"Social Blockchain": Improving Situational Awareness for Open Entrepreneurs by Designing a Bitcoin Seismograph

Marcel Morisse[1], Ingrid Schirmer[1], and Malte Nottmeyer[2]

[1] Universität Hamburg, Fachbereich Informatik, Hamburg, Deutschland
{morisse,schirmer}@informatik.uni-hamburg.de
[2] Versility Labs GmbH, Hamburg, Deutschland
nottmeyer@versility.com

Abstract. Modern economies and especially open source (OS) communities are fueled by entrepreneurs. Yet, in case of community disruption, entrepreneurs are more affected than larger firms due to lesser resources. Initial point for our research was the Mt.Gox bankruptcy in the Bitcoin community. Based on a qualitative analysis among open entrepreneurs we investigate on situational awareness as an instrument for improving resilience. For this purpose, we propose a tool, the Bitcoin Seismograph, which provides a rapid understanding of changes in the Bitcoin open source system. Its design, launch and evaluation are presented. Our Seismograph correlates discussions from social media platforms and online forums in the Bitcoin community with technical data from the blockchain and business data such as currency statistics. As such, our insights so far contribute to improving situational awareness in open source and blockchain communities.

Keywords: Situational Awareness, Bitcoin, Entrepreneurship, Blockchain, Design Science.

1   Introduction

When Mt.Gox, one of the largest Bitcoin exchange and an entry point for new users of the cryptocurrency, went bankrupt overnight in 2014, the Bitcoin community was thrown into turmoil. As the real reason behind the downfall was unknown (and still is), community members had to make sense based on speculation and uncertain observations. The explanation ranged from hacking, technical problems, unprofessional behavior from the Mt.Gox owners to fraud and customer asset stealing [1]. The bankruptcy of Mt.Gox is understood to be a major shock for the emergent sociotechnical field to date as it made many question the future of Bitcoin and blockchain technology. Since then, this question has never faded away due to recurring criticism [2, 3]. However, a growing number of entrepreneurs have built businesses that rely on the Bitcoin infrastructure. These entrepreneurs have to constantly observe their open source system to anticipate new trends or unwanted developments. As one

entrepreneurs interviewed in a previous study [4], stated: "*I try to follow the Bitcoin news as closely as my time allows, so if something does come up that we can react as fast as possible and not just learn about it after one or two days.*"

As a result, we conclude that situational aware entrepreneurs are more capable to foresee developments in their context and react to them faster in comparison to unaware actors. But this comes at a price. Whereas mature firms typically have more resources to continuously analyze their environment [5], entrepreneurs firms must work with fewer resources [6] for bouncing back. Again, this is expressed in the next statement underlining the cost needed for situational awareness: "*That it requires more attention and more time, because these spaces are just moving so quickly and there were so many new things happening every day, so actually I'd like to dedicate more time to follow news about Bitcoin specific news and I just scan it, because otherwise I couldn't run my business.*"

This presents us a practical puzzle as entrepreneurs have to choose between dedicating time and resources observing their OS system to protect their ventures or expanding their businesses to become a mature organization. This organizational problem leads us to ask the following research question: *How can situational awareness of entrepreneurs embedded in an open source context be improved by reducing the required use of resources?*

Our answer to this question lies in a design science based development of an open source tool, the Bitcoin Seismograph. The Seismograph provides overview over a large amount of a variety of available data resources combining and correlating them. It enriches technical/block chain data with data from the business and social realm.

The paper is structured as follows. In the next section, concepts of situational awareness in entrepreneurial OS systems are defined. We describe the context Bitcoin in the third section. Then, our research approach and our research findings are presented. Finally, we discuss our findings, draw limitations and present theoretical as well as practical contribution of this paper.

2 Situational Awareness in Entrepreneurial Open Source Systems

Entrepreneurship is a vivid part of modern economies [7] as a source of new jobs, innovation and new business models [8]. While entrepreneurship is often understood as creation of new businesses [9], we define it more broadly as a venture of "a creative and social/collective organizing process" [10]. Entrepreneurs discover and exploit opportunities in their environment and transform them into business models and processes. This is especially true for open entrepreneurs, who build their businesses entrepreneurship on an open source community [11, 12]. We define open entrepreneurship as discovery and exploitation of business opportunities in an open source context (definition adapted from [13]). Open entrepreneurs benefit from low barriers to entry and exit [14, 15], fast internationalization and access to collectively generated knowledge. Especially, knowledge transferred from the community to the entrepreneur is an essential resource for open entrepreneurship [16, 17] as it will open

paths for new business opportunities or adapting existing business models to new circumstances [18]. Furthermore, knowledge gathered from the open source community supports the alignment of entrepreneur's actions with community developments fostering the entrepreneur's legitimacy [19] and reputation [20]. This gives entrepreneurs the chance to direct and control the open source community [21].

Nevertheless, interweaving into an open source community can be a double-edged sword. Strong reliance on a chosen open source community can also hurt entrepreneurs as unwanted developments in the OS context might damage entrepreneurs' reputation and legitimacy in the non OS environment and limits access to financial, human and social capital as well as public resources from authorities [22–24]. Open entrepreneurs have to balance the goodwill of the OS community in which they primarily operate, with their profitability and long-term success depending on stakeholders outside of the OS community. Thus, an open entrepreneur must gain situational awareness over its open source context to sponsor promising trends, limit the damages of harmful developments or even leave the chosen OS context in case of a cataclysm [25].

Situational awareness can be broadly defined as "knowing what is going on" [26] and includes a state of knowledge as well as "a variety of cognitive processing activities" [27]. In more detail, a fully situational aware actor perceives critical and relevant elements in its environment, interprets and evaluates the elements to achieve a comprehensive understanding of a given situation and can make prediction how a system will behave in the nearer future [26]. To achieve this, data from the environment must be compiled, processed and fused [28] in adaptive and changing systems [29] and under uncertainty [30]. Situational awareness is not an end in itself but a prerequisite for the sense making process [31], because "situation parameters or context of a problem largely determines the ability of individuals to adopt an effective problem-solving strategy" [26]. This means situational awareness is essential during uncertain situations as the "less adequate the sense making process directed at a crisis, the more likely it is that the crisis will get out of control" [32].

3 Context Bitcoin

Bitcoin and blockchains in general have developed into a vivid environment for entrepreneurial activities. Introduced in 2008 by an entity named Satoshi Nakamoto, Bitcoin has established an alternative for exchanging goods, store value and as unit of account lowering transaction costs and allowing new business models or the adoption of existing ones.

Motivated by a rising distrust in the banking industry [33] and a need for frictionless payment systems [34], cryptocurrencies are decentralized digital currency schemes based on peer-to-peer networks and cryptographic tools. Bitcoin as the most prominent example was founded as "an electronic cash system" [35] and quickly after its introduction transformed into an vivid open source system in 2009. Since then, Bitcoin became the most used cryptocurrency today with a market capitalization of around 137 billion USD (11/21/2017) and a price of around 8000 USD per Bitcoin [36].

Bitcoin users, who want to exchange Bitcoin, must implement the Bitcoin protocol to connect to an open peer-to-peer network. All users store a copy of a transaction ledger, the blockchain, permitting participants to verify all publicly available transactions to prevent misuse and fraudulent behavior. This has created a community of active supporters fostering the Bitcoin protocol and network. Embedded into the open source community are also open entrepreneurs offering eCommerce and financial services like Bitcoin exchanges, peer-to-peer Bitcoin lending or selling mining hardware to the community [37].

Since its introduction, Bitcoin is heavily discussed in online forums and social media websites (like Reddit). These platforms are used to announce updates of the Bitcoin protocol, debate developments of Bitcoin or notify each other of new events in the Bitcoin context. As of today, bitcointalk.org as the largest Bitcoin related forum has 1.125.392 members engaged in 761.449 forum threads, whereas the largest Bitcoin subreddit (/r/Bitcoin) exceeds 300.000 subscribers. At the same time, due to the availability to publicly available data from the blockchain, several websites gather statistical data around Bitcoin and present them to users. One of the most prominent websites, blockchain.info, enables users to check currency statistics (e.g. Bitcoin market price), block details (like transactions per block) or mining and network information (e.g. current mining difficulty). Other websites like btcforkmonitor.info focus on detection of blockchain forks or comparing market capitalizations of cryptocurrencies (coinmarketcap.com). Nevertheless, to the best of our knowledge, we have found no tool which combines statistical data and discussion from the Bitcoin community to provide a quicker understanding and explanation of developments in the Bitcoin open source system.

4 Research Methods

We followed the design science paradigm by Hevner et al. [38] to create a "purposeful IT artifact" [38] to address the problem of entrepreneurial situational awareness. To foster relevant and rigorous results, we used the Design Science Research Methodology (DSRM) by Peffers et al. [39]. This widely used methodology in IS research is a "consensus-building approach to produce the design" [39] and describes an iterative process consisting six core activities, described further below.

Problem identification and motivation. We identified our organizational problem in a previous study published in [4]. The problem is described in the introduction.

Define the objectives for a solution. Shortly after the problem identification, we turned to Bitcoin entrepreneurs and asked for further insights into the problem of situational awareness. From ten inquired entrepreneurs, a Bitcoin entrepreneur from Germany agreed to a workshop to gather requirements for the artifact. We conducted the workshop in a four-hour session with five participants at the site of the entrepreneur in October 2015. We conducted open, inductive and iterative coding of the workshop's transcript and triangulated our findings with literature about situational awareness and our knowledge about Bitcoin gathered in previous studies.

Design and development. The tool was designed in two iterations, but due to page restriction only the second iteration is described in this paper. The tool was developed by the authors using agile development methods Weekly sprints were established for coordination of the project supported by cloud based collaboration tools for day-to-day conversations and cooperation.

Demonstration. The tool was made public via a website (http://www.bitcoinseismograph.info/) in August 2017. The URL of the website and the intention of the tool were announced in Bitcoin related online forums and social media platforms to raise interest and direct users to our website. The source code is published as OS project on Github.

Evaluation. The evaluation of the Bitcoin Seismograph is based on two tiers; first, feedback from the Bitcoin OS community through active engagement with the community via social media channels and second, feedback from Bitcoin open entrepreneurs. We conducted a second workshop together with the German entrepreneur who already provided requirements for the artifact. During a two-hour session with five participants (four of them participated in the first workshop), we discussed the current version of the tool, future enhancements and the tool's ability to improve situational awareness of open entrepreneurs. Completed discussion with the community as well as the entrepreneur were saved and coded openly.

5 Improving Situational Awareness via the Bitcoin Seismograph

We turn now to outline the Bitcoin Seismograph. The results of each DSRM activity is described in the corresponding section.

5.1 Defining Objectives of a Solution

Literature about situational awareness describes three major requirements for designing situational awareness tools. Firstly, a tool must capture "status, attributes, and dynamics of relevant elements in the environment" [40] and put them in a second step "in relation to relevant goals and objectives" [40]. Thirdly, a situational awareness tool should have "the ability to predict what those elements will do in the future" [40]. Data collected must be accurate and consistent to avoid misinterpretation [41]. Other authors [42] suggest to store historical data to facilitate pattern recognition and learning.

In addition to requirements described in literature, the Bitcoin entrepreneur named further, context-specific challenges. Bitcoin indicators like Bitcoin price, transaction volumes or current blockchain difficulty have to be collected on a regular basis. These quantitative data should be set into context with current discussion in the OS community supporting the interpretation of indicators' developments. Bitcointalk.org and the Bitcoin subreddit are named as most important platforms for Bitcoin community communications. Due to the high frequency in these message boards, the community contributions should be filtered and pre-analyzed (e.g. via a sentiment analysis) to present only the most relevant to the user. But, the user shall also have the

possibility to go deeper and get a more detailed information about Bitcoin trends. Therefore, it is necessary to switch between community centric and data centric views. Additionally, the interviewees demand a traffic light system to get quick assessment of the situation: *"With these statistics, it is usually the case that everything is normal on 363 days per year and then there are two days something out of the ordinary happens. This makes tired, therefore, if there would be a traffic light with green, yellow and red signals and with a yellow signal you check again, and with a red signal you definitely check again and trigger further actions"* (translation by the authors).

Warning and alert levels have to be defined for each Bitcoin indicator, for example triggering an alert when group of miners control more than 50% of the network's mining hash rate. The frontend of the situational awareness tool shall have an esthetic and modern look to support user to find relevant information quickly. In addition, an API is for the entrepreneur to be able to integrate certain data into their website.

5.2   Design & Development

We designed and implemented a web service with a website as a visualization frontend. The theoretical and practical objectives are addressed by a series of distinct features, which we describe in the following paragraphs. We detail in which software components these features are realized. Each one of them is also collectively illustrated in the data flow diagram (Figure 1), including its name, technological implementation and individual purpose.

Capture relevant elements in the environment. Through a selection of multiple complementary and redundant sources (e.g. blockchain.info), we gather Bitcoin quantitative technical and business data (Bitcoin indicators) about the Bitcoin price (in euro, dollar and yen), Bitcoin market, blockchain status, network details and mining pools. An integrated data model is defined by merging overlapping data and thus improving data accuracy and consistency. Data is extracted via *API Crawlers* which are realized as one-off Python scripts, which request the data via HTTP, apply necessary transformations and load it into storage (see below). The scripts are executed periodically in a 5 min interval by the *Job Scheduler*. Sources for qualitative data are social media platforms named by the entrepreneur like Reddit and bitcointalk.org. All text is scraped with another set of Python scripts (*Forum Scrapers*) and stored in an Elasticsearch database (*Text Storage*).

Putting elements in relation to objectives. Improving situational awareness resource-efficiently, we query and compose quantitative data and qualitative data by analyzing and filtering them in the *Analysis Backend*. For Reddit we use the native ranking system to show the ten most relevant threads. Since the forum threads work fundamentally different, we filter out every thread older than 3 days and show ten with the most views as a rough depiction of an active forum discussion. Additionally, we provide a sentiment analysis of the initial thread post by utilizing the Python library TextBlob with its default model. The sentiment analysis supports detection of atmosphere in the Bitcoin community. In our *Frontend*, we integrate and correlate Bitcoin indicators with analyzed threads from current community discussions for a quick overview. The key indicators are displayed as a structured number dashboard with appropriate sections,

labels, optionally information source, and applicable units. Current discussions are placed next to the dashboard. The sentiment is indicated by a green (positive) or red (negative) background of the thread display. For a further drill down, the user can click on the threads for a detail view and switch between a community- and indicator-centric view.

Display warning levels. As a main objective, we provide warning and alert levels for most of the Bitcoin indicators, which are following a traffic light scheme. In case pre-defined thresholds are exceeded, the indicators are displayed in yellow (warning) or red (alert). Once any indicator is yellow or red, the header color of the *Frontend* changes to yellow or red to make users aware of the overall status of the Bitcoin OS system.
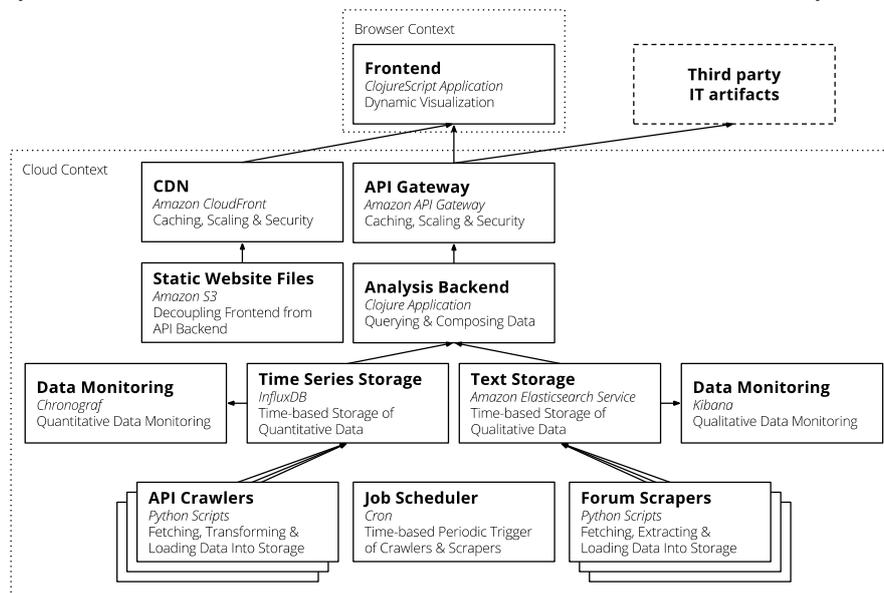

Figure 1: Data Flow Diagram of the Bitcoin Seismograph

Store and provide historical data. We store every data point in the *Time Series Storage* InfluxDB decoupling collecting data and delivering data to the *Frontend*. The database allows us to query data by time range and to generate additional Bitcoin indicators based on history of the underlying value (e.g. price volatility and change), which are also shown in the dashboard. For displaying historical data, we provide a second interface component in the *Frontend*: an interactive timeline chart, which can display all dashboard indicators mapped out over the past 30 days with an aggregated granularity of 12 hours. Then applicable community discussions are displayed below the timeline chart, for selectable timeline points in the past.

Predict future outcome of elements. Trend analysis of gathered indicators (e.g. price) are helpful to predict future developments in Bitcoin. We showcase this by offering a linear regression and displaying the percentage increase of the expected next value (with 12 hours granularity).

Provide an API. The web service can be also accessed directly via HTTP and JSON in a documented (Swagger) and standardized manner. Tool users can access available information directly and integrate them into their tools and processes.

5.3 Demonstration

Since launch of the Bitcoin Seismograph (August 1) until end of August, 4480 service requests (excluding bots and search engine robots) were handled by our CDN. Most user originated from the United States of America (34.2%), followed by Germany (28%) and Russian Federation (4.2%). In total, users from 49 different countries accessed the tool. At the time of writing, most visitors per day were counted on the 31st of August (809 service requests), shortly after a heated discussion about the tool started on bitcointalk.org. At the moment, the website is called 170 times per day on average.
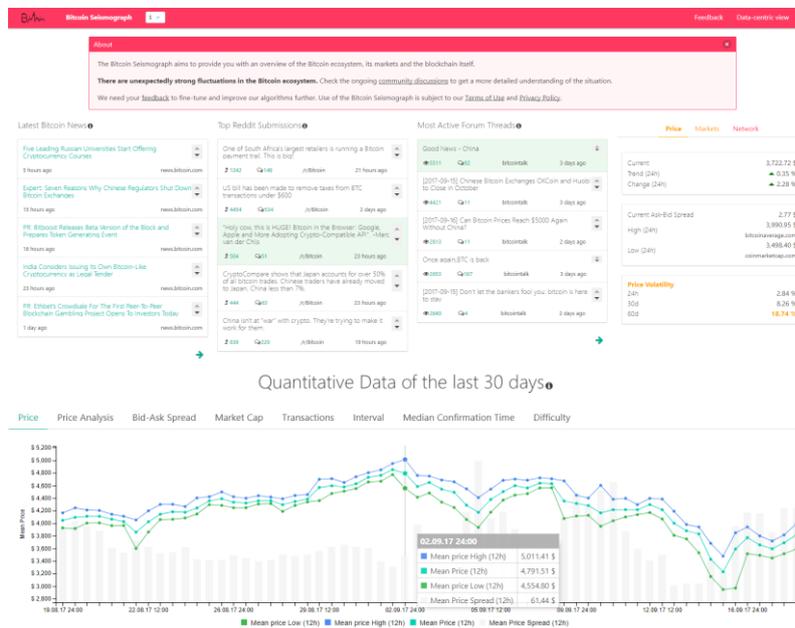

Figure 2: Screenshot of Bitcoin Seismograph illustrating Bitcoin Price Drop

Shortly after tool launch, Bitcoin came under heavy pressure due to new restriction on Bitcoin trading introduced by Chinese legislators [43]. Two major Chinese based Bitcoin exchanges, BTCC and ViaBTC, are forced to close their exchanges, other Chinese exchanges are expected to follow. As a consequence, the Bitcoin price dropped from an all-time high of $5,013 on September 2 to $2,951 on September 15 returning to around 4000 USD per Bitcoin on September 18. This turbulences in the Bitcoin market were fully captured by the Bitcoin Seismograph, the alert status was triggered informing users about the price fluctuations and correlating discussions (see Figure 2).

5.4 Evaluation

The Bitcoin Seismograph receives generally positive review from the Bitcoin OS community supporting the idea of the tool and the combination of quantitative and qualitative data. The claim, that the Bitcoin Seismograph is helpful to understand movements in the Bitcoin ecosystem and captures crisis and unforeseen developments, is supported by feedback received from users and OS community members. Criticism aims at misleading warning and alert level descriptions and the tool's emphasis on price volatility. As a response, we changed the descriptions to make them more comprehensible, improved user guidance for stronger attentiveness of the community-centric view as well as raised the volatility warning and alert levels to reduce sensitivity of the indicator.

The Bitcoin entrepreneur evaluating our tool also supports the hypothesis, that the Seismograph will improve situational awareness during unforeseen events and will save time and resources to understand developments. One participant answers to the question of intention to use in general: *"But, I would use something like that [Bitcoin Seismograph], because it is also great to have community and quantitative data at a glance" (translation by the authors)*. Especially the history graph is praised for the possibility to investigate previous events with correlating social, technical and business data at that period of time. To the entrepreneur's knowledge, no other Bitcoin analysis tool offers this potential making the Bitcoin Seismograph also interesting for blockchain researchers and journalists. Similar to comments from the Bitcoin community, the pre-defined threshold values of warning and alert levels are named as the important point of criticism. These values for each Bitcoin indicator shall be customizable based on users' needs. In addition, the workshop participants ask for future inclusion of more technical and business data, like blockchain fork detection and analysis of Bitcoin financial instruments (e.g. futures). As a conclusion, it can be stated, that the Bitcoin Seismograph is seen as a helpful tool to solve the organizational problem, but needs a higher adaptability to meet the different information requirements of diverse Bitcoin open entrepreneurs.

6   Conclusion and Limitations

The overall contribution of this design science research project is an open source IT artifact under the guidance of the DSRM [39]. The Seismograph addresses the need to observe a fast-moving open source environment to detect trends or unwanted events with only limited resources at hand. So far, no research has covered this subject yet. The resulting artifact thus addresses this need with the implementation of objectives triangulated from research literature and practical observations. To the best of our knowledge, no similar tool is available in the Bitcoin. The demonstration of the artifact shows interest and the intention to use of the open source community and entrepreneurs. An unexpected Bitcoin price drop and its impact was captured by the artifact underlining the tool's usefulness. The evaluation in a real-life setting indicates that the Bitcoin Seismograph is effective to gain situational awareness resource-efficiently, both for community members as well as open entrepreneurs. Especially, the historical

display of quantitative and qualitative data is seen helpful to understand previous events and facilitates organizational learning and preparation for future events. Admittedly, situational awareness can be further enhanced, if Seismograph users are able to change warning and alert levels to their individual needs. Although this is anticipated in the tool's architecture, the implementation remains to be done in the following development iterations.

We believe that our findings have implications for situational awareness and blockchain research: 1) highlighting the dynamics between correlated social, technical and business data to observe developments in Bitcoin; 2) showing how open Bitcoin entrepreneurs can be situational aware with only limited resources; and 3) demonstrating how design science based artifacts can improve situational awareness. The practical implications of this research are twofold. Firstly, Bitcoin entrepreneurs can use the developed tool to get a faster understanding of a given situation in Bitcoin without time-consuming checking statistics and Bitcoin related communication channels on manifold websites at the same time. Secondly, due to the Seismograph's open source character, open entrepreneurs and other Bitcoin community members can check and change the implementation to their specific needs. This is especially important for the heterogeneous group of open entrepreneurs as they have different triggers and interest based on their business models, ideologies and resources at hand. It is therefore a starting point for future refinement of the IT artifact.

There are some limitations of the research. The Bitcoin Seismograph only covers publicly available information. Data originated from internal entrepreneurial processes can also provide helpful insights to understand current developments. Nevertheless, the inclusion of such data is possible in future, entrepreneur-specific versions due to the adaptability of the tool's architecture. Also, this research focusses on Bitcoin only. Other promising blockchain based projects like Ethereum are not covered by the tool, but might have also effects on the success of Bitcoin. Data from non-blockchain based system interfering with Bitcoin are also not included into the tool. Thirdly, the designed artifact is yet to be tested in an entrepreneur or system threatening situation. But, tool's behavior during the demonstration phase suggests, that the Seismograph can support entrepreneurs during devastating events. Fourthly, the Bitcoin Seismograph has only limited capabilities to predict crisis beforehand due to limited data and valid prediction methods. As it serves as a crisis detection tool in today's version, future tool enhancements should focus on crisis prediction. Finally, the Bitcoin specific definition of objectives and the evaluation rest upon the experiences of one Bitcoin entrepreneur. Future iterations of the DSRM will focus to include more entrepreneurs to get a more complete picture of their needs and triggers to be situational aware in Bitcoin. In summary, despite current missing adaptability for diverse needs of open entrepreneurs, the Bitcoin Seismograph improves efficient situational awareness of entrepreneurs and other OS community members by correlating social, technical and business data from the Bitcoin open source system. Consequently, it underlines that the Bitcoin context although it is evidently based on blockchain technology, is also highly depending on social behavior, letting the Bitcoin context converge to a "social blockchain".

References

1. Decker, C., Wattenhofer, R.: Bitcoin Transaction Malleability and MtGox. In: Proceeding of 19th European Symposium on Research in Computer Security. pp. 313–326. Kutyłowski, M. and Vaidya, J., Wroclaw, Poland (2014).
2. Roberts, J.J.: Bitcoin Crashes Again—Is Brexit to Blame?, http://fortune.com/2016/06/23/is-brexit-to-blame-for-bitcoin-crash/, (2016).
3. Henry, D., Irrera, A.: JPMorgan's Dimon says bitcoin "is a fraud," https://www.reuters.com/article/legal-us-usa-banks-conference-jpmorgan/jpmorgans-dimon-says-bitcoin-is-a-fraud-idUSKCN1BN2PN, (2017).
4. Morisse, M., Ingram, C.: A Mixed Blessing: Resilience in the Entrepreneurial Socio-Technical System of Bitcoin. J. Inf. Syst. Technol. Manag. 13, 3-26 (2016).
5. Mosakowski, E.: Entrepreneurial Resources, Organizational Choices, and Competitive Outcomes. Organ. Sci. 9, 625–643 (1998).
6. Sine, W.D., Mitsuhashi, H., Kirsch, D.A.: Revisiting burns and stalker: Formal structure and new venture performance in emerging economic sectors. Acad. Manag. J. 49, 121–132 (2006).
7. King, R.G., Levine, R.: Finance, entrepreneurship and growth. J. Monet. Econ. 32, 513–542 (1993).
8. Van Praag, C.M., Versloot, P.H.: What is the value of entrepreneurship? A review of recent research. Small Bus. Econ. 29, 351–382 (2007).
9. Davidsson, P., Wiklund, J.: Levels of analysis in entrepreneurship research: Current research practice and suggestions for the future. Entrep. theory Pract. 25, 81–100 (2001).
10. Johannisson, B.: Towards a practice theory of entrepreneuring. Small Bus. Econ. 36, 135–150 (2011).
11. Yetis-Larsson, Z., Teigland, R., Dovbysh, O.: Networked Entrepreneurs. Am. Behav. Sci. 59, 475–491 (2015).
12. Gibb, A., Seidle, N.: Being an open entrepreneur. XRDS Crossroads, ACM Mag. Students. 23, 42–45 (2017).
13. Gruber, M., Henkel, J.: New ventures based on open innovation - an empirical analysis of start-up firms in embedded Linux. Int. J. Technol. Manag. 33, 356–372 (2006).
14. Davidson, E., Vaast, E.: Digital entrepreneurship and its sociomaterial enactment. In: Proceedings of the Annual Hawaii International Conference on System Sciences. pp. 1–10. IEEE (2010).
15. MacInnes, I., Moneta, J., Caraballo, J., Sarni, D.: Business models for mobile content: the case of m-games. Electron. Mark. 12, 218–227 (2002).
16. Gupta, A.K., Govindarajan, V.: Knowledge flows within multinational corporations. Strateg. Manag. J. 21, 473–496 (2000).
17. Grant, R.M., Baden-Fuller, C.: A knowledge-based theory of inter-firm collaboration. In: Academy of Management Proceedings. pp. 17–21. Academy of Management (1995).
18. Ardichvili, A., Cardozo, R., Ray, S.: A theory of entrepreneurial opportunity identification and development. J. Bus. Ventur. 18, 105–123 (2003).
19. Ingram, C., Morisse, M.: Almost an MNC: Bitcoin Entrepreneurs' Use of Collective Resources and Decoupling to Build Legitimacy. In: 2016 49th Hawaii International Conference on System Sciences (HICSS). pp. 4083–4092. IEEE (2016).
20. Cai, Y., Zhu, D.: Reputation in an open source software community: Antecedents and impacts. Decis. Support Syst. 91, 103–112 (2016).
21. Dahlander, L., Magnusson, M.G.: Relationships between open source software companies and communities: Observations from Nordic firms. Res. Policy. 34, 481–493 (2005).

22. Aldrich, H.E., Fiol, C.M.: Fools rush in? the institutional context of industry creation. Entrep. Concepts, Theory Perspect. 19, 105–127 (1994).
23. Tornikoski, E.T., Newbert, S.L.: Exploring the determinants of organizational emergence: A legitimacy perspective. J. Bus. Ventur. 22, 311–335 (2007).
24. Zimmerman, M.A., Zeitz, G.J.: Beyond Survival: Achieving New Venture Growth by Building Legitimacy. Acad. Manag. Rev. 27, 414–431 (2002).
25. Morisse, M., Ingram, C.: A Mixed Blessing: Resilience in the Entrepreneurial Socio-Technical System of Bitcoin. J. Inf. Syst. Technol. Manag. 13, 3–26 (2016).
26. Endsley, M.R.: Toward a Theory of Situation Awareness in Dynamic Systems. Hum. Factors. 37, 32–64 (1995).
27. Sarter, N.B., Woods, D.D.: How in the World Did We Ever Get into That Mode? Mode Error and Awareness in Supervisory Control. Hum. Factors J. Hum. Factors Ergon. Soc. 37, 5–19 (1995).
28. Franke, U., Brynielsson, J.: Cyber situational awareness – A systematic review of the literature. Comput. Secur. 46, 18–31 (2014).
29. Comfort, L.K., Kapucu, N.: Inter-organizational coordination in extreme events: The World Trade Center attacks, September 11, 2001. Handb. Environ. Chem. Vol. 5 Water Pollut. 39, 309–327 (2006).
30. Mykich, K., Burov, Y.: Uncertainty in Situational Awareness Systems. In: Proceedings of TCSET'2016. pp. 729–732. , Lviv-Slavske, Ukraine (2016).
31. Vogus, T.J., Sutcliffe, K.M.: Organizational resilience: Towards a theory and research agenda. Conf. Proc. - IEEE Int. Conf. Syst. Man Cybern. 3418–3422 (2007).
32. Weick, K.E.: Enacted Sensemaking in Crisis Situations. J. Manag. Stud. 25, 305–317 (1988).
33. Teigland, R., Larsson, T.: Breaking Out of the Bank in Europe Exploring Collective Emergent Institutional Entrepreneurship through Bitcoin. 15th Annu. SNEE Conf. 2013. (2013).
34. Meiklejohn, S., Pomarole, M., Jordan, G., Levchenko, K., McCoy, D., Voelker, G.M., Savage, S.: A fistful of bitcoins. A Fistful Bitcoins Charact. Payments Among Men with No Names. (2013).
35. Nakamoto, S.: Bitcoin: A peer-to-peer electronic cash system. Consulted. 1, 28 (2008).
36. CoinMarketCap: Cryptocurrency Market Capitalizations, https://coinmarketcap.com/.
37. Brito, J., Castillo, A.: Bitcoin: A Primer for Policymakers. Mercatus Center at George Mason University, Arlington (2013).
38. Hevner, A.R., March, S.T., Park, J.: Design Science in Information Systems Research. MIS Q. 28, 75–105 (2004).
39. Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S.: A Design Science Research Methodology for Information Systems Research. J. Manag. Inf. Syst. 24, 45–77 (2007).
40. Endsley, M.R., Jones, D.G.: Designing for Situation Awareness: An Approach to User-Centered Design. CRC Press, Boca Raton (2016).
41. Harrald, J., Jefferson, T.: Shared Situational Awareness in Emergency Management Mitigation and Response. In: 2007 40th Annual Hawaii International Conference on System Sciences (HICSS'07). pp. 1–8. IEEE (2007).
42. Friedman, L., Leedom, D.K., Howell, W.C.: Training situational awareness through pattern recognition in a battlefield environment. Mil. Psychol. 3, 105–112 (1991).
43. Zhao, W.: Bitcoin Exchanges Lack Legal Foundation, China Internet Finance Association Says, https://www.coindesk.com/china-internet-finance-association-bitcoin-exchanges-lack-legal-foundation/, (2017).