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BLOCK CHAIN INTEGRATION IN SUPPLY CHAIN MANAGEMENT

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Abstract - The need for supply chain networks to connect suppliers & customers located all over the world is growing. To address concerns about the lack of transparency & security in supply chain procedures, pilot projects are being run to test out blockchain solutions. These solutions will provide an IT architecture that addresses these needs. This essay offers a model for integrating blockchain solutions into supply chain processes & advances ongoing work. The purpose of this research is to provide a comprehensive review of the existing models for integrating technology. Furthermore, a systematic analysis of content is used to gather and classify needs for particular integration of blockchain technologies. These needs inform the evaluation, comparison, & eventual use of the models in the creation of new models. There is a need to refine the current models since they do not adequately address the unique needs of blockchain technology. Particularly, existing models do not accommodate for, and must be methodically integrated with, an increase in the quantity of external stakeholders & supply chain partners participating in blockchain-based systems. This study introduces a model for integration that takes into account the requirements of blockchain-based supply chain activities.

***Key Words*: Blockchain, Supply Chain, Technology, Integration Model.**

1.INTRODUCTION

Supply chain management has always been a challenge for most multinational corporations. Spending a lot of money has always been a problem for the organization, leading to a number of inefficiencies & need to find ways to cut costs. Businesses are planning ahead as blockchain technology approaches. This technology has the potential to improve the supply chain in the future. By enhancing supply chain efficiency, transparency, & trust, experts believe that blockchain technology could completely transform the current supply network [1]. Furthermore, a large number of supply chain executives are of the opinion that blockchain technology represents the future of the sector. According to a 2019 PwC report [2], over 25% of the industrial manufacturing industry is contemplating utilizing blockchain technology for SCM. According to the 2020 Deloitte global blockchain study [3], over half of the senior executives & practitioners surveyed considered blockchain to be their top priority.

The industrial sector of the 4.0 era relies heavily on the distributed security aspects of blockchain technology, illustrated in Figures 1, 2, and 3.

Prominent figures in academia and business have taken notice of the technology [4]. For a small fee, participants in blockchain-based distributed ledger technologies can ensure the safety of financial transactions & transfers [5]. Even though blockchain has been around for a while, it is revolutionary in the realm of supply chain networks, which hold the key to a company's future success.

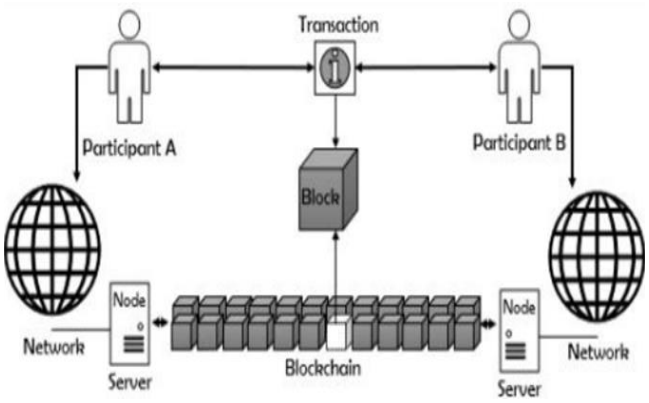

Fig1: Blockchain Technology

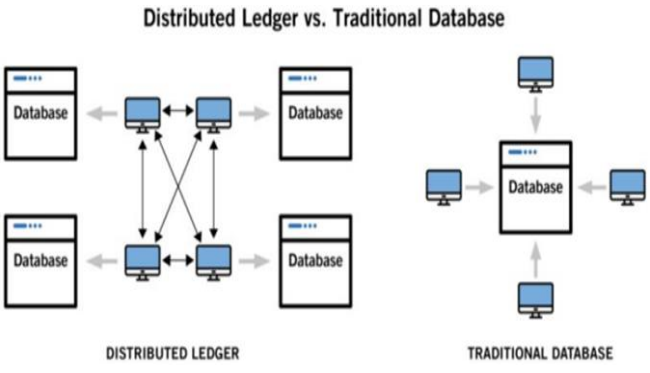

Fig 2: Blockchain Platform

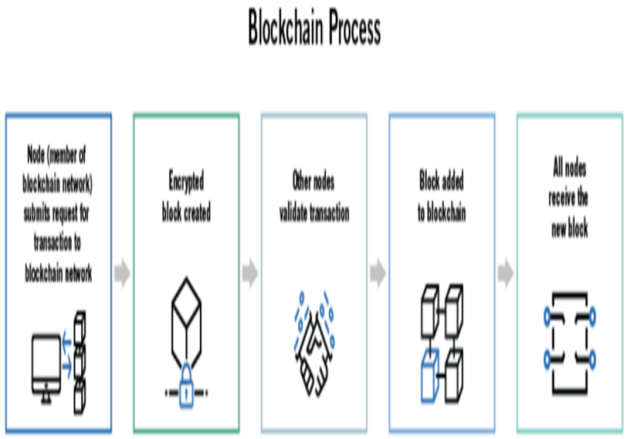

Fig 3: The Blockchain Method

1.Blockchains and supply chain relationships-

When used to supply chain management, blockchain technology has the potential to cause revolutionary changes across all kinds of businesses. As a result, the disintermediation of transactions is primarily responsible for the reconfiguration of old relationship patterns. A smart-contract process is shown in Figure 4 to help further comprehend blockchains & relationships within the supply chain. The transaction between producer A & supermarket B is shown in fig 2. A contract is drafted, coded, and "stored" in a blockchain structure once all trade conditions have been met. When the terms of the negotiation are met, a contract is considered activated. Subsequently, the contract dictates the transfer of monies & things. An intermediary is not necessary for this procedure. Since all nodes or players in the network have a copy of the ledger, it not only encourages cost reduction but also speeds up the transaction & boosts confidence [6-7].

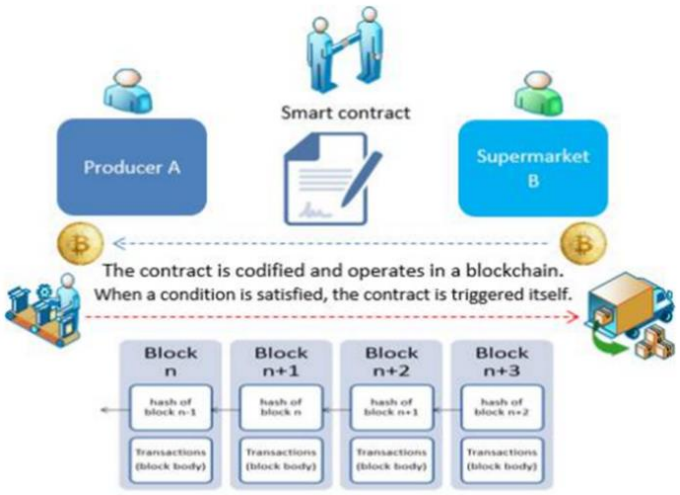

Figure 4: An SCM-related example of a smart contract

2.Methodology

Due to the lack of available integration models for blockchain technology, this study examines and synthesizes existing literature on integration models for other types of information technology. Thus, in order to assess the discovered models, requirements pertaining to blockchain technology are formulated and put into play. Van Wee (2016) and Durach et al. (2017) [8-9] provide the basis for the literature research procedure. Information technology integration ideas are sourced from Scopus, Elsevier, IEEE, Google Scholar, & Springer Link. By utilizing the filter functions & pyramid system, additional relevant articles are found. The articles are mostly chosen based on their peer reviews, but gray literature is including to ensure a diverse range of models that are relevant to practice.

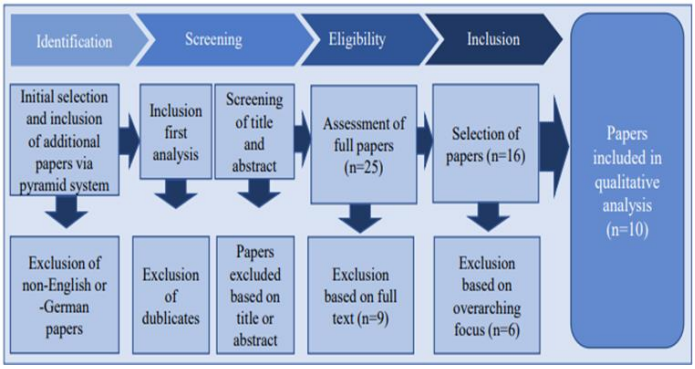

Figure 5: Methods for Selected Literature, Referring to Casino et al., 2019, p. 59

Figure 5 shows the four steps of the model selection process. To begin, neither German nor English will be accepted as an article language. Additionally, titles that fail to adequately address the incorporation of IT technologies are disregarded. The third step is to review the other articles to make sure we can propose integration models that work. Fourthly, we do not include papers that are either overly general or overly detailed. The analysis is then limited to ten models.

3.Existing Models for Integration

The five primary stages of the Accelerated SAP Model (ASAP) constitute a phase model. Project planning and preparation occur in the first stage. "Business Blueprint" is the second step that lays out the criteria for the business. Phase three entails configuring the base system, setting up system administrators, planning interfaces, and converting data. Phase four entails training staff & conducting final system tests. Last but not least, there is constant support & system check [10].

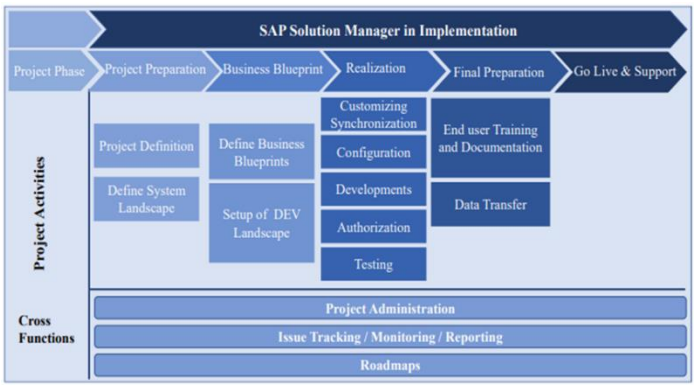

Figure 6: Accelerated SAP Model

The spiral model is the basis of Scholl's cycle. The problem and its associated duties are first specified. After that, we take into account the stakeholders and what they require. After conducting preliminary research, the next step is to reorganize the company's procedures & data organization based on the findings. Following this, the information system is designed, implemented, & evaluated. Evaluation finishes the first run. Management & project team determine if another run is required. [11] The growth of this cycle is heavily dependent on stakeholders. The project team & stakeholders are able to gain a deeper understanding by concentrating on this stakeholder group. [11].

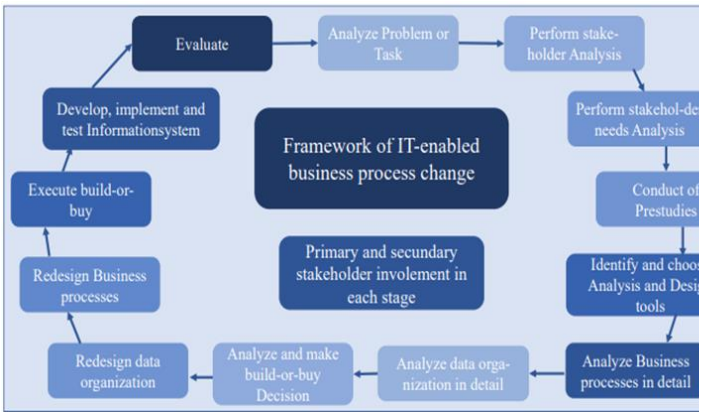

Figure 7: Scholl's cycle of process change enabled by IT

A literature review forms the basis of Nedbal's process model. The model's stages are not sequential but rather overlap and can be rearranged as needed. The first step is to assess the current state of affairs and establish the most important goals. Analyzing information systems, current business processes, or technical infrastructures is done in the second phase to determine the current status. Choosing appropriate ideas & resources is the emphasis of the third stage. The technical implementation happens in the fourth step. We present the integration strategy and develop the integration solution that is ready to be used. Evaluation of the integration solution is the last step in the process. Constant vigilance guarantees ongoing & long-term progress. [12]

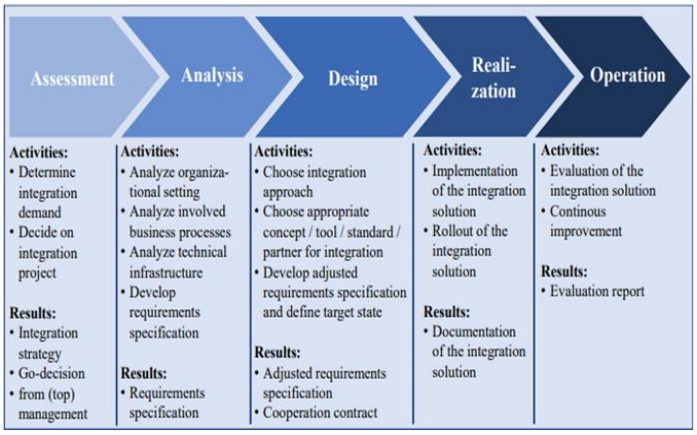

Figure 8: The model of Nedbal's process

Management of knowledge, information flows, data flows, business processes, functional organization, and value generation are all aspects of Qu et al.'s framework. [13] There are three parts to the model: the ASIS, the TO-BE, & investigation of feasibility. Business procedures, IT infrastructure, & current state of management are all examined in the AS-IS model. The TO-BE paradigm entails revamping company procedures & information systems. Ideally, organizations would have a flat, decentralized structure and synchronized inter-organizational procedures would replace business processes. To make sure the new system is efficient, the feasibility study uses quantitative methodologies to test the information system. [13]

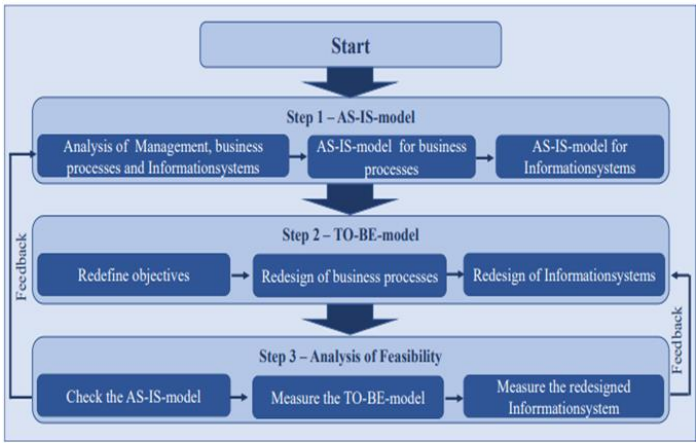

Figure 9: Qu et al.'s model

4.Needs for Integrating Blockchain Technology- we design needs related to blockchain technology once we select models for the integration of IT technologies. This is accomplished by utilizing the requirements engineering methodology that was created by Pohl (2015) [14]. The role of necessities engineering involves "identifying the

requirements of the stakeholders, documenting them correctly, checking & integrating them and managing the documented needs throughout the entire life cycle of the system". The procedures are shown in the illustration below.

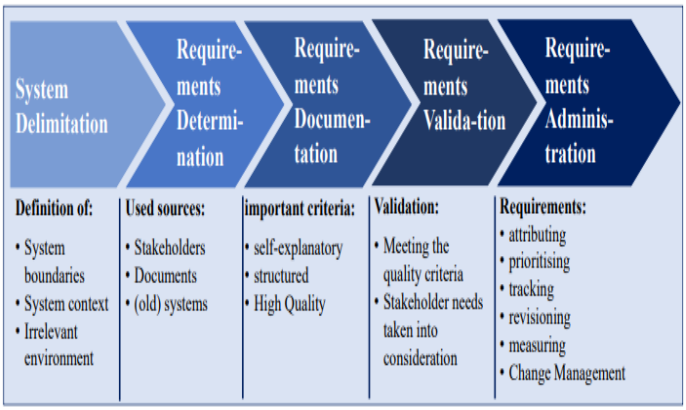

Figure 10: Requirements engineering Rupp

When doing requirements engineering, it is necessary to isolate the system under development from its surrounding environment. Blockchain technology and the demands it puts on integration models are the main topics of this research. Business & supply chain processes, together with the factors that affect them and the interfaces between them, are also important. Step two involves figuring out what needs doing, which involves looking at key requirement sources including stakeholders & documentation processes for current IT systems. In order to ascertain the needs, more literature study is conducted. Data is subsequently compiled and recorded. [14] Creating a list of all necessary specifications is the third stage. The objective is to simplify and organize the requirements such that they are easier to understand & implement. At this stage, eight criteria are established for an integration model via blockchain technology. In what follows, we shall go further into these points. [14] The quality of the specified requirements is checked in the fourth step, which also involves considering the demands of the stakeholders & fixing content problems. Completeness, verifiability, accuracy, consistency, and necessity are the categories of errors that are investigated. Here, we can combine two requirements. Step five involves handling the needs. Here, we sort the needs in order of priority so we may decide how to use them. According to Rupp, while deciding what to prioritize, one looks at factors such implementation costs, risk, damage in the event of a failed implementation, volatility, importance, and duration. As it does not advance the integration project's goals, one criterion is omitted in this stage [14]. These six conditions are a direct outcome of the process. considerations must be made for a supply chain integration strategy that centers on blockchain technology:

The concerned parties and their wants, needs, or requirements for an effective integration [15];

the current information systems being considered or examined from various angles in order to construct a complete system architecture (Kahloun 2016); [16]

The business and its surroundings to prevent further adaptation processes [17];

The management of data and the control mechanisms to be supplied [18];

The financial assessment of integration costs or benefits upfront to guarantee financial stability [19];

The integration model's quality or complexity. A high-quality, easily-understood model is required [20].

5.Evaluation

Using the established criteria, the utility analysis is applied to assess the chosen integration models for IT technologies. For both qualitative & semi-quantitative multi-criteria decision issues, the utility analysis is a common tool to employ. In addition to being easily adaptable to unique instances, it aids in decreasing complexity. It is also easy to remove or re-insert specific components. [21] The needs for evaluation are defined in the first stage of utility analysis. Everything has been taken care of. Phase two involves developing a target tree to prioritize evaluation criteria. Internal & external factors are the two primary types of requirements used for this purpose. Phase three involves defining potential requirements' features. To achieve this goal, we use a utility value scale to numerically assign values to the spoken response options. (As an example, if a need is really taken into account in the model, it would be 6, and if it is not, it would be 0.) [21] Phase four involves creating partial utility values to assess each integration model in light of the specific needs. The final step involves using the weighting factors to get the total utility of each model. Plausibility & sensitivity analyses are used to verify the outcome. The last step is to determine the order of importance. In order to highlight the best options, the total benefits are arranged in a certain order. [21] Figure 7 displays the top four models, namely Scholl's cycle, ASAP, Nedbal's process, & Qu et al. framework.

models	requirements						overall benefit
	Quality & Com-plexity (20 %)	Control mechanism & data ma-nagement (15 %)	Mone-tary expense (10 %)	Busi-ness context (15 %)	structure of Informa-tionsys-tems (20 %)	Stake-holders & system users (20 %)	
Royce, Fairley: Waterfall model	6	4	2	4	6	0	3,8
Boehm: spiral model	6	4	2	4	6	0	3,8
Microsoft: MSF	6	4	2	4	6	0	3,8
TOGAF	6	2	2	6	6	4	4,6
ASAP & SAP Solution Manager	6	4	4	4	6	6	5,2
Ortiz et al: IE - GIP	4	6	2	6	2	4	4,0
Scholls cycle	4	6	6	6	6	6	5,6
Pilorget: MIIP	0	4	2	6	6	4	3,7
Nedbals process model	6	4	4	6	6	4	5,1
Qu et al.s framework	2	6	4	6	6	6	5,0

Figure 11: Integrated model total benefits

One distinctive feature of Scholl's cycle is the unique role that stakeholders play within it. In order to satisfy the needs & desires of stakeholders, thorough analysis is conducted. The model optimally meets several of the specified requirements because of the procedure's tiny phases. The model's intricacy and lack of use are its weaknesses. There is less complexity in the ASAP model. This gives a solid overview of the project's development & guarantees that the process is straightforward to understand. One potential issue with using blockchain technology here is the control mechanisms.

With a distinct separation between actions & results, Nedbal's procedure model streamlines goal-oriented project work and allows stakeholders to be actively informed about development. Nevertheless, data management ought to take center stage in relation to blockchain integration. Qu et al.'s framework is defined by a thorough examination of the starting point & structure of the current information system. Although it follows a three-stage process, this model is more involved and challenging to implement than others. The organization's information systems & their context are thoroughly examined by the TOGAF model. [22] is a but there aren't enough checks and balances to keep it in check. In the stakeholder and system user area, the IE-GIP model excels. But the current information system architecture & monetary setting are almost completely ignored. The approach focuses heavily on data management and has a straightforward structure. [23] The waterfall model is notable for its straightforward structure and thorough analysis of the current information systems architecture; yet, it is not very flexible. [24] The simplicity is a defining feature of Boehm's spiral model. At each stage, we also think about ways to manage & govern the data. The MSF is straightforward and easy to understand, and it makes heavy use of the preexisting framework of the information systems. There is a lack of consideration for stakeholders & system users, similar to the spiral and waterfall models. [25] The 64 declared process dependencies & 17 MIIP processes make Pilorget's model exceedingly complex. [26] This model ranks last because it is difficult to work with, even though it does well in other areas.

6.Results

Using the blockchain-specific requirements that were created earlier, four applicable models for technological integration were chosen & subsequently evaluated for their merits and shortcomings. A novel approach to the targeted application of blockchain technology to supply chain operations is presented in this chapter. Finding a happy medium between simple & intricate depiction was a top goal throughout the model's development.

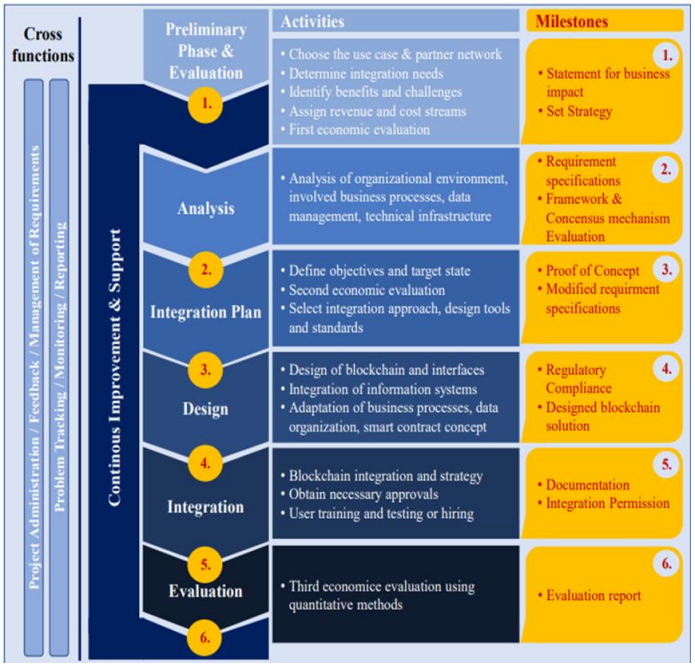

Figure 12: An approach to supply chain integration using blockchain technology

There are six distinct parts to the new model. The one-time-only integration project begins with the preliminary & evaluation phase. After this initial step, there are six further procedures that can be executed in a cyclical fashion to take user feedback & changes into account and to do regular quality checks. In addition, the cyclical form allows for easy integration & identification of new requirements. This ensures the system will continue to work for the foreseeable future. Meeting milestones is necessary to go to the next stage of the model. In addition to breaking the project down into more manageable

chunks, milestones outline specific requirements for moving on to the next stage. [24] Additionally, the model includes the following cross-functional tasks: reporting; tracking problems; managing requirements; considering feedback; & administering the project. New requirements can be quickly registered & documented by focusing on these aspects so they can be considered in the future development cycle. This is also a good method to take into account the needs that stakeholders have expressed. In addition, the project & problem tracking is done continuously so that mistakes and anomalies are caught and fixed before they can ruin the whole thing. Management is able to track the integration process thanks to the documentation & reporting, which also provide a solid foundation for conversations with blockchain partners. It is possible to report on the project's success to other stakeholders or implement the acquired learnings to future blockchain projects. [10] The blockchain's use case, its domain of application, and possible collaborators are identified during the preparatory & assessment phase. Possible sources of income and expenses, as well as the advantages & disadvantages of integrating a blockchain, are discussed. A preliminary assessment of the effect on the company is generated through this process, in conjunction with the techniques used for economic evaluation. The last step is to issue and get agreement from the appropriate parties on an integration strategy including key objectives & requirements.

The next step is the integration model's primary cyclical phase. Parts of the chosen models form the basis of the analysis in the first stage. This includes not just the project team's selection & organization's overall climate, but also the data management system, business procedures, and technological framework. At the end of this analytical step, we compile all of the findings into a requirements specification. At this stage, you should figure out which parts of your company and which procedures would be impacted by integrating blockchain technology. Because of the importance of selecting a consensus method and blockchain framework that prioritize data security & integrity, this phase is also heavily focused on technology. Modifying the requirements specifications is a part of the integration planning process. During this stage, you should look for an acceptable integration strategy & choose the right tools to implement it. The next step is to settle on an integration strategy, which involves decomposing it into smaller parts and then selecting the most important ones. All data types, information systems, middleware, and business processes that could be impacted must be considered in the integration strategy. It is at this stage that security procedures, ancillary tools and standards are chosen. At long last, we have reached a milestone: we can add more details about the business processes to the economic evaluation we did in step one, and we can merge all of our results into a formal need specification.

The technological system is created during the design phase. Considerations like as knowledge management, data & information flows, functional organization, and value-added activities are essential in this context. Businesses may need to rethink or rebuild their data organization, business processes, and how they deal with existing information technologies. System configuration, interface planning, and data conversion are subsequent tasks of the project team. The decision of whether data should be stored on-chain or off-chain is also part of the installation of a smart contract notion here. Last but not least, the launch of operations must be timed and regulated compliance must be guaranteed. At the end of this phase, all partners will have contributed to a finalized, documented design of the blockchain system.

The integration step involves incorporating the blockchain system into the evaluated company procedures. This can only be achieved by thoroughly testing the system both before & throughout the integration process. During this stage, the human element is given more attention than the organizational one. Every employee, including upper management, who must think about the strategic implications of altered business processes, needs training, not just end users. At this point, we have secured all approvals needed to launch the system. It will be possible to test the blockchain solution if the necessary permissions have been obtained. Approval of the ready-to-use blockchain solution is the milestone of this phase. The blockchain system undergoes additional testing during the review process. The third economic review takes into account the growing amount of quantitative data available for use in making assessments, as well as operational costs & benefits, project risks, strategic importance, and the needs for internal resources. Quantitative methods are suggested by Qu et al. (2018) as a means to do this [13]. Assuring complete consideration and assistance for the business environment is the goal of the evaluation. This entails polling end users, validating technical factors, & evaluating business processes. At the end of this stage, you will have an evaluation report that proves the blockchain integration was a success. The next step, after the system evaluation, is support & continual change. The integrated blockchain solution is enhanced over time by the concept of continuous change. Since the cyclical organization permits the quick recording & incorporation of newly developing requirements, this last step in our model signifies the transition to the analysis phase. Therefore, the incorporation of blockchain technology is a part of a never-ending loop of refinement.

7.Statical Analysis

Figure 13 shows the total number of articles included in the sample, broken down by publication year & article category, as a starting point for the descriptive statistics &

literature sample analysis. Without limiting the time frame of the search, the inaugural article came out in 2016.

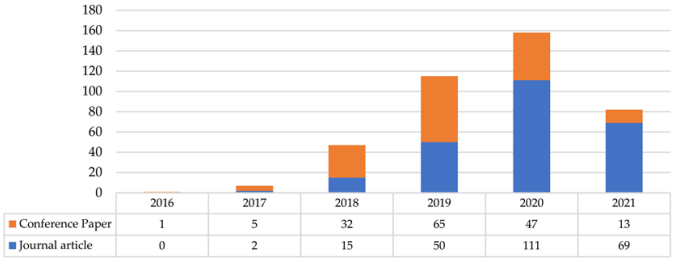

Figure 13. Number of articles by year and type.

Journal publications are gradually replacing conference proceedings as the preferred method of publication (71% of all articles in 2017 vs. 29% in 2020), which bodes well for the topic's development & future prominence. We searched the literature set for instances of publications with substantially identical material, as occasionally scholars submit papers to conferences and then to journals, but we did not find any. By displaying just journals with four or more articles, Figure 14 displays the journals with the greatest number of published papers. Other publications cover 153 stories as their only linked coverage, while sixteen other outlets cover three articles each. Figure 13 analysis already reveals two interesting & complementary topics of inquiry. There is one set of journals that focuses on business and engineering (e.g., International Journal of Production Economics, Supply Chain Management, and International Journal of Production Research) or another set that focuses on information systems research (e.g., IEEE Access, Lecture Notes in Computer Science, or International Journal of Information Management) and has nearly the same total number of publications.

According to our research, more than a thousand writers worked on BCT studies in OM and SCM. Choi, T.-M. has written thirteen articles, Li, Z., & Huang, G.Q. have written seven each, Fosso Wamba, S. has written six, and Queiroz, M.M. has written five. Hong Kong Polytechnic University, The University of Hong Kong, Worcester Polytechnic Institute, TBS Business School, Chinese Academy of Sciences, and Hong Kong Polytechnic University are the top contributing universities. See Table 1 for a rundown of the literature set's 10 most-cited papers. The articles from various journals that focused on BCT and are part of this article's literature set include: International Journal of Production Economics ("Investigating supply chain structural dynamics: novel technologies that disrupt or disruption risks"), Robotics or Computer Integrated Manufacturing ("Blockchain technology in industry"), Computers or Industrial Engineering ("Blockchain or Tokenization for Industry & Services").

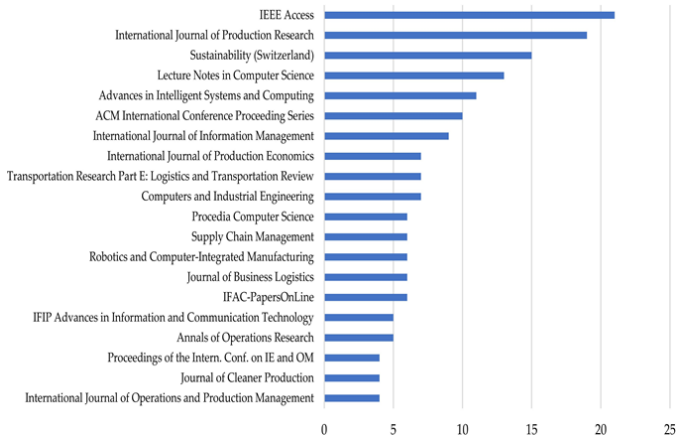

Figure 14: Quantity of articles published in each journal/conference

Table 1: Top Scopus-cited literature articles

Article/Citation	Citation Count
Saberi et al. (2019): Blockchain technology and its relationships to sustainable supply chain management	781
Tian (2016): An agri-food supply chain traceability system for Chinabased on RFID &blockchain technology	658
Kshetri (2018): Blockchain's roles in meeting key supply chain management objectives	625
Tian (2017): A supply chain traceability system for food safety basedon HACCP, blockchain & Internet of things	371
Korpela et al. (2017): Digital supply chain transformation toward blockchain integration	344
Queiroz & Fosso Wamba (2019): Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India andthe USA	318
Kim & Laskowski (2018): Toward an ontology-driven blockchaindesign for supply-chain provenance	291
Caro et al. (2018): Blockchain-based traceability in Agri-Food supplychain management: A practical implementation	281
Toyoda et al. (2017): A Novel Blockchain-Based Product Ownership Management System (POMS) for Anti-Counterfeits in the Post Supply Chain	265
Kamble et al. (2019): Understanding the Blockchain technologyadoption in supply chains-Indian context	241

Conclusion

Blockchain technology is still in its early stages of development, it is finding its way into many different supply chain activities of organizations. To find the best models for technology integration, researchers conduct extensive literature reviews. The second body of literature reviews the integration approaches in light of the demands imposed by blockchain technology. This led to the development of four foundational frameworks for integrating technology. The development of an integration model made it possible to incorporate blockchain technology into supply chain operations. But restrictions must be thought upon. Firstly, information technology (IT) is the central theme throughout all of the chosen papers for the literature review. Innovation and strategic management are two further examples of scientific methods that are ignored.

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