and towards more relevant research question. There might for example be the case that other aspects of BT has stronger relevance, and that there is no reasonable argument for examining smart contracts when other solutions can be better both technologically and regarding resources.

5. Discussion

In the flow chart for evaluation, which is given in Figure 1, if BT should be used or not, we might end up concluding that it should not be used in the total scope of our research.

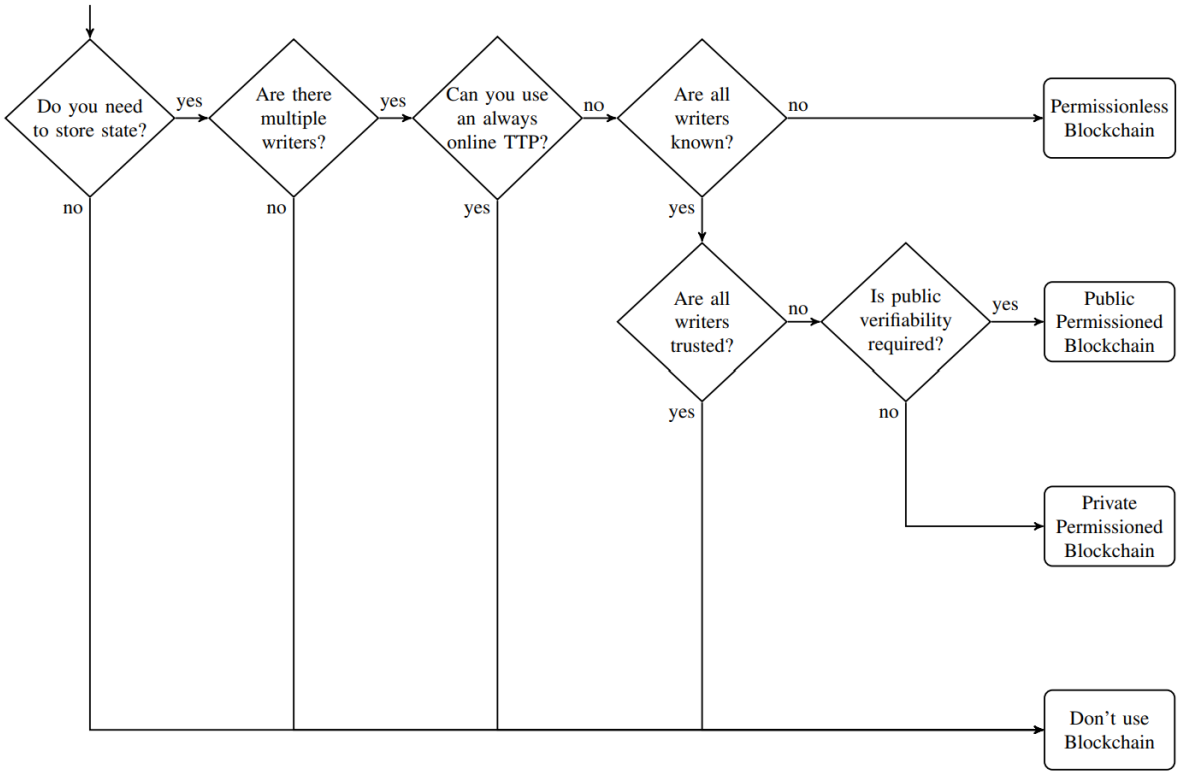

Fig. 1. : A flow chart to determine whether a blockchain is the appropriate technical solution to solve a problem (K. Wüst and A. Gervais)

We do not aim for being original, but rather to build on the body of knowledge. The use of methodology from Wang et al. (2019) ensures that a tested and acknowledged approach is used. Yet we use this methodology in a more narrow scope within one field of business (health care). Since it is being pointed out that the use of BT is somewhat contextually dependent, we argue that using an even more intensive approach compared to Wang et al. (2019) could be a relevant contribution to the body of knowledge.

6. Conclusion – further research opportunities

The grounds for this research lies in identifying the need for narrowly scoped case studies pointing towards practical relevance. If BT is to take hold in i.e health care, the technology needs to take steps beyond hypothetical solutions towards binding practitioners and the technology closer together.

One could argue that this research is a minuscule contribution to the normal-science paradigm. As BT is thought to be a foundational technology with potential for disruptions, we argue that the field of research needs to build the knowledge base by taking these small steps, until we reach critical mass and a technological maturity that can provide actual benefits.

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This working paper is a result by group A in completion of DRL028

Molde University College
Specialized University in Logistics

HiMolde PhD

DRL028 Blockchain Applications in SCM

Credits: 5 ECTS

Time: Week 49, 30 November to 4 December 2020

Supply chains drives the macro economy and global markets. The push towards digitalization and sustainability have intensified the need for interoperability among organisations. Blockchain technologies facilitate coordination of spatially dispersed complex tasks at a low cost. This PhD-course present current research on blockchain applications in supply chains, and offer an opportunity to discuss future applications and research on information sharing in extended supply chains.

Monday 30 November
- Welcome & introduction (By Bjorn, Arvind and Svein)
- Present group work as a Blockchain-SCM Project (Arvind)
- Students presents themselves
- Blockchain technology and SCM (Lecture by Nitin)

Tuesday 1 December
- Paper review & discussion
- Blockchain-SCM Project: Group forming & project ideas
- Blockchain technology and SCM (Lecture by Nitin)

Wednesday 2 December
- Paper review & discussion
- Blockchain-SCM Project: Identify research focus, gap identification & research method

Thursday 3 December
- Lecturer work/research on Blockchain in SCM (Bjorn, Arvind, Svein)
- Paper review & discussion
- Blockchain-SCM Project: Data collection / experimental setup

Friday 4 December
- Blockchain-SCM Project: Group A paper draft presentation
- Blockchain-SCM Project: Group B paper draft presentation
- Blockchain-SCM Project: Group C paper draft presentation
- Summing up

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