

Systematic Literature Review of the use of Blockchain in Supply Chain.

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ABSTRACT

In this day there is an emerging interest about the use of Blockchain in Supply Chain, and many big companies are looking into it, but the pace of implementation is still uncertain at such an early stage. However the literature published during 2015-2016 about the topic can be used to research the trend of implementation and cast some light over it. The objective of this study is to research only the literature using the methodology of Systematic Reviews.

Blockchain (Pilkington 2015) has been one of the recent technological developments that is introducing radical change in the way we deal with assets interchange in digital economy (Nakamoto 2008). Either it be in the financial industry or more recently in encompassing manufacturing and supply chain (Abeyratne and Monfared 2016).

However, all the actual hype about Blockchain technology, the fully operative projects are few, mainly in the financial industry with the Bitcoin flagship, and many more in pilot evaluations, in development or in conceptual consideration. Because of the distributed and cryptographic nature of their operation the implementation is not less free of challenges.

One changing factor to the above is the fact companies like IBM are already introducing a “Blockchain foundational layer” (MENA Report 2016) for the implementation of projects. Besides the large IT groups, specialized companies providing solutions for Blockchain projects deployment (Mougayar 2015; L. Kemp 2017) are emerging out of the earlier implementations of digital currency systems.

Being this technology (P. Satyavolu 2016) a data structure supported by a distributed data base where linked transactions are recorded as a chain of blocks not possible to tamper with, making it possible to create, access and share a digital ledger in a secure way without resorting to a central trust authority.

Adoption in the financial industry is now being followed by considering the application of this technology to the supply chain, with references starting in 2015. Where payments, smart contracts, and assets transactions of different types from manufacturing to sale can be tracked reducing time delays, human errors and costs associated. The online publication “Supply Chain 24/7” (Vorabutra 2016) considers this technology could improve recording the quantity and transfer of assets moving

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between logistic centres, and the tracking of orders, receipts, shipments and other transaction documents.

The Top Four management consulting companies (Deloitte 2016; EY 2016; PwC 2016; Accenture 2016) are already including in their latest foresight publications the Blockchain in the list of future technologies to watch for financial, healthcare, law, government, industry and logistics.

Price Waterhouse Cooper in a recent publication “Shifting patterns: The Future of the Logistics Industry” (2016), refers to the Blockchain technology as enhancing security of the supply chain, reducing bottlenecks, reducing errors and increasing efficiency. On the other hand it considers as uncertain, the rate of adoption and the emergence of one or several competing solutions.

The early adoption phase of implementations, none earlier than 2015, and the growing attention from industry, academy and research, still does not provide a sound foundation on the issues, methods, findings and direction of the Blockchain-Supply Chain solutions.

This poses the need to understand the current state of the implementation and research from the perspective of answering some questions about the early adoption. The questions of interest are related to; the type and volume of publications since 2015, the topics and issues addressed, the industrial sector intended, and the countries involved.

The research method adopted is based on Systematic Reviews (Petticrew and Roberts 2006) which is supported by evaluating and interpreting available relevant literature in relation to a particular topic using categorical analysis This review can provide convenient summaries on a particular issue and answers to questions characterising the topic of interest (Barnett-Page and Thomas 2009b).

This research approach, normally associated with healthcare analysis and social sciences, is beginning to be used to analyse the Blockchain adoption (Oshodin, Molla, and Ong 2016) in different possible sectors, allowing to research the published results during an observational period systematically.

The research is supported by a special software tool for Systematic Reviews and Meta Analysis. The tool used is EPPI-Review-4 (Thomas and Harden 2008) developed by the Department of Social Science University College London (UCL)

The study in this work requires as a first step to populate a data base of relevant literature for the period 2015-2016 from appropriate Publications Data Bases (Dickersin, Scherer, and Lefebvre 1994). The information to be collected includes citation information, publication abstract and full text document in pdf format (when possible).

Following the creation of the relevant literature data base, the categorical codes and its hierarchy for the analysis have to be defined.

The next step is the systematic analysis with the help of EPPI. The final result is a categorical multiple classification of the information, including coding part of the text in the document, allowing frequency analysis, crosstabs analysis and summary reports. The analysis can be extended to cover

other research interest, providing information is available in the Data Base (Barnett-Page and Thomas 2009a).

The Systematic Reviews method used allows a stepwise approach for this study. With a preliminary report based on a short and open sourced of references, and a second report with a larger document base, corrected by the findings to increase the quality of the searched results. The current status of the work is in the preliminary report.

Keywords: Blockchain, Supply Chain, SCM Technology, Logistics, Systematic Reviews

STATUS OF THE WORK

The study is in the preliminary report stage. About 111 records corresponding to the research topic have been found searching in several data bases. Quite a number of the records are dealing with Supply Chain sparsely which could bias the analysis. To eliminate that problem would require extending the literature terms of search to have more insightful published references.

The codes used for the categorical analysis would need to be upgraded for a better classification of the information in the records.

The results shown in this paper, which is a draft of the preliminary report, have been elaborated with the actual records and set up codes.

INTRODUCTION

Blockchain (Pilkington 2015) is introducing radical change in the way we deal with assets interchange in the digital economy (Nakamoto 2008). From the financial industry to the manufacturing and supply chain (Abeyratne and Monfared 2016), affecting sectors as mining, petrochemical, pharmaceutical, agro-food, energy, automobile, and many of the global chain industries.

Nowadays the fully operative projects are few, focused in the financial industry, and many more in pilot evaluations or in conceptual consideration for other sectors as those mentioned above. The distributed and cryptographic nature of Blockchain operation and implementation is not less free of challenges (P. Satyavolu 2016).

Although the growing attention from industry and academy the adoption phase still does not provide enough information about the issues, methods and direction of the Blockchain-Supply Chain solutions.

To understand the current state of the implementation and research an analysis of the literature is proposed (Kukafka, Johnson, and Linfante 2003). The questions of interest are related to the type and volume of publications considering the topics and issues addressed, the industrial sector intended, and the countries involved.

The research method adopted is based on Systematic Reviews (Petticrew and Roberts 2006) which is supported by evaluating and interpreting available relevant literature in relation to a particular area of interest using categorical analysis.

This study requires building a data base of relevant literature for the period 2015-2016 resulting from appropriate Publications Data Bases. In particular is needed citation information, abstract and full text in pdf format (when possible) (Dickersin, Scherer, and Lefebvre 1994).

The systematic analysis is performed with the help of different categorization methods using a software tool. The selected tool is EPPI-Reviewer-4 from the Department of Social Science University College London. The final result is a categorical classification allowing frequency analysis, crosstabs analysis and summary reports (Thomas and Harden 2008).

The Systematic Reviews approach allows implementing a stepwise approach for this study. Starting with a preliminary report based on an open source of references, followed by a report with a larger document base.

The work presented in this study corresponds to a draft of the preliminary report.

RESEARCH METHOD

This study is based in the Systematic Reviews,

which allows identifying, classifying and interpreting available published literature relevant to a topic area. The analysis process requires two steps, searching to create the literature Data Base, and screening for the categorical analysis.

Searching

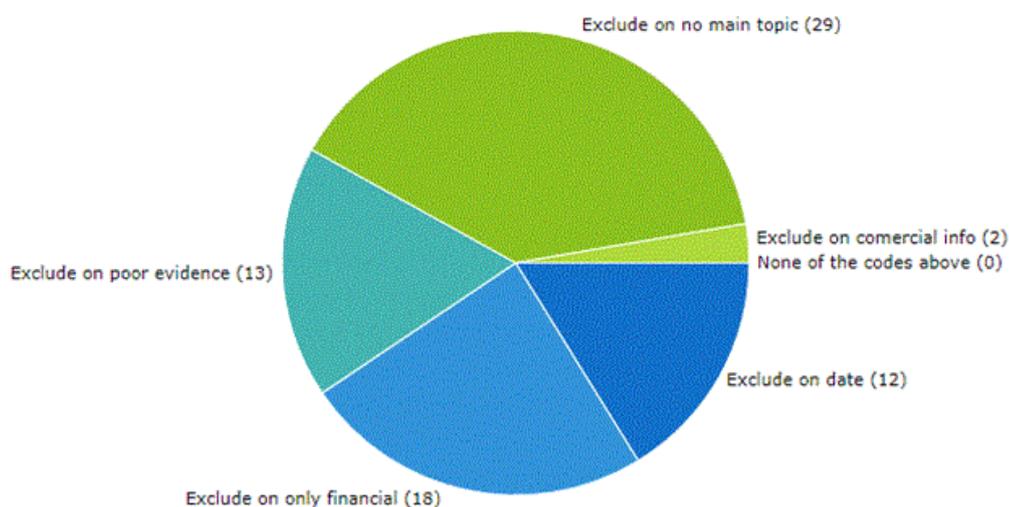
Searching involved decisions regarding the period to search, data sources, terms to search for and records collection.

To create the records of the literature Data Base the query: “Blockchain AND (Supply Chain OR Logistics)” is directed to several Publications Data Bases. The information required for each record is the citation information, abstract and full text document in pdf. The full text collection sometimes requires paying for downloading the document. In this preliminary report only free access text has been considered.

The period of search considered is restricted to 2015-2017, as there is very little consideration for the use of Blockchain in Supply Chain before 2015.

The Data Bases considered have been: IEEEExplorer, Willey Interscience Journals,

Figure 1. Excluded Records



Source: EPPI Review 4 for Blockchain records

ProQuest, WorldCat and Google Scholar, the last providing access to the full text of some records.

To mash up the different references to create the Data Base, Mendeley Desktop Reference Manager (ELSEVIER) was used with the RIS format.

A total of 111 records were collected with 50 full text documents in pdf.

Screening

Screening is the process of categorization of the records according to the set of codes set up for the analysis.

The screening involves first the exclusion (EXCLUDE) of records based on Title&Abstract and Date criteria. The exclusion results are presented in figure 1.

The remaining records (INCLUDE), in total of 37, are coded according to the set up for the analysis. The Analysis codes are divided in two hierarchical groups: Study Identification with 36 codes and Work Description with 29 codes. The coding of the records is based on abstract and full text.

RESULTS

This section presents results associated to the Review.

Type of Logistics activity

The figure 2 depicts the frequencies of the categories associated to the type of logistic applications described in the included literature.

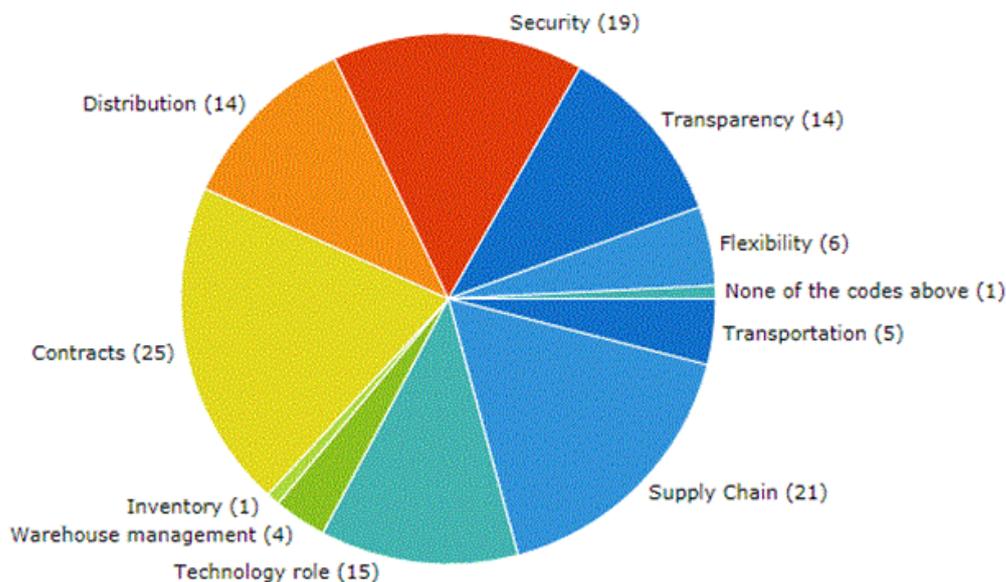
Smart Contracts is the top application, related with the trust associated to Blockchain digital ledgers.

When management of documents as results of ongoing transactions needs trust and flexibility the model of smart contracts can also be included in the logistic process. This document trust is the key for many of the applications in logistics.

Supply Chain is the second application, followed by Security.

In Supply Chain the recording of assets, tracking of trade-related documents,

Figure 2 Logistics Applications: Blockchain



Source: EPPI Review 4 for Blockchain records

provenance, sharing of information and linking physical goods to ID numbers (Vorabutra 2016) can be largely improve by the use of Blockchain

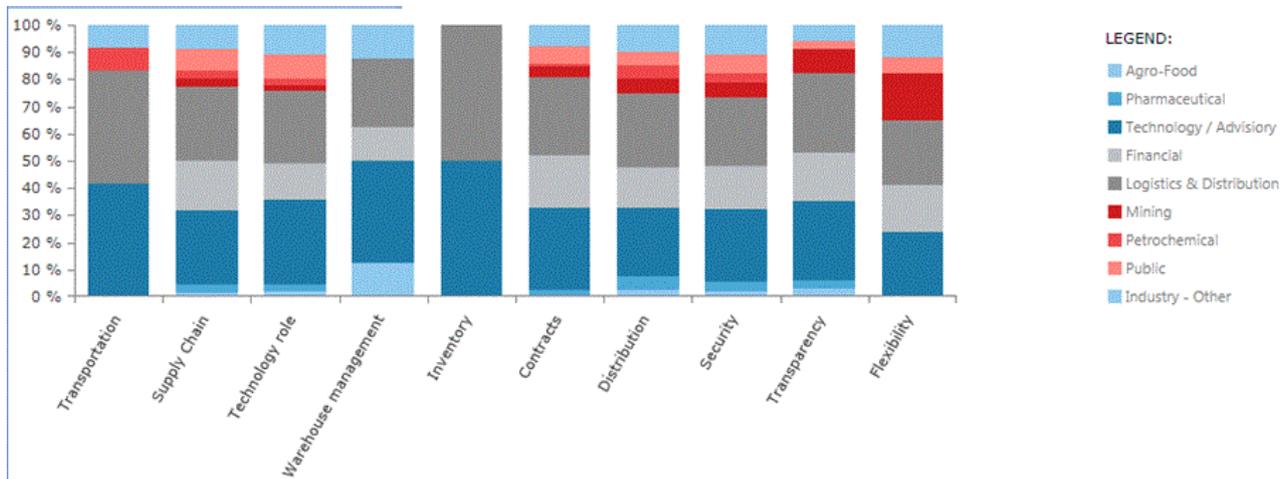
Security is one of the reasons digital ledgers in Blockchain can be trusted.

The crosstab between selected industry sectors and the applications in logistics of Blockchain is represented graphically in the figure. 3.

Mining is present in the Transportation, Supply Chain, Distribution, Security, Transparency and Flexibility. To be mentioned is the Blockchain-Supply Chain solution of BHP Billiton (Rizzo 2016).

Public Agencies are also present. In particular can be notice in Supply Chain, Technology, Contracts and Security. Public Agencies are considering applications in sourcing and Law. But also in special areas like Healthcare is seen as very promising applications

Figure 3 Logistic Application vs Industry Sector



Source: EPPI Review 4 for Blockchain records

The industry sector with presence in all the logistics applications is Technology (Software and Technology) and Advisory (Management and IT Consulting).

Financial has also a noticeable presence in all the applications. The fact that e-payments have to be included in the logistic applications makes the digital money and the financial institutions part of the solution.

Agro-Food is mentioned in Warehouse Management.

technology.

Literature organization analysis

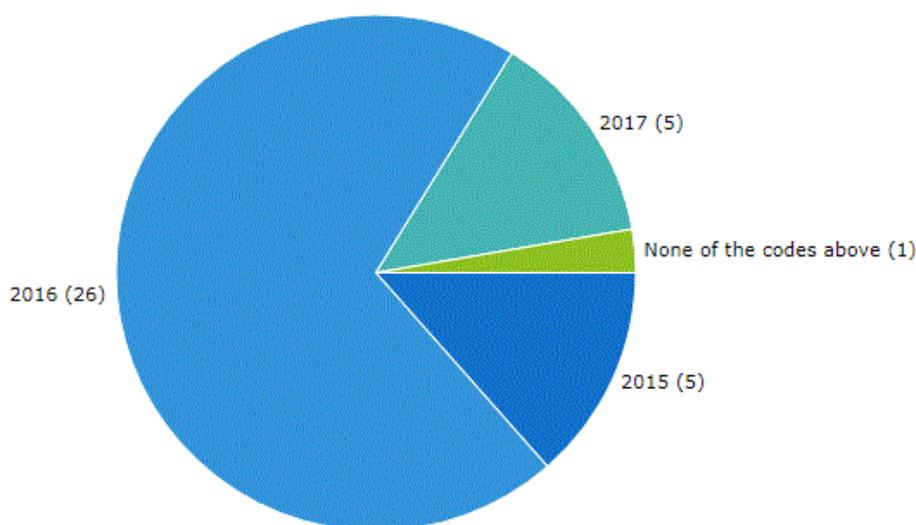
Certainly the years 2015 and 2016 have seen the emergence of commercial and academic works being published about Blockchain and Supply Chain. In the figure 4 is presented the annual contribution of literature in the review.

The year 2016 is relevant with most of the publications analysed corresponding to it. The previous year, 2015 presents very few publications.

There is to be noticed that the current year

white papers describing a commercial solution

Figure 4. Year of publication



Source: EPPI Review 4 for Blockchain records

2017, with only 2 months gone into it, accounts for the same number of publications as all of the year 2015.

What organizations, and to what organizations belong the authors of the papers, is another information of interest. Who is taking the lead in the technology application?. In the figure 5 is depicted the information about the organizations.

Commercial Companies are the first in the frequency count but very close are Universities too, followed in the third position by Research Centres.

Putting together Research Centres and Universities as Academic Organizations, then the Academic Organization takes the first position.

The number given of commercial oriented papers represents those appearing in commercial magazines, industrial conferences,

and foresight working papers from Advisory companies.

Considering the early stage of development for the solutions of Supply Chain based on Blockchain. It is surprising that the “users” and “technology suppliers” are so active in the proof of concept of the solutions for the different logistic applications.

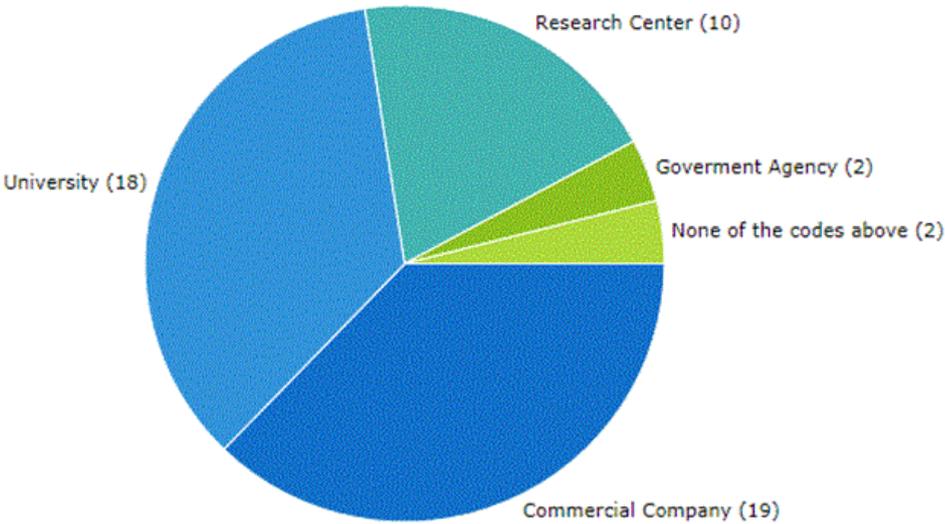
While digital currency and other financial assets applications are going mainstream into public use, the Supply Chain and other Logistic applications can be developing faster than anticipated.

With reference to the regions where those organizations are situated, three regions include a sizable amount of them: USA with 19 organizations, UE with 13 organizations, centred in countries like UK, Netherlands, Switzerland, Germany, and Asia mainly Japan and China.

Figure 6 depicts the relations between organizations and regions.

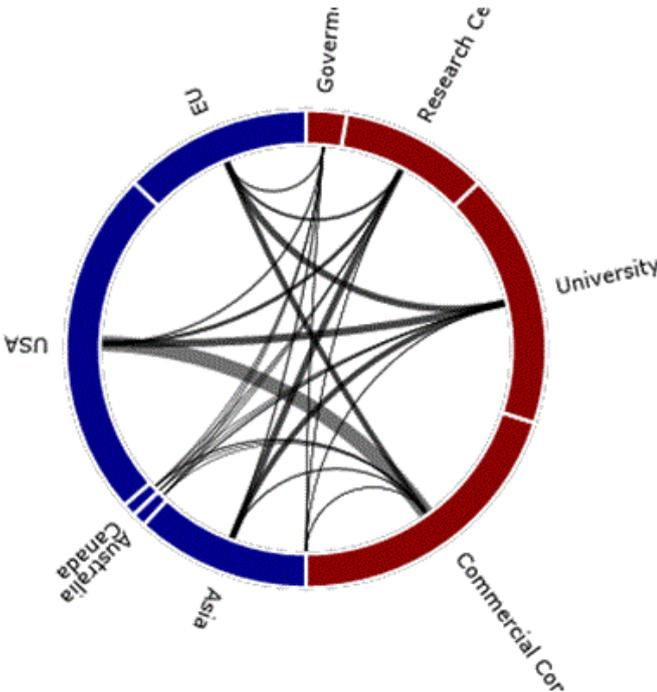
In this figure can be noticed that USA is stronger in Commercial organizations, followed by University.

Figure 5. Organizations participating



Source: EPPI Review 4 for Blockchain records

Figure 6. Organization vs. Region



Source: EPPI Review 4 for Blockchain records

The EU communications are divided more equal between Commercial Companies and Universities.

Asia however has a bigger link with Research Centres and Universities than with Commercial Companies.

One reason behind this is that most technological companies involved in commercial Blockchain software development are either US or EU (mainly UK) organizations.

Type of Work

Another aspect of interest is what relation is between the type of work described by the papers and the organizations producing them. Figure 7 depicts this relation.

In this representation, Application has a strong link with Commercial, secondly with University, and thirdly with Research Centres.

With reference to Technology the relation is more even between the three main organizations, Commercial, University, and Research.

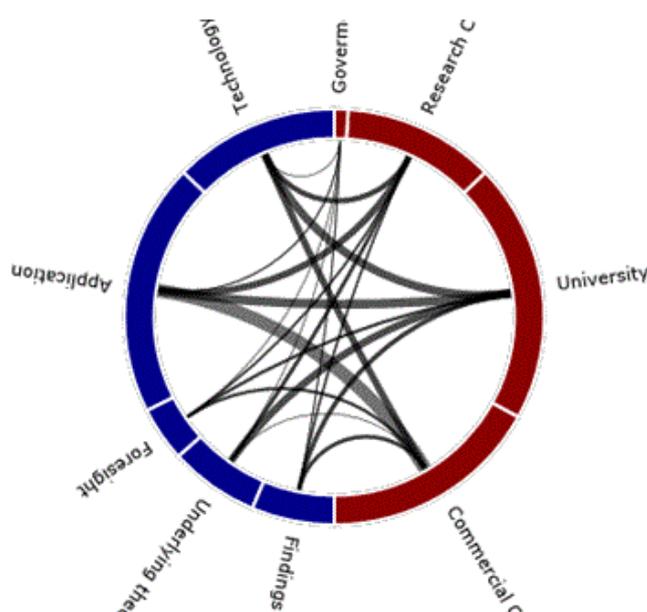
Foresight is linked, with less strength (number of papers) with the three main organizations, nearly even between them.

Underlying Theory has stronger links with University and secondly with Research.

Findings have links with University, and secondly with Commercial.

There is interesting to notice how Commercial not only has links with Applications and Technology, but has also links with Foresight and Findings. This links emerge from the presence of papers from Advisory companies.

Figure 7. Type of work vs. Organization



Source: EPPI Review 4 for Blockchain records

CONCLUSIONS

This literature Systematic Review is a draft of the preliminary report. It cannot claim to have exhausted the entire literature search, and all the codes for the analysis of the categorical information.

The ongoing analysis for the “market perspective” of an emergent application of Blockchain to Supply Chain has to accept limitations imposed by the period of information collection, 2015 to 2016, and the use of literature that is not peer-review like the commercial publications.

However the circumstances, some interesting perspectives are emerging from the review. For example the importance of Smart Contracts in the Supply Chain, the strong commercial participation in early adoption stage, the balance between USA and EU in the implementation of the technology.

The future work would be to complete the preliminary report, including the changes detected from the draft.

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