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Supply Chain with Blockchain Technology-Based at Automotive Industry

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Abstract: ***The research of adoption Supply Chain Management System (SCMS) Blockchain Technology-based in automotive industry still infancy. Based on several research reports recently, the significant development of automotive market causes several issues in SCMS automotive components industry such as fake component. However, fake component might possible to create problems from financial implication until loss of life. This research tries to elaborate Blockchain Technology (BT). Blockchain Technology as identified might be possible as a way out for development of SCMS automotive components. There are several research questions in this research such as how BT can facilitate the SCMS issues? What is the BT adoption success factor for implementation of BT in SCMS? Therefore, this study is essential for industry to develop SCMS by adopting Blockchain technology. The study method used systematic literature review (SLR) know as PRISMA technique to gather all contemporary researches information from twelve famous publishers and an international index journal. Levitt Diamond model (people, process, technology and organization) will be used to facilitated. The study found several essential factors and the influence of the critical factor into People, Process, Technology and Organization framework. Ultimately, 30 essential factors obtained for Blockchain adoption in SCMS automotive components industry, 3 essential factors impact to People, 20 essential factors impact to Process, 15 essential factors impact to Technology and 9 essential factors impact to Organization..***

Keywords: Automotive SCM Blockchain, SCM SLR, Adoption Blockchain SCM, SCM Automotive, Blockchain Automotive SLR

I. INTRODUCTION

The new technology Blockchain is famed for cryptocurrency named Bitcoin. Keeping in mind, the feature of Blockchain Technology development smart contract makes Blockchain might adopted beyond cryptocurrency such as Supply Chain Management System(SCMS) and Customer Relationship Management System (CRMS)(Swan, 2015)(Liu, 2018). In the other hand, SCMS used in many industries such as in automotive industry for tracking genuine components distribution(Madhwal and Panfilov, 2017)(Guhathakurta, 2018), monitoring and control of shipping container(Kshetri, 2018), food and drug distribution traceability(Tian, 2017). Therefore, this essential study will focus on adoption Blockchain Technology on SCMS in automotive industry especially in components aspect and the serious implication found because of it such as loss of life. This study is a starting point of the Design Science Research(DSR)(Peffers *et al.*, 2007) process, Systematic Literature Review (SLR) methodology(Weerakkody *et al.*, 2015) facilitated the research to look for essential aspect of adoption Blockchain Technology on SCMS for automotive components such as contemporary problems, essential factors, and implication to people, process, technology and organization as this are critical factors in industry(Chen and Popovich, 2003)(J.Leavitt, 1965). In consonance of the study, 12 reputable journal publishers and an index used, from total 969 papers found, however, it only 13 papers that specifically match (very limited research found) with the research topic. Finally, the study result found 7 contemporary issues, 30 essential factors that consist of 3 factors implication to people, 20 factors implication to process, 15 factors implication to technology and 9 factors implication to organization. Global picture of the model shown in Figure 1. The study report starts with introduction of the study, review of literature and methodology used, result and discussion that will explore the finding, implication research to industry and in the end is conclusion and future research.

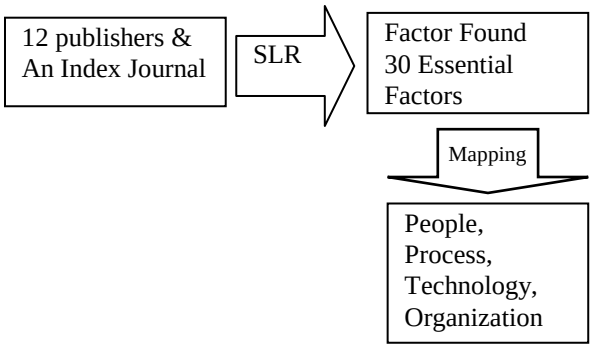

Figure 1. Research Design

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II. LITERATURE REVIEW

In this session, describe some relevant and important literature.

A. Supply Chain Management Systems

The Supply Chain Management System is as system that support or manage supply chain activities that integrated

management process among several business entities such as suppliers, retailers, manufacturers and distributors who work together to process raw materials processed into a product and then distributed to retailers (Beamon, 1998)

B. Blockchain Technology

The Blockchain Technology exhibits in Figure 2 is a famed technology in cryptocurrency named BitCoin since 2009(Satoshi Nakamoto, 2008). The first time in 2008 a paper published by a group (a person) named Satoshi Nakamoto(Satoshi; Nakamoto, 2008). The development of Blockchain Technology with Smart Contract feature, enables Blockchain Technology might possible to facilitate for Supply Chain Management System(Swan, 2015) (Surjandy *et al.*, 2019). It believes, the adoption Blockchain Technology on SCMS might cause significant improvement of SCMS and reduce the contemporary problems found especially for automotive components industry. Therefore, Blockchain Technology presents the benefits for industry for example tamperproof security, sharing, immutable, distribution, open, accuracy, transparency, and reliability (Liu *et al.*, 2020)

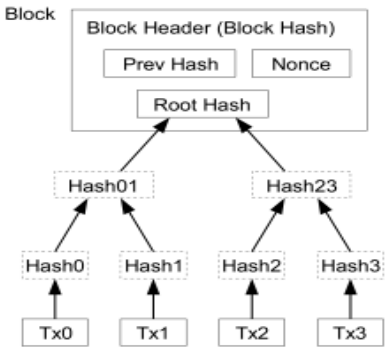

Figure 2. Blockchain Technology

C. Leavitt Diamond Model

The information systems implementation essential factors in the industry are people, process, technology and organization(Chen and Popovich, 2003) or commonly known as Leavitt's Diamond Model Figure 3. The Leavitt Diamond Model is an enhancement of Leavitt Golden Triangle that add organization as another important factor. The people factor described as workers/actors in operational, the organization is industry as a whole that will engage with other organization; the process factor described as activities of business that can be done by people, and the technology factors described as is a device or service that facilitate within the organization to run or operate the business activities(J.Leavitt, 1965).

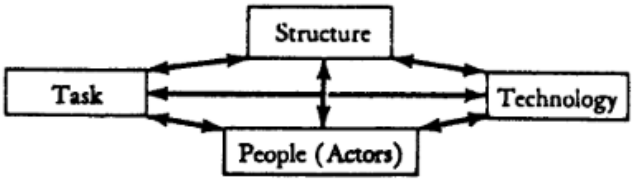

Figure 3. Leavitt's Diamond Model

D. Systematic Literature Review (SLR)

The use of SLR will facilitate the search for important factors in the discussion for the adoption of Blockchain in SCM. In this point, it will become the basis for further development of research. Therefore, this method served as a reference to any discussion of factors, as well as characteristics such as the year of publication, institutional background, and country.(Weerakkody *et al.*, 2015)

III. METHODOLOGY

In this section, it describes steps to develop the research process methodology performed. The success process of SLR, depend on the searching process mechanism, the searching includes two keywords, i.e. "Blockchain", "Blockchain" AND "Component", the searching keyword "Blockchain" AND "Component" only used for paper publisher with more than 500 papers found with "Blockchain" keyword. The aim of the searching is finding related publications topics of early research report publications. In this respect, the search performed at 12 reputable journals such as Taylor and Francis, Emerald, Wiley Online, IEEE Explore, Sage, Science Direct (Elsevier), ACM, MDPI, EBSCO, AISEL, Inderscience, Springer and an index Scopus. In the process, 969 papers found, 893 papers are eliminated for irrelevant, unmatched and duplicate topic respectively. In the topic selection process, the study acquired 76 candidate papers. In this scope, this research study solely dissects on 13 selected papers for further discussion. Figure 4 exhibit the sequential step processes.

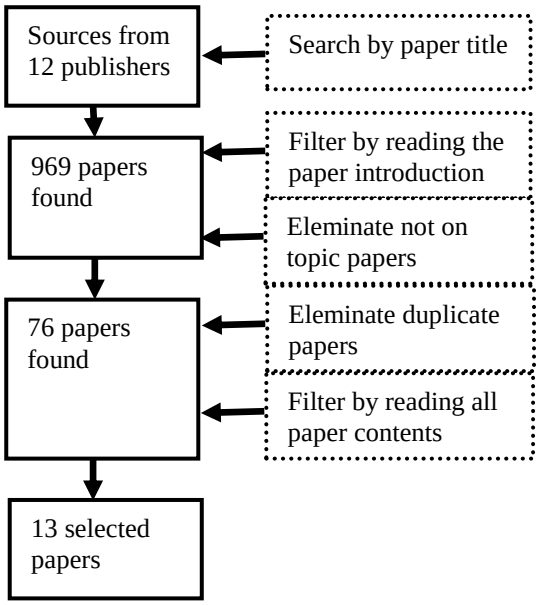

Figure 4. SLR Sequential Processes

IV. RESULT AND DISCUSSION

In this session will describe data analysis process of ultimate status of Blockchain in SCMS automotive industry and explore the essential factors, author background or characteristic as year of publication, department, contemporary challanges & discussion factors, and publication type e.g. symposium, conference, or journal.

A. The Challenges or Problems founds

The study found the most challanges stated in 5 papers (38.46%) out of 13 papers, SCMS automotive components issue is unreliable component or fake component, followed by process complexity with 4 papers (30.77%) out of 13 papers, and distrust information,

unreliable data, unperformed and quality of product issues found in 3 papers (23.08%) out of 13 papers and the last is cost of production issue with a paper (7.7%) out of 13 papers. Detail exhibit in Table 1

Table- I: The Challenges Found

No	Challenges	References	Papers
1	Fake Components	(Madhwal and Panfilov, 2017)(Gao *et al.*, 2018)(Toyoda *et al.*, 2017)(Negka *et al.*, 2019)(Holland and Stjepandi, 2018)	5 (38.46%)
2	Process Complexity	(Madhwal and Panfilov, 2017) (Gao *et al.*, 2018)(Li *et al.*, 2017)(Nakasumi, 2017)	4 (30.77%)
3	Unperformed process	(Kamble, Gunasekaran and Arha, 2018)(Tijan *et al.*, 2019)(Mandolla *et al.*, 2019)	3 (23.08%)
4	Distrust information	(Kamble, Gunasekaran and Arha, 2018)(Kuhn *et al.*, 2019)(Imeri *et al.*, 2019)	3 (23.08%)
5	Unreliable data	(Nakasumi, 2017)(Mondragon, Mondragon and Coronado, 2018)(Tijan *et al.*, 2019)	3 (23.08%)
6	Quality of Product	(Negka *et al.*, 2019) (Kuhn *et al.*, 2019) (Mondragon, Mondragon and Coronado, 2018)	3 (23.08%)
7	Production Cost	(Negka *et al.*, 2019)	1 (7.70%)

B. Year of publication

As reported in various researches, that Blockchain become essential part in Industry 4.0, however, Industry 4.0 the first time announced in 2014(Xu, Xu and Li, 2018) and relaunching of Smart Contract Ethereum was available in September of 2015(Swan, 2015). In this sense, the study found no publication of the Blockchain Technology in SCM automotive components research before 2017(Surjandy *et al.*, 2019). The study found the research topic of Supply Chain Management automotive components is relatively new with only 13 papers selected or match with the topic from twelve famous publisher and an index. The study revealed four publications out of 13 or 30.77% in 2017, four publications out of 13 or 30.77% in 2018, and five publications out of 13 or 38.46% until September in 2019. There is increasing of research of SCM in automotive components found in 2019.

C. Publication Types

The searching result found seven papers (53.85%) out of 13 of publications from conferences, five papers (38.46%) out of 13 of publications from journal and the last a paper (7.7%) out of 13 of publication from symposium. The detail of paper can be seen at Table 2.

Table- II: Publication Types

Types	Description	Papers
Conference	37th International Conference on Distributed Computing Systems Workshops	1 (7.7%)
Conference	2017 IEEE 19th Conference on Business Informatics	1 (7.7%)
Symposium	28th DAAAM International Symposium on Intelligent Manufacturing and Automation	1 (7.7%)
Journal	IEEE Access	1 (7.7%)
Journal	Journal of Computer Science and Technology	1 (7.7%)
Conference	COINS, 2019	1 (7.7%)
Journal	Inernational Journal of Production Research	1 (7.7%)
Conference	2018 IEEE International Conference on Applied System Invention (ICASI)	1 (7.7%)
Journal	Sustainability 2019	1 (7.7%)
Conference	2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC)	1 (7.7%)
Conference	CompCom 2019	1 (7.7%)
Conference	2018 IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD)	1 (7.7%)
Journal	Computers in Industry 2019	1 (7.7%)

D. Essential Factors Found.

The research study successfully obtained 30 essential factors come from 13 papers see Table 4. Based on case and topic discussed in the selected papers, the factor found will be organized into People Process, Technology and Organization aspect. The most or dominant factors found are integrated (integrated logistic process)(Gao *et al.*, 2018)(Toyoda *et al.*, 2017)(Kamble, Gunasekaran and Arha, 2018)(Kuhn *et al.*, 2019)(Mondragon, Mondragon and Coronado, 2018)(Mandolla *et al.*, 2019) and transparent (distribution to transparent network[3][17][19][20][22][23])with 6 papers (46.15%), follow by Sharing Information (sharing information among organization)[17][18][19][20][21], Security and Tracing and Tracking (monitoring and security of delivery of goods)[15][16][20][22][23] factors with 5 papers (38.46%), speed of production (matching with market need)[3][22][23], compliance (comply with regulation ISO26262)[13][16][20],

efficiency(operational and manufacturer process efficiency)[13][17][22] and safety (customer safety)[16][20][23] with 3 papers (23.08%), continuity (stock continuity)(Li *et al.*, 2017)(Mondragon, Mondragon and Coronado, 2018), cost (operational cost)(Negka *et al.*, 2019)(Mandolla *et al.*, 2019),
real-time(real-time sharing data or information) (Li *et al.*, 2017)(Tijan *et al.*, 2019), trust (trust to customer and company/product) (Kamble, Gunasekaran and Arha, 2018)(Imeri *et al.*, 2019) and visibility(process delivery visibility) with 2 papers (15.38%)(Li *et al.*, 2017)(Kamble, Gunasekaran and Arha, 2018). Auditability (auditable data), Capability (capability process), Data Exchange (data exchange among organization), Decision making(improve making decision process), Distributed (distributed data), Integrity(integrity of data) , Monitoring (process monitoring), Privacy(customer data privacy), Provenance (source of component), Reliability (data reliability), Sharing risk (risk sharing to other organization), On Time (on-time delivery process), Originality(originality of component) , Quality and Regulation (quality of product and follow regulatory regulation)with a paper each (7.70%)

Table III:. Essential Factors

No	Factors	People	Process	Technology	Organization	References	Papers stated the factor	Papers %
1	Integrated		x		x	(Gao *et al.*, 2018)(Toyoda *et al.*, 2017)(Kamble, Gunasekaran and Arha, 2018)(Kuhn *et al.*, 2019)(Mondragon, Mondragon and Coronado, 2018)(Mandolla *et al.*, 2019)	6	46.15%
2	Transparent		x	x		(Madhwal and Panfilov, 2017)(Li *et al.*, 2017)(Kamble, Gunasekaran and Arha, 2018)(Kuhn *et al.*, 2019)(Tijan *et al.*, 2019)(Mandolla *et al.*, 2019)	6	46.15%
3	Sharing Information			x	x	(Li *et al.*, 2017)(Nakasumi, 2017)(Kamble, Gunasekaran and Arha, 2018)(Kuhn *et al.*, 2019)(Imeri *et al.*, 2019)	5	38.46%
4	Security			x		(Negka *et al.*, 2019)(Holland and Stjepandi, 2018)(Kuhn *et al.*, 2019)(Tijan *et al.*, 2019)(Mandolla *et al.*, 2019)	5	38.46%
5	Tracing and Tracking		x	x		(Negka *et al.*, 2019)(Li *et al.*, 2017)(Kuhn *et al.*, 2019)(Tijan *et al.*, 2019)(Mandolla *et al.*, 2019)	5	38.46%
6	Speed of Production		x	x		(Madhwal and Panfilov, 2017)(Tijan *et al.*, 2019)(Mandolla *et al.*, 2019)	3	23.08%
7	Compliance		x		x	(Gao *et al.*, 2018)(Holland and Stjepandi, 2018)(Kuhn *et al.*, 2019)	3	23.08%
8	Efficiency		x	x		(Gao *et al.*, 2018)(Li *et al.*, 2017)(Tijan *et al.*, 2019)	3	23.08%
9	Safety	x				(Holland and Stjepandi, 2018)(Kuhn *et al.*, 2019)(Mandolla *et al.*, 2019)	3	23.08%
10	Continuity		x	x		(Li *et al.*, 2017)(Mondragon, Mondragon and Coronado, 2018)	2	15.38%
11	Cost		x			(Negka *et al.*, 2019)(Mandolla *et al.*, 2019)	2	15.38%
12	Real-Time		x	x		(Li *et al.*, 2017)(Tijan *et al.*, 2019)	2	15.38%
13	Trust	x			x	(Kamble, Gunasekaran and Arha, 2018)(Imeri *et al.*, 2019)	2	15.38%
14	Visibility			x		(Li *et al.*, 2017)(Kamble, Gunasekaran and Arha, 2018)	2	15.38%
15	Availability		x			(Madhwal and Panfilov, 2017)	1	7.70%
16	Auditability		x	x		(Negka *et al.*, 2019)	1	7.70%
17	Capability		x			(Gao *et al.*, 2018)	1	7.70%

No	Factors	People	Process	Technology	Organization	References	Papers stated the factor	Papers %
18	Data Exchange			x		(Tijan *et al.*, 2019)	1	7.70%
19	Decision Making				x	(Tijan *et al.*, 2019)	1	7.70%
20	Distributed		x	x		(Madhwal and Panfilov, 2017)	1	7.70%
21	Integrity		x		x	(Tijan *et al.*, 2019)	1	7.70%
22	Monitoring		x			(Mondragon, Mondragon and Coronado, 2018)	1	7.70%
23	Privacy	x			x	(Negka *et al.*, 2019)	1	7.70%
24	Provenance		x	x		(Mondragon, Mondragon and Coronado, 2018)	1	7.70%
25	Reliability		x	x		(Madhwal and Panfilov, 2017)	1	7.70%
26	Sharing Risk				x	(Nakasumi, 2017)	1	7.70%
27	On-Time		x	x		(Nakasumi, 2017)	1	7.70%
28	Originality		x			(Toyoda *et al.*, 2017)	1	7.70%
29	Quality		x			(Kuhn *et al.*, 2019)	1	7.70%
30	Regulation				x	(Kuhn *et al.*, 2019)	1	7.70%
	Total	3	20	15	9			

E. Leavitt's Diamond Model.

PPTO is an essential factor in SCM(Chen and Popovich, 2003). Shown in Figure 3 delineated the summary as referred to Table 4 the linkage essential factors to People, Process, Technology and Organization

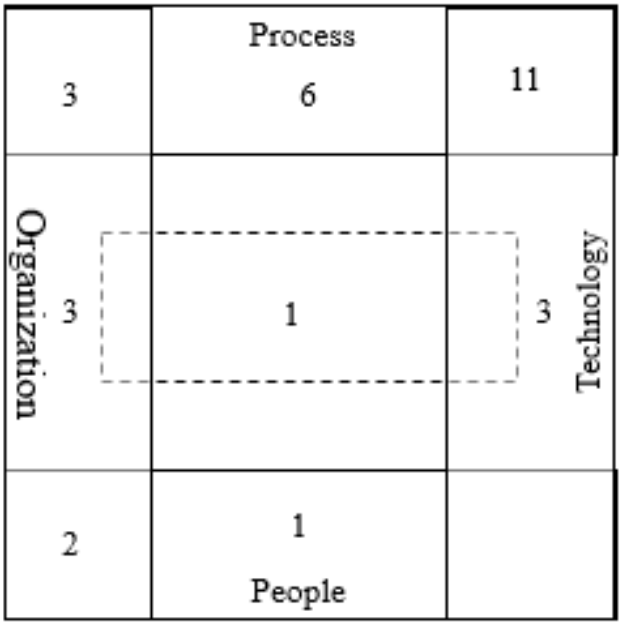

Figure 5. Linkage of Essential factor into Leavitt's Diamond Model

- **People Aspect Impact**
  People aspect impact of Blockchain Technology is focus on safety factor, where Blockchain Technology facilitate to ensure the automotive component can be used for safely production(Holland and Stjepandi, 2018)(Kuhn *et al.*, 2019)(Mandolla *et al.*, 2019), it can be happened because of traceability and tracing ability of Blockchain Technology, where the fake component can be avoided in the production
- **People and Organization Aspect Impact**
  People is a part of the organization Blockchain Technology will create trust of people to the industry or company (Kamble, Gunasekaran and Arha, 2018)(Imeri *et al.*, 2019) cause of distributed, immutable data of Blockchain. In the other hand Blockchain Technology will create another aspect of privacy of people in organization as well(Negka *et al.*, 2019).
- **Organization Aspect Impact**
  Organization aspect impact of Blockchain Technology in decision making process to speed up the decision and accuracy(Tijan *et al.*, 2019), it because of real time data and immutable characteristic of Blockchain, another aspect that possible for automotive component industry by using Blockchain technology is risk sharing(Nakasumi, 2017), this aspect is very possible because of trust between industries because of distributed and sharing information Blockchain characteristic and the last is the regulation aspect(Kuhn *et al.*, 2019) by using the Blockchain Technology it will not possible to neglect the regulation of automotive component production such as ISO26262 or safety aspect regulation.
- **Organization and Process Aspects Impact**
  Process is part of business process in Organization, integrated the process using Blockchain Technology is possible to do by adding the IoT, sensor of process the monitoring of the integrated process will easily performed by Blockchain Technology(Gao *et al.*, 2018)(Toyoda *et al.*, 2017)(Kamble, Gunasekaran and Arha, 2018)(Kuhn *et al.*, 2019)(Mondragon, Mondragon and Coronado, 2018)(Mandolla *et al.*, 2019) , Compliance factor is very important part in automotive component process(Gao *et al.*, 2018)(Holland and Stjepandi, 2018)(Kuhn *et al.*, 2019) several regulation need to comply by using Blockchain Technology is very possible to trace the product compliance from the row material until the product level. The other aspect is integrity(Tijan *et al.*, 2019), in this part it will focus on data integrity where there is no possibility of data tamper or changes, there for Blockchain Technology will be ensure the integrity of data.

- **Process Aspect Impact**
  Blockchain Technology can be facilitated to maintain availability of stock of automotive component(Madhwal and Panfilov, 2017), production capability(Gao *et al.*, 2018) and monitoring(Mondragon, Mondragon and Coronado, 2018) production process,
  automotive component originality(Toyoda *et al.*, 2017) to ensure the source of product or provenance and in the end the automotive component quality(Kuhn *et al.*, 2019).
- **Process and Technology Aspects Impact**
  Blockchain technology will create transparent(Madhwal and Panfilov, 2017)(Li *et al.*, 2017)(Kamble, Gunasekaran and Arha, 2018)(Kuhn *et al.*, 2019)(Tijan *et al.*, 2019)(Mandolla *et al.*, 2019) transaction and information regarding the component information, transaction and invoicing or payment, Tracing and Tracking(Negka *et al.*, 2019)(Li *et al.*, 2017)(Kuhn *et al.*, 2019)(Tijan *et al.*, 2019)(Mandolla *et al.*, 2019) capability to ensure the distribution information of automotive component. Blockchain may cause speed of production(Madhwal and Panfilov, 2017)(Tijan *et al.*, 2019)(Mandolla *et al.*, 2019) cause of sharing information in processing level, efficiency process(Gao *et al.*, 2018)(Li *et al.*, 2017)(Tijan *et al.*, 2019) in production level, Blockchain can ensure continuity(Li *et al.*, 2017)(Mondragon, Mondragon and Coronado, 2018) row material required and automotive component stock availability information on-time(Nakasumi, 2017) as well, Real-Time process data recording, reliability(Madhwal and Panfilov, 2017) and distributing information(Madhwal and Panfilov, 2017) of Blockchain Technology(Li *et al.*, 2017)(Tijan *et al.*, 2019). Blockchain Technology will ensuring auditability(Negka *et al.*, 2019) function and source of automotive component or provenance(Mondragon, Mondragon and Coronado, 2018).
- Technology Aspect Impact
  One of the most powerful of Blockchain Technology is security(Negka *et al.*, 2019)(Holland and Stjepandi, 2018)(Kuhn *et al.*, 2019)(Tijan *et al.*, 2019)(Mandolla *et al.*, 2019) in this case Blockchain will be used by the industry for machine instruction (command) to ensure there is no changes or tamperproof, the visibility of information(Li *et al.*, 2017)(Kamble, Gunasekaran and Arha, 2018) can be used to support in the logistic process of automotive component delivery, Blockchain /technology can facilitate the data exchange(Tijan *et al.*, 2019) in automotive industry such as in product design level or financial data exchange.
- Technology and Organization Aspects Impact
  Sharing Information (Li *et al.*, 2017)(Nakasumi, 2017)(Kamble, Gunasekaran and Arha, 2018)(Kuhn *et al.*, 2019)(Imeri *et al.*, 2019) required in automotive component process such as stock availability, market needs or requirement of automotive component.

F. Paper Author's per Country

The profile of the paper author involved 13 countries, 3 papers author come from USA & Germany countries (23.07%), 2 paper authors come from India & Japan countries (15.38%), a paper author comes from Austria, Russia, China, Greek, UK, Canada, Croatia, Italy & France (7.69%) countries. The countries mostly come from the manufacturer automotive.

V. CONCLUSIONS

The research of Blockchain Technology for automotive component industry is still infancy, no much research paper found however, the research successfully found the recent open problems that can be facilitate by Blockchain Technology, and implication of Blockchain Technology capabilities to increase in several areas in Leavitt's Diamond Model. The 30 essential factors (3 factors impact to People, 20 factors impact to Process, 15 factors impact to Technology and 9 factors impact to Organization) has been identified and explained in this paper, the result very useful of industry in adopting Blockchain technology and making preparation of policy, procedure in the future

VI. RESEARCH LIMITATION & FUTURE RESEARCH.

Limitation of research is associated with 12 publishers and one Scopus-indexed, paper source language in English. Similarly, access to several literature access is restricted. Based on the research finding report, Blockchain can be implemented in Supply Chain Management System especially for automotive component to monitoring, tracing, protecting delivery automotive component logistic, to improve the manufacturing performance, reduce operational cost, increase user safety, increase sharing information, and increase the quality of the product.

The qualitative research can be used for future research by using Principal Component Analysis (PCA) to look for the essential component and based on the essential factors found, it can be used to generate the SCM model in the future.

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