Politecnico di Torino

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Application of Blockchain technology & IoT based smart sensors in supply chain management via business development approach

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Abstract

The industrial world is moving towards the next layer of technological advancement with the inclusion of technologies like IoT, artificial intelligence, robotics, industry 4.0 in its operations and managerial process, this is demanding the revolutionizing the ways of data handling and utilization, so it has given the evolution to the field of Big Data and the concept of using distributed ledger technologies i.e., Blockchain. Implementation of M2M communication with the invention of 5G connectivity is enabling the industries to push towards smart and autonomous manufacturing and managerial processes. The objective of this thesis is to explore the ways and methods for resolving the challenges of existing supply chain practices with the adoption of blockchain technology. The focus of the study is to build the foundation of the business development process for STELLANTIS and TIM, first one tends to embrace the blockchain technology in its supply chain and the former one is realizing the potential of using its technical expertise and knowledge for creating profitable Business Model in the upcoming paradigm shift. At the beginning of the thesis, the concepts related to innovative technologies has been discussed, then the literature review of the implementation and adoption of Blockchain technology in the specific industry has been performed, along with analysing the existing case studies and use cases specific to our area of interest and after that systematic framework of business development methodology named as GUEST has been used for proposing the modified value chain and potential of creating the new business model in the scenario of implementation of IoT based devices and blockchain technology in the supply chain management. The GUEST methodology has five phases i.e. GO, Uniform, Evaluate, Solve and Test, involvement of analytical tools such as PEST analysis, Porter five forces analysis, business model canvas, Balance score card makes its extremely persuasive for efficient business development procedures in the dynamic environment full of uncertainties. The result of the using GUEST incentivise to get solution canvas, which is useful documents for elaborating the costumer with the definitive steps towards the solution of considered problem of visibility of battery supply chain with the adoption of IoT based smart sensors inside the blockchain paradigm.

The implementation process entails that the using Blockchain and IoT based smart sensors is an effective tool for resolving collaboration and trust issues within a supply chain and can enhance the overall efficiency of the supply chain structures, mitigating the negative consequences of information monopoly along supply chain of different industries and also

discouraging companies from engaging in any malpractice such as counterfeiting and low-quality product.

Chapter 1: Introduction

The notion is often made that competition in today's globe is no longer amongst different organisations but between supply chains, many companies are working on new ideas, such as IoT, Industry 4.0, Artificial intelligence, and blockchain for being competitive and profitable in the time of rapid technological advancement, so adopting the modifications in existing business processes is becoming essential. The concept of smart and sustainable supply chain management is demanding the change in the traditional supply chain management practices as well for gaining operational efficiency and excellence, as traditional supply chain management faces many challenges like the flow of quality from upstream to downstream, less visibility, and traceability of material flow, disruption of the supply chain in case of unforeseen circumstances, lack of trust between the two parties, too much transaction cost. Secondly, the inclusion of modern innovations increases the complexity of the modern supply chains, it's very hard to maintain transparency in the whole process of the chain.

We can ascertain that the world of supply chain operates in the environment characterized by the VUCA[1] world, the implementation of the decentralized, immutable, and safety features of the blockchain technology has been extensively considered for enhancing the transparency, visibility, traceability, security, validity, and suitability of the process in the supply chains management.

i. Project with STELLANTIS

The automotive industry is the center of innovation in this era, as there are a lot of innovative concepts on the production level that are capturing the attention and focus such as manufacturing and adoption of hybrid, electric, and sustainable vehicles. On the other hand, the connected and autonomous deriving vehicles are envisaging the digital transformation of the entire value chain of the industry, apart from this the customer expectation is varying rapidly which is redefining the means of mobility, hence forcing the traditional business process to pursue the operational excellence and transparency for remain profitable, along with the shifting towards the new business model. The objective of thesis is to implement the blockchain technology in the battery SCM of the company, specifically considering the case of track, trace and monitoring of conditions in compliance with pre-shipment tests standards and

[1] Volatility, uncertainty, complexity and ambiguity

safety regulations, it has the same goal of increasing the efficiency and effectiveness of SC operations and paving the way to adopt this innovation for meeting the customer expectations.

ii. Project with TIM

The objective is to define the stages of business development for TIM, to modelized the opportunities and challenges in the view of the integration of 5G enabled IoT-based smart sensor and blockchain in supply chain management along with identification of potential consumer areas.

In chapter 2 of the conceptual foundations, the brief idea about the main innovative technologies is covered, the research has been carried out on the concept of the smart supply chain, then a review of innovative technologies is mentioned in the view of the inclusion of these technologies in SSCM, chapter 3 is dedicated to the introduction of a GUEST methodology for performing the business development process based on the above-mentioned literature review. Chapter 4 is devised to cover the first phase of the GUEST methodology, the insight from case studies and use cases has been specifically considered for maintaining the practicality of the thesis work within the framework of tools available in the GO phase, then the business model canvas is created in chapter 5, which is second step of the methodology, aim to uniform or standardized the information analysed in the first phase. Based on the BMC the alignment of the strategical objectives of the Stellantis with the business model canvas is written under the perspective of balanced score card model in chapter 6, chapter 7 is about the presentation of the solutions to the prospect clients with the help of solution canvas model, chapter 8 contain the test phase of the Guest methodology, test phase usually dedicated to the monitoring section but here we have covered some technical framework for further deepening our insight about the practical scenario of proposed solution, lastly the conclusion is discussed and included in separate chapter 9, the analysis and compatibility of this methodology have also been discussed along with the suggestions for possible improvements.

Chapter 2: Conceptual Foundation:

2.1 Preliminaries

For conducting the literature review, research papers are searched by the keyword such as supply chain management, smart supply chain management, then addition of more keywords with supply chain is done, such as of AI, blockchain, 5G connectivity, industry 4.0 revolution etc, insight from case studies and use cases are treated as separate topics and include in the framework of GO phase, so that the detail view can be grasped for implementation of the gradual steps of GUEST methodology useful for business modelling.

While conducting the literature review, it's noted that the research carried out on the topics of integration of innovative technologies with the SCM lacking the use of the systematic framework of business development approach, which is vital for enhancing the possibilities of adoption and commercialization phase of the technology.

Before using the GUEST for our specific problem, the general overview of the applications of the blockchain and IoT in the current supply chain practices is done with the combination of linear model of supply chain structure with the porter analysis of value chain, as the porter value chain analysis is beneficial in spotting the competitive edge of any businesses that's why this general framework is used for analysing the existing challenges in the supply chain and the impact of devised technology on each segments of value chain, this would also be helpful to remain focused on the view of business development approach or the implementation of GUEST methodology.

Firstly, formal description of the theoretical concepts of innovative technologies such as AI, Blockchain, IoT and 5G is given then the challenges associate with existing SCM and its areas of Impact on SCM process with the help of proposed impact matrix, the qualitative approach is used. Practically, impact assessment matrix is used within the organizations for assessing the vulnerability of existing organizational processes towards the dynamic environment of disruptive technologies in the quantitative way, but for the purpose of refine view before implementing the new technology, we have used this in the qualitative way.

The general and liner model of the supply chain in the manufacturing industry can be shown as (1):

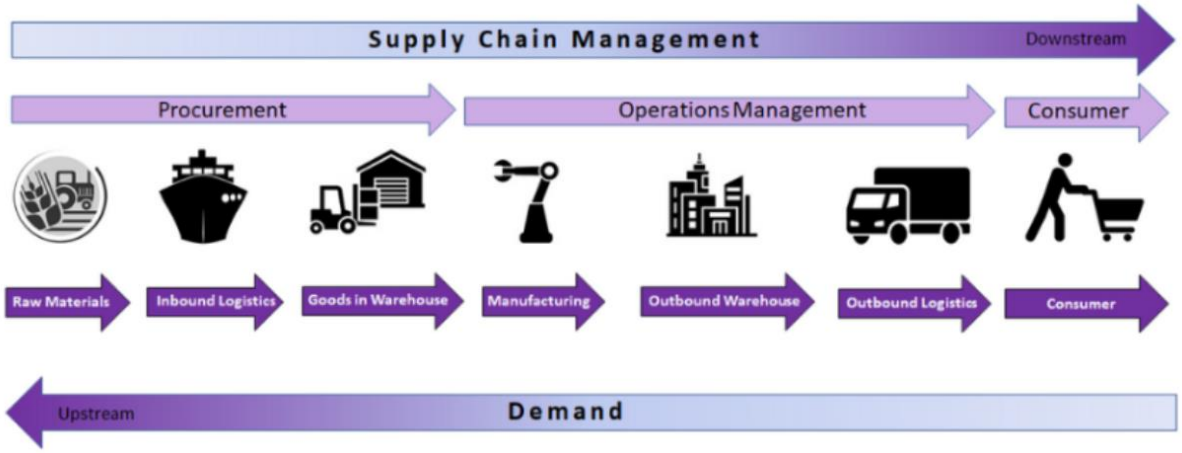

Figure 1 Supply chain general model

The activities such as planning and purchasing, coordination, control have been performed in usual supply chain,

- Planning and procurement: Activities such as demand forecasting, order placement, purchasing order, tracking and traceability of supplies, inbound inventory management usually performed. These activities are using the inputs from the outside and inside problems of demand variation, price variation, supply disruption etc, the optimization problem is solved by using different information tools such as Enterprise resource planning, Value stream mapping etc.
- The efficient coordination comprising of decision making and communication based on authentic data coming from upstream and downstream.
- The control activities helps the smooth flow of quality through out the supply chain with quality control management, variability of the customer requirement should be adequately monitored and controlled for satisfying the needs of the customers, controlling of risks is also involved in supply chain management.

The primary objective of supply chain management can be define as optimizing production, quality, cost by balancing the downstream and the upstream.

Porters value chain analysis:

How a firm is creating value for its customer, can be analyzed by the analysis of Porter value chain analysis, porter formulates the general framework by viewing the activities performed by its internal departments, porter distributed the sets of activities in primary and support

activities, this tool is valuable for determining the sources of value creation for your organization. The framework of the value chain is given as (2):

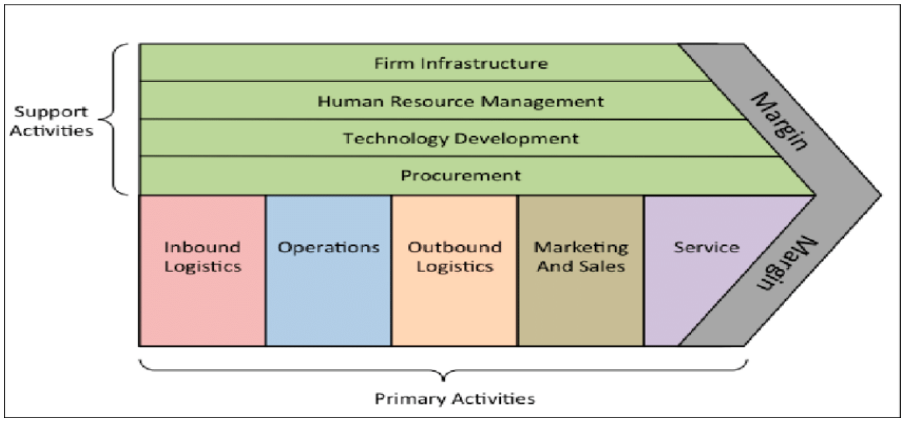

Figure 2 Porters value chain

For analysing the impact of any disruptive technology on SCM we can propose the following framework of impact analysis after considering the reformulation of general supply chain model, we have use this model for observing the impact of utilization of innovative technology on the activities and processes performed in SC of organization, the impact is mentioned and gathered on the bases of available research articles.

Category	**Typology**	**Impact of technology on SCM**
SCM activities	Planning and procurement activities	The following questions has been proposed in this analyses, the literature review has been conducted for taking the insight and impacts on existing supply chain structures. ○ What are the impacts of technology on the flow of information in each stage of SCM activities and process? ○ What are the impacts of technology on the flow of material on each stage of SCM activities and process?
	Coordination activities	
	Control activities	
SCM process	Logistics	
	Operations	

	Marketing and sales	○ What are the impacts on flow of capital?
	Services	

Table 1 Proposed questions for impact analyses

2.2 Supply chain management

2.2.1 Introduction

A supply chain management is defined as the management of the flow of information, material and capital between the different organizational entities situates at upstream to downstream of the value chain, starting from the source of raw material to final costumer (3). The main idea is originated from the implication of lean approach in the industry, aims at availability of the right thing at right place at right time but in practical scenario (4), the presence of multiple uncertain factors both in the downstream and upstream of the supply chain, generates the wastages described as Muda in lean, hence shrink the margins and profitability of organization (5).

After mind mapping we can visualize the effect of exogenous factors of uncertainties found in SC process causing the generation of lean wastages in the manufacturing process, some of the wastages generated by adopting the strategy to cope the factors of uncertainties for example; for dealing with price variability one have to spend on the maintenance of inventory etc, eventually further increase the cost.

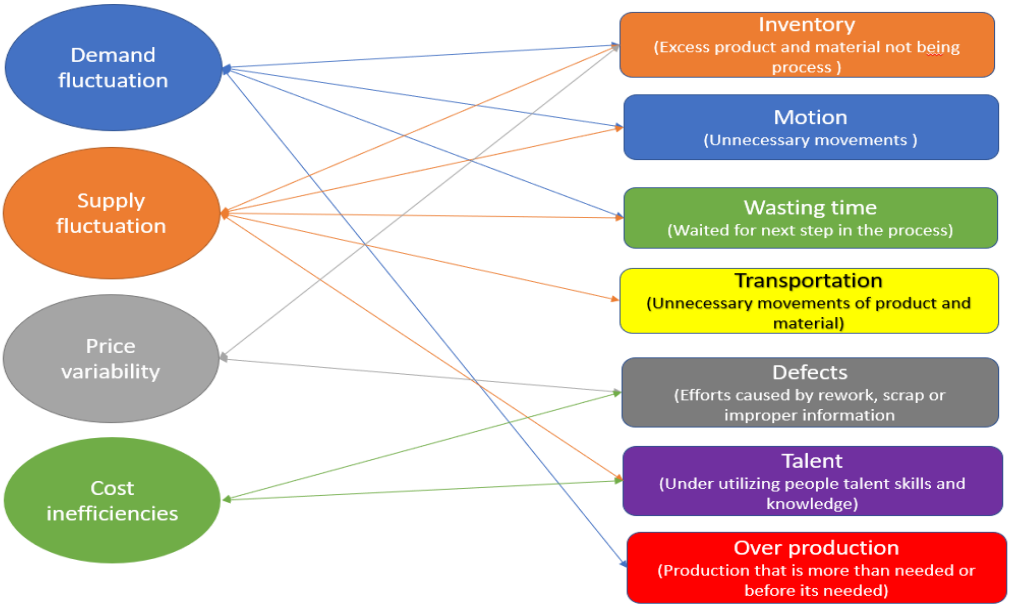

Figure 3 Relationship between Exogenous uncertainties and Lean wastages

2.2.2 Challenging factors in existing SCM

The factors of typical uncertainties in SCM make the process vulnerable and risky, those factors includes; demand variability, raw material prices fluctuation, lead time fluctuation, cost uncertainties such as production cost, labour cost, delay cost, so for coping these inefficiencies the concept of modern supply chain has been adopted aims to develops global dimension of network, increased used of outsourcing, minimizing number of the supplier, lean approach of decreasing the waste such as lead time and lot sizes, costumer driven supply chain modelling, optimizing the product life cycle and using the multi partnership approach. But this makes the process of global supply chain quite complex due to generation of tons of data.

We can generalize the problem and challenges for the modern supply chain as below;

Category	Typology	Factor of uncertainties and problems
SCM activities	Planning and procurement activities	○ Global chain of network enhance the uncertainties in the parameters like information, scheduling, costing (6)

		o The flow of capital involves high proportion of cost spend on intermediaries' parties, due to the issues of trust among the coordinating organization. o Variability of the external factors e.g., Users' preferences vary significantly with times, leading to changes in spec. And demands. (7) o Optimization problem of the inventory management system. o Bulkiness of the components lead to complexity problem. (7) demanding more resources o Visibility of the product travelling across the chain is not present, hence its hard to spot the origin and history of it, even beyond the tier 1 supplier.
	Coordination activities	o Communication gaps are present due to global networking and increase in the coordination. o Complexities in the decision-making process due to unavailability of real-time parameters. o Hectic documentations of compliances and contracts expenditures. o Longer time of dispute resolutions due to unavailability of transparent data.
	Control activities	o Planned or unintentional link precedence relations between two or more components, operations, and supply chain actors grows the complication in the control efforts exerted in supply chain structure. o Variation in products or processes results in the supply chain results in enhancing the difficult control. (7)
SCM process	Logistics	o Traceability gaps in the geographic region and condition of supplies lead to inadequate planning and resource allocation, increasing costs, causing

		shortages, and displeasing consumers demanding on-time shipments (8). o Disruption risk as happened in the Covid 19 pandemic, the most severely hit industry was the transportation one. o Lack of ability to track and retrieve defective items in real-time, operational capital is restrained for lengthy periods of time. o Custom & Border intermediaries were established in response to legislative restrictions and convoluted processes. They complicate and increase the cost of delivery in proving the validity of documents, lowering risk, shortening processing times, and avoiding fines. o Inability of enterprises to generate real - time batch commodities for shipment results in inefficient container utilization and higher shipping costs.
	Operations	o Redesigning the production strategy on a regular basis on the reflection of market developments. o Optimization of scheduling problems based on the variations of exogenous factors. o Excessive lead times due to delays in supplies. o Overproduction. o Optimization problem of incoming supplies and outbound products.
	Marketing and sales	o Product not compatible with the costumer needs, as the costumer requirements change quickly and rapidly. o Identification of hidden areas of market segments for diversified product, untap willingness to pay of consumers

		o Ineffective or unintegrated marketing and sales channels and communication gaps towards the upstream of supply chain o Stockout or scarcity of products due to optimization problem of inventory.
	Services	o Absence of systematic integration of costumer dissatisfactions causes significant effects on the upstream of the supply chain. o Ensuring the flow of quality till end users is complicated tasks especially in case of right of after sales services pass to the third parties. o Warranty claims disputes. o Cost spends on dispute resolution with partners and consumers. o Absence of registry of right of ownership o Difficult to introduce the business model innovations due to lack of integration within the value chain, hence knowing the severity of the dynamism.

2.2 Emergence of Smart Supply chain Management

Due to digital revolution and complexity enhancement of modern supply chains, the concept of Smart SCM emerged, which is equipped by the capabilities to deal with vast amount of data via advance tools of machine learning and artificial intelligence, integrated with revolutionary concept of industry 4.0 with the introduction of 5G enabled IOT based devices, blockchain technology etc., its possible for the organization to obtain the self optimization in the business processes. The distinctive characteristics of smart supply chain management is shown in following figure (6);

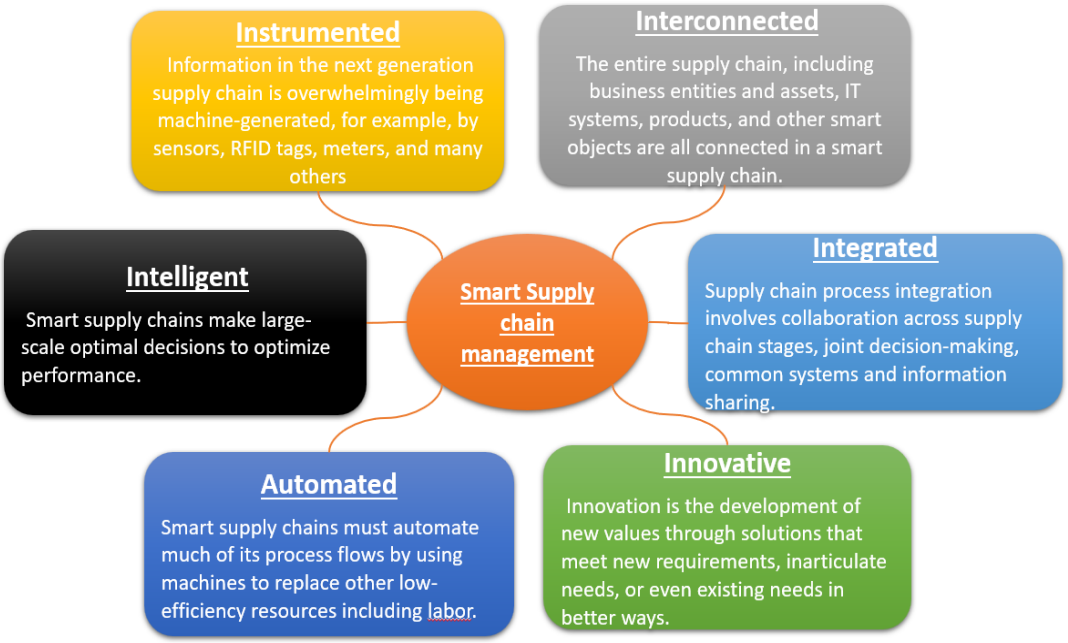

Figure 4 Attributes of Smart Supply chain

2.3 Integration of Innovative Technologies in SSCM

The below graph is depicting the adoption scenario of digital supply chain and the other innovative technologies and concepts evolving in the field of supply chain which would become the essential part of it, for preserving the competitive advantage, the companies are not focusing on the question of its adoption rather the timing of adoption is important.

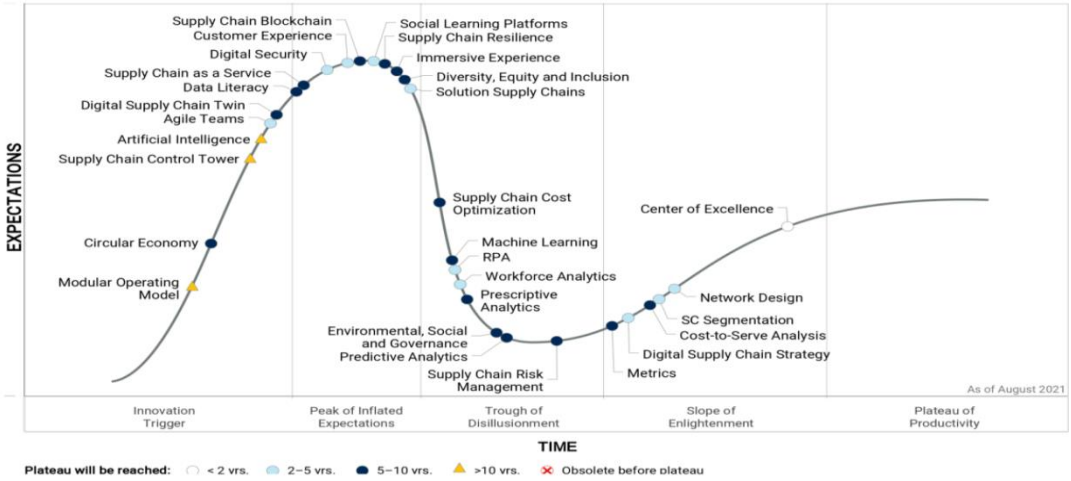

Figure 5 Hype cycle of supply chain strategies (9)

2.4 Blockchain technology

The blockchain can be defined in terms of various definitions considering its applicability according to one of important DLT based currency exchange, blockchain is "a distributed, public ledger that contains the history of every bitcoin transaction" (10)and according to oxford dictionary it can be defined as "a digital ledger in which transactions made in bitcoin or another cryptocurrency are recorded chronologically and publicly" (11)

As per further details, It is defined as the Distributed ledgers that use to store data in the decentralized manner by censuses algorithm, blockchain contain the concept of peer to peer (P2P) storing of data in the secure and consistent manner, in blockchain, actor can enter the data or transaction in the sequence, if transaction has been entered and verified at the all node then it can not altered or tempered unless the changing would be made in all the sets of transactions, it enhance its security. Blockchain is highly seems as the revolutionary approach to solve the issue of trust exist in supply chain of industries.

2.4.1 Essentials of Blockchain:

Distributed ledger:

This is perhaps the central concept of distributed ledgers, the one that distinguishes it from existing datasets or traditional ledgers. The company's business does not reside in a single location with a common ledger. Rather than that, lots of encrypted copies of data are stored on a variety of systems located throughout the globe. This strengthens the data security since it is significantly simpler to attack a centrally controlled ledger that has just one copy of the files than it is to exploit a shared ledger that contains replica.

Encryption mechanism:

The security layer of blockchain is increased use of cryptographic mechanism, It is a polite euphemism for a communication that has been encrypted, similar to decoder key but far lengthier and significantly very tough to break. Additionally, cryptography is utilized to guarantee that historical documents are unalterable (12). The mechanism is that it takes the data of your business and uploads toward the network as just a basis for creating a encrypted key known as "hash".

A hash is usually 64 characters in length, or 16 times the length of the passcode you're most probably using on the any smart device. No one has really cracked a cryptographic hashing. Each block on the blockchain — that is, each transaction documented on the registry – is linked to the blocks before that and following it by a 64-character-long 256-bit key. A further critical aspect of a block's layout is the Merkle base, which seems to be the hashes of all the transaction included inside that block. (13)

Consensus Method

Consensus agreement, in the setting of blockchain technology, refers to the agreement of two or more parties on the accurate state of the information on the network and the synchronization of data on the chain. (14)

Smart Contracts:

Another key element to remember is that documents in Blockchain databases can have smart contract software that can be executed. Smart contracts may now be executed automatically.It is the computer protocol that makes contract negotiation and execution easier, faster, and more secure. These smart contracts needs the constant validation by the external agents present in the system, the using of such procedure is contradicting the basic objective of using blockchain, that is to end the need to middle party or agent, for resolving this issue the use of sensors are required for Blockchain networks to interact directly with the physical environment. The accessibility of these devices is contingent on the existence of growth of the Internet of Things (IoT). (15)

2.4.2 Types of Blockchain:

i. Private Blockchain

Private blockchains use permissions to restrict who may participate in the network and able to add transactions to the blockchain. Generally, consensus methods and mining are not necessary due to few entities owns and controls the generation of blocks.

ii. Public Blockchain:

A public blockchain does not need any permissions. Anyone may join the blockchain network and read, publish, or participate in it. A public blockchain is distributed, meaning it is not

controlled by a single party. Information on a blockchain network is safe because it is impossible to change or edit data after it has been authenticated. Bitcoin and Ethereum is well-known example of public blockchain.

iii. Hybrid Blockchain

Also referred to as consortium blockchains, these are private blockchains that are accessible exclusively to a select group of individuals. The consensus process is managed by known, privileged networks in accordance with an agreed-upon set of rules. Because copies of the blockchain are disseminated exclusively to authorized parties, the network is only partially decentralized.

2.4.3 Impact matrix of Blockchain in Supply chain:

Category	Typology	Impact of technology on SCM
SCM activities	Planning and procurement activities	Costs are saved and processes are hastened by eliminating hectic documentation process involved in planning and procurement stages. Transparency process can be ensured throughout the stage. Uncertainties involved in Price, demand, supply fluctuations would be mitigated in presence of integration mechanism
	Coordination activities	Supply chain collaboration and coordination is one of important perk of using blockchain, the transaction cost will become less by enabling the M2M communication or the process automation is viable with the use of blockchain, the cost of hiring the third party would also be reduced. (14)
	Control activities	Elimination and minimization of low quality and counterfeited product through out the chain. Ensuring the automated quality control mechanism through out the chain via smart contracts. Production control process can also be automated with the layer of smart contracts by integration

		with the upstream data utilization. Optimization of Inventory management process in presence of exogenous uncertainties.
SCM process	Logistics	Concept of smart logistics or logistics 4.0 has originated in the perspective of DLTs in the supply chain. Tracking and visibility of the supply chain especially at the stage of logistics is possible under Blockchain implementation.
	Operations	Effective inventory management. Reduction in the lead times and production delays, hence cost saving. Possibility to automate the OM process of industry, resulting in reduction in unwanted breakdowns.
	Marketing and sales	Integration of downstream with in the chain results in adoption of strategic marketing channels of direct convincing hence resulting in huge cost savings.
	Services	Flow of quality services through out the downstream of the supply chain is possible. Transparent supply chain structures results in more satisfaction of the consumer e.g. In case of wine supply costumer can trace back the originality of the wine. Effective management of retailers channel and distributers. Eradication of fraudulent products, spare parts and drugs Blockchain can provide the tracking of ownership

2.5 Internet of Things

The Internet of Things (IoT) is a network of physical objects equipped with sensors, software network connection, and computing capabilities that collects and exchange data autonomously to securely track inventory and monitor equipment.

The impact framework analysis through out the chain has been evaluated and can be described as:

Category	Typology	Impact description
SCM activities	Planning and procurement activities	IoT integration have the utilization in planning and procurement planning, for instance, RFID and smart sensors and other IOT based devices has the potential use of demand forecasting by pursuing its integration through out the supply chain process, it would have the usage in autonomous and optimized inventory management as well, the advancement in the connectivity paradigm can give information for better precision and speed. By enabling more informed decision-making and process optimization, the Internet of Things will cut costs and result in more effective resource use. (16)
	Coordination activities	The speed of the decision-making process could be vastly increased in the presence of authentic data module collecting from the smart IOT devices. The organization can save the transaction cost involves in the inefficient coordination between the human. (17)
	Control activities	The management for mitigating the risks , flow of quality for ensuring the costumer satisfaction and the other controlling and monitoring activities would reach at next level of efficiency by using IOT in SCM.

SCM process	Logistics	Continuous product visibility throughout the supply chain, Stimulus tracing of the shipment, Smart sensing of the product to get complete picture of the process (e.g., Variables such as humidity, temperature and vibrations), Protection and preservation of product quality by sensing the alarming situation. Improving road and driver safety. Effective delivery of product and supplies with respect to timing.
	Operations	IoT based smart sensors and devices that capture real-time data may give a more precise picture of demand than was previously feasible. This improves operations by ensuring that current plans are feasible and providing businesses with the knowledge necessary to realign immediately if circumstances such as warehouse management and transportation capacity planning change. (18)
	Marketing and sales	Possibility of the effective and targeted marketing by using the IoT based devices in the product and flow of information towards the upstream for knowing useful parameters.
	Services	IoT use is taking as disruptive paradigm shift in the recent years, it propagates the use of business model innovation in the existing industry, e.g., due to management of vast amount of data the data intense business model shits has been observed such as car

		manufacturer doing partnership for launching concepts of shared mobility. Potential benefits of trackability of ownership problem of asset and product with the help of

The Internet of Things provides more efficient and rapid data collecting and processing for monitoring important technical metrics during the logistics stage of supply chain, The quality of incoming lots of the shipment can be evaluated by getting the real time data shipment.

2.6 Artificial Intelligence

Due to its key position in autonomous systems, robotics, and data science, artificial intelligence (AI) will have a significant impact on the performance and growth of the future SC sector. The use of artificial intelligence and machine learning enables the development of fully or partly automated supply chain processes and procedures. By replicating human performance and knowledge via use of AI and machine learning, optimization improves production, scheduling, operation, and management in logistics. AI and machine learning enhance the end-to-end supply chain, with the following effect areas on SCM functions and the supply chain.

Category	Typology	Impact description
SCM activities	Planning and procurement activities	Inventory management, shipping transactions, and delivery routing are all automated. The main challenge is to process the tons of data to fetch the useful data for using in planning and procurement activities, the easiness will be obtained by using the AI and big data analytics. Smart contract based on smart algorithm has the potential to resolved the challenges of existing SCM structures. (3)
	Coordination activities	The usage of Smart layers of machine learning above the layers of smart contracts of blockchain layer can make the process efficient.

	Control activities	By providing complete insight throughout the supply chain, we can enhance our management of key performance metrics (KPI). Data security would be enhanced by using the AI integration in SCM sector.
SCM process	Logistics	Predictive modelling of third party logistic is possible by using it in the sector. Disruption prediction can also be beneficial to lower the uncertainties using smart algorithm.
	Operations	Industry 4.0 revolution has the foundation of using AI and advance machine learning, pushing the industries towards M2M communications minimizing the inefficiencies and accidents generated from excessive human to machine interaction.
	Marketing and sales	Big data and Artificial Intelligence is the backbone of current digital and potential and cheap advertising on the social media. (4)
	Services	Enhancement of the quality of services results in the costumer satisfaction. Business model innovation is possible in paradigm shift of AI and smart supply chain.

2.7 5G

Qualcomm asserts that 5G lays the groundwork for future innovation, which is true when it comes to supply chain. When suppliers lack connection, obtaining real-time data is challenging. Without 5G, procurement becomes patchy. And third-party transportation is enabled by 5G's

multi-Gbps peak speeds, ultra-low latency, and tremendous data capacity. When 5G links people, machines, objects, and devices, high efficiency, improved performance, and new user experiences become possible. Additionally, 5G enables the extrapolation of greater quantities of data on geolocation, climate, humidity, and other vital information about the end-to-end supply network, Ascertaining of consistency in the dissemination of information to all stakeholders, Identification and resolving of problems that might be exacerbated by time delays, ensuring the back tracking of the origins of raw materials in real time.

Category	Typology	Impact description
SCM activities	Planning and procurement activities	Reduction in latency time due to adoption of 5G has major effect on adoption of solution having the concept of real time (19)monitoring.
	Coordination activities	
	Control activities	
SCM processes	Logistics	
	Operations	
	Marketing and sales	
	Services	

2.8 Digital Twin:

Several scientific research demonstrate that a supply chain digital twin is a strategic simulation of a supply chain that incorporates optimization models and data analytics. (20)

The core technology that allows a reasonably accurate depiction of the physical supply chain - its digital twin – to be developed is a mix of simulations, optimisation, and data analytics. The goal of developing a digital twin is to better manage supply chain risks, making them more dependable and long-lasting in the case of a breakdown. The supply chain management technologies enable important hot spots to be detected and timely alerts about occurrences that might have a significant effect on the supply chain to be sent. (21) All of this real-time failure data, as well as environmental, economical, and political hazards, may be included into the simulation model. It is feasible to employ simulations for strategic planning by combining simulation and optimization with online or "live" data.

Basic technologies like as simulation and optimization are largely employed as strategic planning tools. However, since judgments must often be taken rapidly, the decisions making, when hazards arise is depend on the availability of authentic and real time data. Modern technology enable vast volumes of data related to supply chains to be collected from various sources based on these the application is linked to determining SCM uncertainties and supplier information such as financial health and manufacturing capacity. (22)

In below we have given the conceptual model just for refining our understanding regarding this concept, which have the potential to be explored in depth, for overcoming the uncertainties and complexities issues of SCM problems. In the shifting paradigm of inclusion of connected cars to connected home and cities, digital twin would be the founding base of new business opportunities in it.

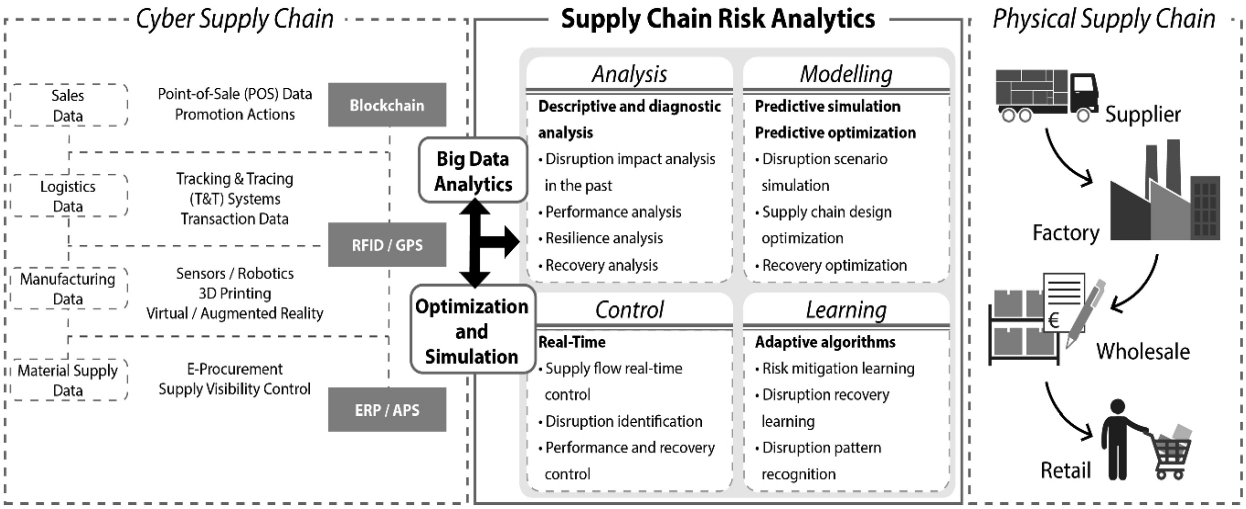

Figure 6 Digital Twin in SCM (23)

Chapter 3: GUEST Methodology

3.1 Introduction of GUEST

GUEST Methodology has been developed by the researchers of Polytecnico di Torino for carrying the business development process, it consists of five simple steps, i.e. GO, UNIFORM, EVALUATE, SOLVE & TEST. Each steps contains different set of tools for standardizing the information, the operation of each step must follow the information flow in which every predecessor become the foundation block for successive step, the close and feedback loop of this methodology makes it compatible to operate in dynamic environment full of uncertainties and demanding authentic path correction for achieving the goal of business model.

The main objective of the GUEST is to pursue the target-oriented business development approach in the paradigm full of uncertainties, for smooth business development we applied this methodology on problem. The list of frameworks which we have use from this methodology in the thesis work, is mentioned below.

3.2 List of Framework in GUEST

In the existing methodology following tools from the literature of business management has been selected for carrying out business development processes. The formal description of each tool is well described in methodology paper. We will try to summarize the information collected in each step and its interaction with the next step. This way is valuable to understand the methodology as continuous flow or as whole instead of composition of discrete set of tools having ambiguous relation or no relation with the next step.

3.2.1 GO Phase

In this phase we define the company/business, analyses of the macro and micro-environment are being done in which this company/business has to work,

- Porter's 5 forces: Analyses of micro-environment specific to industry, we consider all the actors those are directly linked & indirectly linked for creation of the value for company. This analysis is crucial for spotting the competitive advantage for the company and the factors affecting the profitability of the industry.

- PEST Analysis: Analyses of macro-environment in which Political, Economical, Sociological or Technological factors would be consider. This analysis broadens the canvas from the industrial actors to the macro influences for depicting the true picture of the industry and the future profitability, so it gives insight of long-term perspective while considering any business decision or strategy formation process.

- Social Business Network: Interaction of all the stakeholder within the considered scenario has been performed through business network diagram. Its the useful tool to visualize the real business scenario in which different stake holder are involved.

- Value proposition: After creating SBN, the value proposition is originated by considering the stakeholder benefits and suffering and the solution which we are devising. In GUEST we use value proposition canvas

3.2.2 UNIFORM

The preliminary analysis in the GO phase gives us enough insight to move towards the next phase of the methodology, which is uniform phase. In this phase we standardized all the information in the context of business model canvas.

- Business Canvas Model: The BMC is a strategy formulation tool that enables you to design and express a business concept or idea rapidly and effectively. It is a one-page document that walks the reader through the key components of a company or product, outlining a concept in a logical fashion. The details of the components is simultaneously covered below with the creation for our business model (24).

3.2.3 EVALUATE

Definition of an operative action plan for solving the problems and developing opportunities is the primary area of focus of evaluation phase of GUEST, we will use this section in the view of standardized information collected from the Uniform phase of the GUEST.

- Balanced Scorecard uses in evaluate phase, in order to collect critical information, such as objectives, measures, initiatives, and goals resulting from the four major area i.e., financial, costumer, internal and learning and growth within the organization, the BSC is employed, with the help of this tool businesses can readily pinpoint what is preventing them from achieving their goals. Further details of the implementation of this tool have been presented in the

3.2.4 SOLVE

The objective of this phase is to translate the information in the view of business model canvas, for presenting our solution to the upper management of the industry, it reflects complete light on all the constraints and benefits in presentable and understandable way.

3.2.5 TEST

This phase devoted to monitor the implemented solution in the real environment, in our case this can not perform as it exists in the real environment, but in this work, we dedicate this step to specify the technical framework and the work flow of implementation in the practical environment.

It's noted that, further detail about Balance score card, Business Model canvas and solution canvas is mentioned under its respective headings in the implementation part. From next chapter we have applied the GUEST methodology, the literature review is conducted in each phase of the methodology, so that the practical scenario of business environment would remain in front our eyes.

Chapter 4: GO Phase

Its the first phase of GUEST methodology, in this phase the preliminary information from the scientific literature regarding the proposed objective of implementation of blockchain and IoT based sensors in the SCM processes has been searched and analysed, the aim of the Go phase is to understand the all drivers which are associated with the future profitability of industry by means of major and minor analytical framework, as the adoption of new technology works in VUCA world so its very important to know multitude of drivers linked with the value proposition of future industry, the adoption of blockchain technology with the IoT and AI is among the evolving future paradigm which seems to be adopted and influence the shifting of sustainable competitive advantage, to validate this observation, we have used the tools like PEST, SWOT, Social business network ,Actor Ids and value proposition frame of work in the supply chains of industry in order to build the fine view about strategical and tactical goals for the businesses.

4.1 SWOT Analysis

The SWOT analysis is beneficial tool to analyse the strong and week areas of the technology, we have carried out the literature review in the frame of this methodology for getting known with all the challenges and opportunities that would be easily faced and harnessed respectively, after testing the proposed solution.

4.1.1 Strengths:

- **Blockchain**

i. Decentralized and distributed ledger:

The data has been stored in blockchain in the form of distributed network. The unviability of central storage make it quite safer from usual disruption, hence enhancing the decentralized decision making. (25)

ii. Transparent and visibility:

The information is confirmed and disseminated across different blockchains nodes present in the network nearly simultaneously. Because the transactions or data cannot be disguised, this increases confidence in the business system and provides value to it. The capacity of supply

chain members to track products across the chain. For instance, the purchasing parties can oversee some parts of activities at its tier-1 suppliers, but seldom at tier-2 or outside of it. The blockchain technology has possibility of providing insight into higher layer. (13)

iii. Safety:

Distributed ledgers is decentralized and it encrypts data using cryptosystem. Authorization and consensus mechanisms built into distributed ledger technology may assist in preventing unlawful or malevolent internet activity node, which are capable of efficiently providing IoT security (26)

iv. Immutability:

The important attribute of blockchain is inalterability, the transaction can not be changed or permanently deleted after the transaction has been validated by all nodes present in the chain.

v. Traceability:

Blockchain data is unaltered and unanalyzable, and its usage in the goods detection phase may result in a chain with obvious tracing and exchange possibilities. Manufacturers, distributors, merchants, or authorities cannot intervene or influence the relevant connections in this network of public monitoring and collaboration. Additionally, it aids in determining the product's uniqueness; additionally, the time and location of these activities may be identified. (27)

vi. Trust:

Because participants in blockchain technology are directly connected to the technology framework instead of just connected to centrally managed organization that may be perceived as untrusted, it has recognised as an effective remedy for removing the trust issue in traditional authorities, blockchain supposedly eliminates the need of the middle man or third party among entities. (28) When it comes to establishing confidence in a system, blockchain-based solutions are designed to accomplish by increasing member trust, rather of depending on a single third-party, blockchain enables independent parties to create a trust circle. (29)

vii. Smart contract:

Self-executing smart contracts may automate all commercial dealings and conditions between the participating stakeholder organizations. (19)

❖ **Internet of Things:**

viii. Tracing and Recognition:

The Internet of Things, RFIDs tags, sensor systems, Unique codes, barcodes, and smart GPS devices enable the tracing and recognition of items, parcels, and vessels for transportation, storage, customer sales, and dumping after the life completion scenario.

ix. Effective Knowledge Management:

Because the Internet of Things is built on widespread connection, it enables simple access to a wealth of data sources, which enables more detailed cost - effective solutions.

x. Real Time Picture:

While sensors aid in detection, stimuli may aid in optimisation. For instance, real-time analysis through sensors enables the identification of goods deterioration occurrences, which are critical in the case of food and drinks, the continuous condition monitoring is also viable via IoT.

xi. Unique Certification:

Using an IoT program, each device is issued a distinct character that it may get data and act on it.

4.1.2 Weaknesses

❖ **Blockchain**

i. Paradox between Energy performance and Security

Due to the large amount of processing power needed to operate blockchain calculations, the growth of this techs on energy devices has been hindered. Additionally, many researchers have disputed blockchain's ability to analyse data sets coming of IoT devices with respect to speed, which is not optimal to manage the mass network of IoT devices so Its recommended to refine the core algorithms to improve the number of verified blocks per second. (28)

Eliminating the blockchain's proof-of-work consensus process, for example, may significantly cut energy usage and boost performance. On the contrary, PoW protects against malevolent Network attacks and ensures that the blocks are un-tamperable. As a result, the objective is to optimize blockchain procedures to strike an acceptable balance between security and efficiency.

ii. Regulatory measures still in maturing stage:

The starting the phase of early majority in the product adoption model, its noted that the regulatory measures is not uniform across the globe, the uncertainties present in the stance of the different government and organization is the source of real challenge for implementation of such technology in the interconnected global supply chain of the industries.

❖ **Internet of Things:**

In below we have discussed some weakness of the IoT, if its used in centralized environment but integration with the Blockchain some of them could be solved.

iii. Mass amount of Data:

IoT will generate massive volumes of data across the supply chain; this data is often held in underutilized silos that are incapable of extracting real-time business insights. As such, data silos may be seen as imprisoned or hidden sources of business insight and value..

iv. Security:

In addition to device trust, other IoT security issues include permissions, data integrity, physical tampering and user privacy. One study found that 70% of IoT devices lack encryption, open interfaces, software security, and authorisation. Because IoT ecosystems are dynamic and distributed, typical security and privacy solutions are judged inapplicable. Additionally, the present Internet architecture may not be able to accommodate an endless number of devices and vast amounts of data due to individual servers being vulnerable to cyber-attacks and physical damage. For example, IoT devices are vulnerable to data theft and remote control.

v. Vulneribilty of IOT devices against forging of counterfiet data:

There is fear that IoT devices may be subjected to fraud and unauthorized access, tampering, and content manipulation via counterfeiting, cloning, and illegal access and content manipulation. Hacking RFID tags, for example, may allow security protections to be bypassed and expose new vulnerabilities during automatic verification. Also, the directions Data regarding unique tag IDs may be obtained and stored in a central database at any time. Thus, it is difficult to identify counterfeit items with ambiguous origin.

vi. Asymetric inofrmations for other stakeholders.

The adoption of smart IoT devices may enhance opacity of the system but it can produce asymmetry of information amongst the other stakeholders of supply chain parties, which can be summarized as trust issues A complicating element is that centrally controlled systems operate in the dark, with nodes unaware of how their data is kept, handled, used, and safeguarded.

vii. Unwanted Decisions in case of absolute Automations

In case, algorithmic terms defined in consensus mechanism are not constantly modified with respect to variability of the outside environment, the system's implementation at large canvas then might be too stiff to meet the demands of diverse settings for the platform. However, if the structure of a smart contract is periodically updated e.g. by Big data analytics or artificial intelligence, there is a danger that the AI would make incorrect or immoral judgments. (12) These adverse consequences may then result in irreversible alterations to logistical, informational, and economic systems. Additionally, issues arising from technology's “hidden treasures” nature become more prevalent. But the potential of cost savings at limited scenarios are too apparent so for involving the large, automated networks, the advance integration of machine learning would be needed.

4.1.3 Opportunities:

As we are using the SWOT as external analysis tools for evaluating the research literature in frame of our proposed questions, so in the opportunities section of the guest we have gathered the use cases of application of integrating the blockchain and 5G enabled IoT based devices,

in below we have considered highly linked use cases with our prospective product, that would be helpful for identifying the potential consumer for our product.

i. Shipping and Port Industries:

As our main area of focus is the logistics of batteries for EV manufacturer, so the shipping and port industry is considered for deepening the understanding involved in the shipping and port industry. The impact of blockchain and IoT based sensors is reviewed in To-be part.

- **As-IS**

Sharing of effective real time information in conventional port and shipping SCM is not followed, shipment tracking and traceability, as well as the integration of data from devices with the shipping data, is seldom accessible at harbors. The problem has the same basis present in centralized SC systems such as a lack of access for the public, resulting in shaking the costumer satisfaction to meet the needs of end customers who want to be able to follow the product's history, the storage and data analysis were undertaken in the SCs on their own and not accessible to other shareholders. (30)

Letters of credit and bills of lading must be used to verify the shipment of valuable products in the global supply chain, as these goods travel across time and space, these letters are vulnerable to missing and forgery as well, until the products arrive and the container is opened, buyers in the conventional shipping supply chain have no idea what's inside a shipping container. To determine what's inside a container, an ocean carrier is limited to the information given by the shipper or freight forwarder. Customs officials may also have difficulty identifying the imported goods and delaying of clearance process. (31) in below pictures the existing supply chain structure is shown.

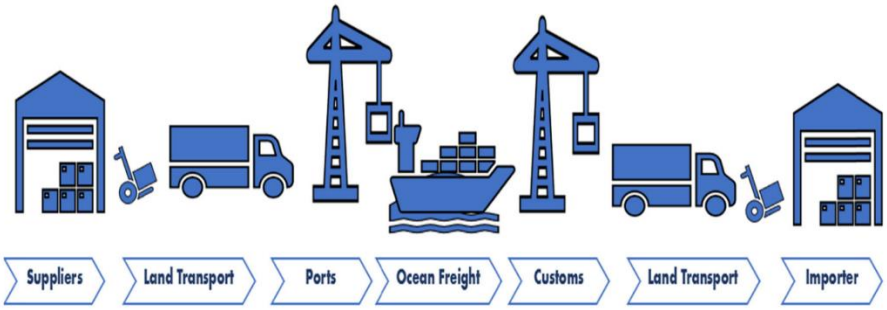

Figure 7 Existing SCM workflow of Port and Shipping Industry

Besides, lack of integration and accessibility of the data, the most painful areas for the stakeholders involved are the timely production of documents and compliances, risk of receiving the counterfeited and damaged product as well, some aspects of concerns varies with respect to industry to industry, for instance for food industry, the quality of food is matters most and for EV car manufacturer safe handling and shipping of Li-Ion is more prior pain.

- **To-Be**

Transnational commerce and transportation in the marine sector need numerous languages and various stake holders and organizations are involved in it, making digitalization and standardization a lengthy process, implementation of process automation via blockchain and IoT based devices, will enhance the process digitization results in the simplification of process, costumer satisfaction and opening the ventures for global trade attraction due to the phenomena of ease of doing business. The blockchain implantation logic is described in the following picture;

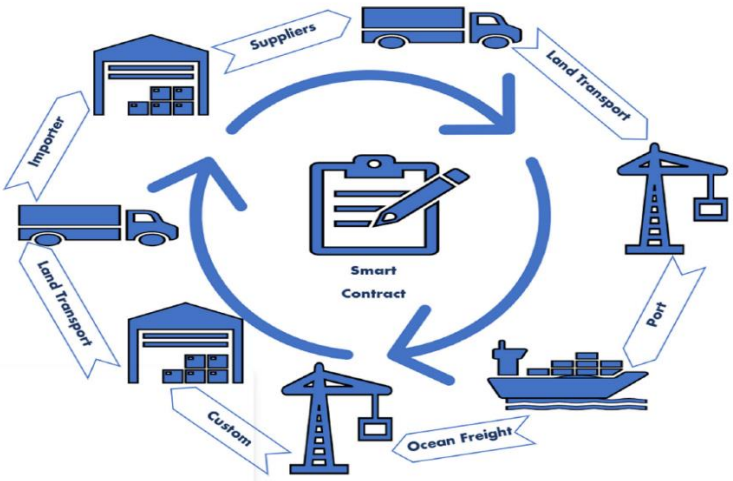

Figure 8 Modelling of SC with Blockchain and IoT

In depth analysis of the shipping and port industry is given, as it is more connected to problem of logistics in the supply chain of batteries, other than shipping and port industry, plenty of use cases of the technology is devised in literature. Just for brief summary, its can be mentioned as;

ii. Agri and Food Supply chain.

As Is Traditional agricultural and food logistic information systems are meant to monitor and maintain orders, but transparency, traceability, and auditability are not given significance importance. (32) The issues of food quality, freshness, and provenance are relevant. For instance, the customers will be disappointed if they pay a high price for a Barolo Riserva Monfortino and find out later that it is not the genuine. Even counterfeit wine transactions have a significant negative effect on the economy, as estimated by the European Union. Lost income from wine fraud is estimated to be €1.3 billion annually (3.3 percent of sales). (26), It is also an expensive issue for the agencies in charge of guaranteeing food safety and health compliance.

To be This initiative of implementation of blockchain and IoT based sensors is not driven by public authorities but also the other stakeholders involved in the supply chain of Agri food, the major concern for the stake holder have been solved by the implementation of blockchain based solution, its the only sectors which have vast amount of case studies, the key point which would be improved by the implementation of said solution can be given as, The call Initiate and promote the use of digital product passports and a circular economy. increasing the traceability and circularity of all EU market goods, product traceability to reduce counterfeiting (for example, high-valued agri-food goods), Agri-food chains may use IoT-enabled customs item monitoring and other IoT applications, such as real-time geolocation and system status tracking, to prove where their products come from and how they've been treated. The invitation also aims to establish a variety of models based on environmental sustainability. (33) (34)

iii. Oil and Gas Industry

As Is:

The oil and gas sector is considered to be the most sensitive sector in terms of constant condition monitoring, tracing, and tracking of shipments throughout the supply chain process; even dedicated storage facilities require precise monitoring in order to avoid major disasters. (35)The following are some of the challenges that must be addressed through the implementation of the said solution. Another research reveals that 15% of assets in the business are counterfeit; given the high cost of the assets in this industry, it costs the victim a

lot. Productivity loss, environmental risk, inspection and validation costs, and manufacturing delays are just a few of the perplexing challenges. (36)

To be:

It is now common practice in the oil and gas industry to use Internet of Things (IoT) sensors to collect data on a wide range of aspects of the oil and gas production process. This data includes saturation of the oil and gas fluids in the wellhead, resource utilization rates and other geological features. In the oil fields, data security is just as crucial, which is why it incorporates smart sensors based on the Internet of Things. The inclusion of integrated framework of blockchain and IoT based sensors viewed as the solution of many problems present in the supply chain of oil and gas industry.

From case study, its noted that, shell company has engaged in purchasing blockchain and IoT-based technologies, which are seen as gradual and modular changes in this business.

The objective of shell is the streamlining the procurement operations in the framework, harmonization of whole supply chain on paperless and error-free methods, to hasten collaborative industry governance. This would be achieved as creating the digital passport of expensive assets of organization, it has a wide range of applications beyond eliminating equipment audit trails0. It might be used to track the carbon footprint of a product or to provide one-click purchase with a ready passport and automated milestone payments via the use of smart contracts. (37)

iv. Smart Cities:

The concept of the smart city is not new, the autonomous and connected vehicles, M2M communication is under commercialization phase in many countries, this is also one of the many factors that is pushing the implementation of blockchain, by definition, smart city is one that can successfully handle economic, mobility, citizen engagement, natural resource management, and other variables. A Smart City is designed to provide services to residents and companies utilizing information and communication technologies. It involves setting up an infrastructure of sensors and smart devices that gather data and make it available to citizens and institutions in real-time. Infrastructural and equipment connection allows it to happen.

The more “intelligent” and linked a city is, the more appealing it is to hackers. Intelligent gadgets that gather data from residents and the environment are the backbone of Smart City administration. An assault on a smart city's vital services poses a significant danger of compromising people' privacy, so in these scenarios the use of 5G enabled IoT device with blockchain framework is the best option with respect to the cyber security and privacy. (38)

4.1.4 Threats:

i. New technology for commercialization phase

Because common standards for distributed ledger systems are still elusive, it is unrealistic to think of blockchain as a "one-size-fits-all" type of technology without the emergence of a standardized environment. While there is plenty of evidence that research efforts to standardize the environment are underway, however it is too early to predict the start of the commercialization phase of proposed technology. (28)

ii. Network effect and favourable ecosystem creation:

Blockchain implementations are necessitated by the digitally driven global commerce, which necessitates a large network size and speed. As a result, it's a major issue if just a tiny portion of a supply chain has the necessary infrastructure and the remainder does not, then it would be difficult to create the benefits of network effects.

iii. Cyber Security risk:

Another big obstacle for blockchain deployment seems to be the potential of cyber assaults. While digitalization has numerous advantages, it also exposes some industries to cybercrime. Even though one of blockchain's key benefits is the security offered by the distributed network structure, relevant research suggest that additional countermeasures are required in the event of cyber assaults. (28)

4.2 PEST Analysis

In PEST analysis, we continue our literature review under the framework of PEST, the literature regarding policies on the blockchain and IoT is searched, the economical factors is also taken into account, the social behaviour linked to the adoption scenario is also included

in this section, at last and most important factors related to technological advancement is also written.

4.2.1 Political Factors:

The political factors such as the policies of the governments regarding the adoption of said technologies is considered, the world developed economies is specifically focused because the adoption of this technology in the rest of the world highly linked with the adoption in developed world, the applications and implementation efforts on the institutional level is also viewed in this framework.

i. Policies and Initiatives of Europe union:

EU has clear vision of becoming the market leader in adoption of blockchain and paradigm shift induced by this technology, EU specifies its expectation in the form of gold standard for blockchain, described as the technology should posses the characteristics related to environmental sustainability, data protection, digital identity initiative of EU, meet the concerns about cyber security, and interoperability (39)

The EU is a prominent advocate for blockchain in terms of the economy, legislation, and regulations, in fact it has adopted the initiative of building its blockchain infrastructure.

The goal for setting this platform is based on the use case such as Notarisation, using the capabilities of blockchain to establish trustworthy digital record keeping, automating internal audits obtaining efficiency in time sensitive procedures and increasing the endurance of data security. Second use is regarding the use in authentication of educational record which reduce the cost incurred on verification procedure and also increase the confidence in their legitimacy; it will also help in developing a generic digital identity that enable users to construct and govern their own identities across borders without depending on centralised authorities, as well as facilitating compliance with the eIDAS[2] regulatory framework, lastly the initial phase aim to use blockchain solutions to safely communicate data throughout EU institutions, beginning with IOSS[3] VAT identity numbers and targeting imports exports, customs and tax officials. (40).

[2] electronic Identification, Authentication, and trust Services (eIDAS), reformed regulation in view of crypto bubble.

[3] Import-One-Stop-Shop (IOSS) scheme impacting VAT for e-commerce businesses.

The important aspect of these measures is that it has the vision to collaborates with private infrastructure as for propagation and take benefits from network effect after completion of the initial phase.

ii. Policies and initiatives of US

The US is among the top ranks on the patients filing and aiming to deploy the technology in initial phases early from the rest of the world, even some state of US are planning to utilize the potential of blockchain in the electoral processes for enhancing the transparency and trust among the population, on other side, the United States Critical Illness and Injury Trials Group (USCIITG) has collaborated with government agencies to develop a new generation inventory platform for the management and recording of combatant health and performance during military operations, as well as supporting patient-level data exchange in the United States Critical Illness and Injury Trials Group (USCIITG). These policies are the indication of favourable environment on the government level necessary for the adoption and commercialization.

iii. Policies and initiatives of China

As per analysis of policies, China seems to have the same will of adoption of the blockchain initiatives as the rest of the developed world. In fact, China is seeing itself to able to build world state of art blockchain infrastructures till 2025. In 2019, China has filed 58990 patents in distributed ledger technologies as more than from any other country in the world. Respect to national strategy plan, Made in China 2025, declares unequivocally the increment in innovation, testing, and adoption of new technologies such as blockchain, IoT etc. (41)

As per the sources of ministry of industrial affairs, China is committed to bolster the implementation of blockchain for acquiring the potential benefits such as brining the real-world economic empowerment by integrating the multi dimensional application of the technology, optimizing corporate operations, decreasing operational expenses, developing a trustworthy system, fostering new designs and innovative approaches. New sectors may all be achieved efficiency using blockchain technology. Secondly, Chinese government is encouraging companies and organizations to use a distributed ledger technology (blockchain)-based supply chain management platform to better manage transportation, traceability, information flow, and

capital flows. To promote supply chain cooperation, create a new collaborative manufacturing system and capacity sharing platform using smart contracts. (42)

State pledge to provide the necessary legislation and services to create a blockchain-based platform for government data sharing, encourage departments and regions to share and use government data, and implement projects in areas such as education, employment, health care, and social assistance, all while encouraging business collaboration and fostering under transparent environment. (43)

iv. Regulatory challenges:

Uncertain and differing rules and regulations have a detrimental influence on the efficiency and efficacy of international trade applications since businesses are hesitant to utilize blockchain in the absence of uniform national or international legislation. This might lead to a negative generalization of blockchain systems, encouraging small and medium businesses and other small-scale supply-chain participants to shun blockchain technology.

4.2.2 Economical Factors

UN digital economy report 2021 has deeply addressed the issues of data ownership with respect to future mass generation of data after implementation of advance technologies, it has mentioned the advantages to be gained from data and trans data exchange should be dispersed fairly rather than concentrated in the hands of a few enterprises or nations, in fact the problem of data ownership can fairly addressed by the adoption of blockchain technology, which would be highly rational in the world of mass data competition. (44)

In World Economic Forum in Davos, Japan's Prime Minister emphasized the need of global data governance and called on world leaders to begin negotiations on "data free flows with confidence". According to the statement, for promoting a free flow of data based on trust, consumers and businesses should be able to exchange data freely. Additionally, the statement said that electronic commerce is an important part of the global economy and that the WTO's work program on electronic commerce is critical to the future of global trade. (45)

4.2.3 Social Factors:

i. The ambiguity in the benefits proposition:

The application of blockchain for supply chain management is still in its infancy, with just a few instances of large-scale implementations. In the perspective of company owners, blockchain functionality, application, and utilization are all unknown. Most enterprises utilize enterprise resource planning (ERP) software solutions to manage supply chains, and many are confused whether they need to switch to blockchain. Furthermore, the advantages of the supply chain must be evaluated against the major impediments to its effective implementation. As a result, unclear advantages are a practical barrier to blockchain implementation in supply chains.

ii. Awareness barrier:

Although blockchain was initially categorized as a technology in 2008, it was not generally understood until the emergence of bitcoin. While academics investigate its possible uses in other industries, most sectors are unfamiliar with recent improvements and are uninformed of blockchains' potential, i.e., to streamline business transactions and communication.

4.2.4 Technological Factors

i. Adoption trends and common barriers

The data from the top consultant of strategic formulation such as McKinsey & Company, Boston Consulting Group (BCG) BCG, Deloitte, and reports from the standard review organizations are analysed to validate the trends of adoption of said technology in the supply chain paradigm.

The worldwide blockchain supply chain market was worth $ 93.16 million in 2017 and is expected to approach $ 9,852.91 million by 2025, increasing at an 80.2 percent compound annual growth rate between 2018 and 2025. (46) Blockchain is not incremental innovation as it has the potential to completely shapeup the existing industry, the existing way of doing thing will tends to obsolete after adoption of this technology (47). We can say that its competencies destroying innovation as the strategic competitive advantage become shifted to new competencies. (48)

Adoption of Blockchain technology in the SCM has the potential to totally change any industry, particularly the complex business operations, by eliminating the need for middlemen and

dramatically disrupting established business structures. However, challenges such as compatibility and scalability must be addressed before it can be widely utilized. This will enable the development of new technologies that will form the basis of an entirely new ecosystem.

ii. Lack of specialization and capabilities

The scarcity of professionals capabilities for leveraging the digitalization in businesses is common technological challenge which companies faced, researchers stated that, among the hurdles to building the foundation for adoption of advance technologies, the absence of initiative, abilities, and expertise in intelligent SC applications, as well as the SC4.0 concept's infancy and earliest stage of development are some keys issues which need to be tackle down with the help of developing the favourable ecosystem for adoption of smart SC technologies like blockchain and IoT based smart sensors.

iii. Case studies overview:

The active and past projects on adoption of this technology is given the insight about the new challenges and opportunities, as the implementation of new technology always pushed the knowledge standardization and the emergence of dominant design. Its worthy to take insight from the systematic literature review of the projects carried out on SCM application, the functionalities which have been considered in the projects is shown in graph; (49)

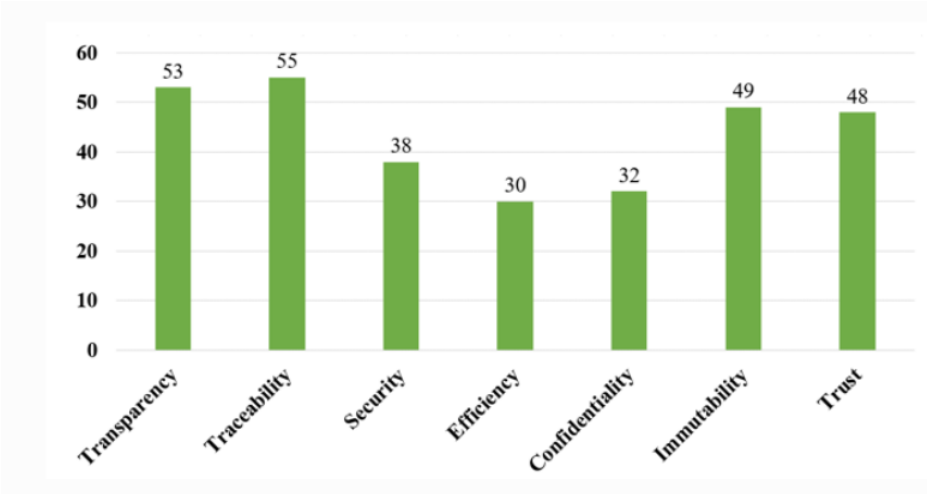

Figure 9 Functionalities of Case studies

The characteristic of safe, real-time data processing with monitoring and regulating data in a virtual environment was noted in many case studies. Reduced (or removed) documentation in supply chain procedures improves efficiency by reducing response times. Similarly, supply chain visibility improves or works hand in hand with traceability. Digitalizing processes minimizes the chance of human mistake and in efficiencies while also reducing geographic barriers and facilitating access from anywhere in the globe.

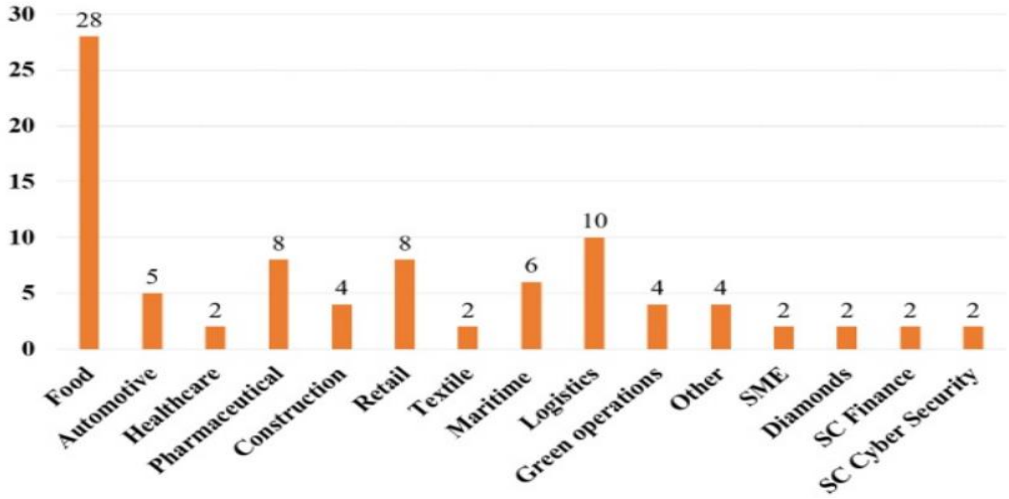

Figure 10 Dominant sectors of case studies in SCM

4.3 Social business network for EV battery supply chain.

In EVs supply chain various stake holders involved such as raw material and parts supplier, cell manufacturer, vehicle manufacturer, testing and certifications organization, battery recycling companies and Institutional authorities. The problem of battery SC process are same as usually involved in the SC process has been discussed in (0), the battery is very sophisticated part of the EVs and the sustainable competitive advantage of the EVs manufacturer largely depends on the vertical integration of the SCM process or strategic integration process. Besides ensuring the development of skills and capabilities to acquire production of the strategic raw materials, the quality control process must be performed at maximum level to match the costumer satisfaction or value proposition, considering all of these reasons the trace and tracking of the battery with 5G enabled sensors under the blockchain framework would give plenty of benefits to manufacturer and the other involved stake holders.

The interaction of these stakeholders is shown under following SBN diagram, for simplifying our analysis, only tier 1 supplier has been considered, the product certification body is assumed to work under jurisdiction of institutional authorities, the brief view of tests required for lithium batteries is mentioned in the section of institutional authorities, this certification body could be treated as separate entity as well or may be located at supplier and manufacturer premises, the objective of our analysis is to traced down the functional necessities which should be covered for obtaining the maximum benefits of deployment of proposed solution.

The charging stations has been also shown in SBN but the analysis has not carried as visibility enhancement in upstream would be valuable of the EV manufacturer to record the health condition of the batteries in real time, the component failure analysis can also be monitor,

i. SBN Diagram:

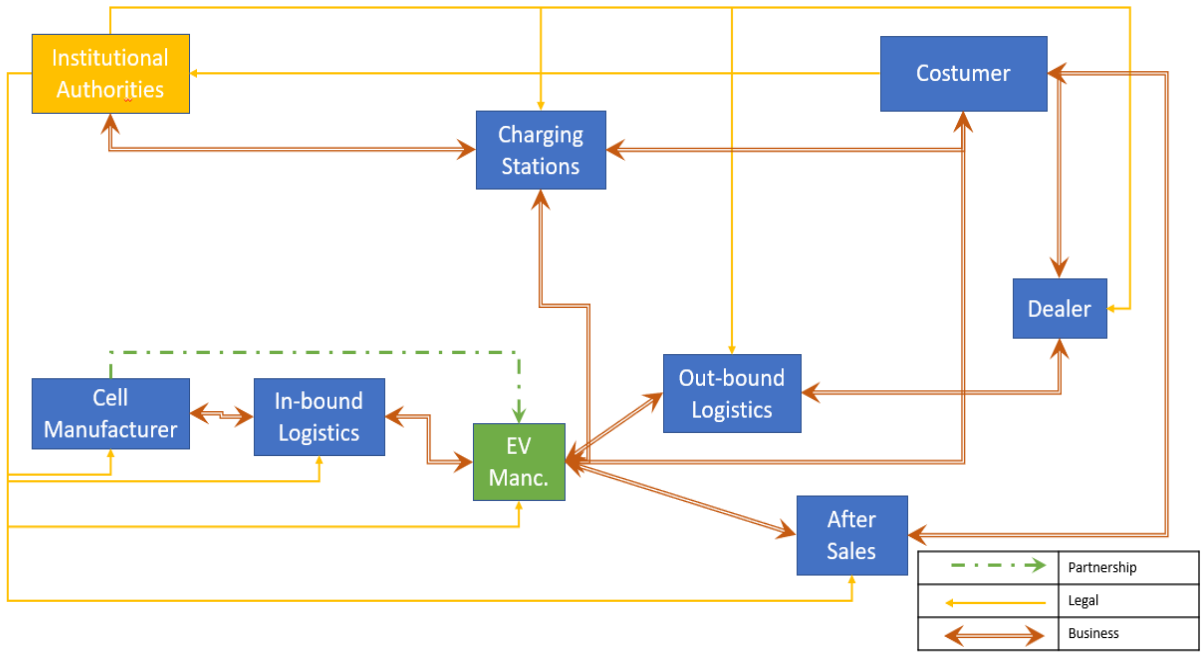

Figure 11 SBN

4.4 Value proposition:

As described in introduction Stellantis tends to implement the blockchain framework with the 5G enabled IoT sensors in the battery supply chain and logistics.

The general problems present in the supply chain has already discussed in detail in section (0), by considering the problem of battery supply chain its important to consider some additional challenges present in the literature, as usually EV batteries contain lithium-ion which is highly flammable material and considered under the regulation of shipping of the dangerous goods, so the whole process of product logistics through out the supply chain requires special testings and documentation procedures. Even during the transportation, the handling of these goods should carried out delicately. (50)

Its worth knowing that unfortunately human mistake in logistics operations at airports has resulted devastation in several cases and led to property loss and death. A incident at the Northwest Airlines cargo terminal at Los Angeles Airport is such element of human mistake that resulted in lithium batteries catching on fire (LAX). Two battery pallets were damaged. One pallet contains 100,000 primary lithium batteries (Sanyo CR2 Li/MnO2), with the remaining 20,000 being rechargeable. Forklift workers damaged the pallets while moving them around an outdoor cargo area without necessary care for such goods. This suggests a lack of understanding (perhaps because of insufficient training) or adherence to proper handling methods. This resulted in a fire, which was perhaps caused by the packing integrity being compromised, enabling the cells to come into touch with one another. Any of the following processes might have triggered ignition: cell crushing, cell short circuiting, charging, or forced charging (51).

So special pre-shipment compliance must be adhered in each step of the logistics process of supply chain besides the extensive documentation due to presence of global supply network, thirdly the authenticity of the test results and documentation are also the greatest areas of concerns.

4.4.1 Institutional Authorities:

In the global supply network, purchase orders bills of landing , commercial invoices, booking confirmations, packing lists, certificates of origin, inspection certificates, insurance certificates, hazardous goods declarations etc. are just some of the documentation that has to be completed at the time of shipment clearance process and this paper work caused lot of cost in term of time delay, estimated to be between 15% to 50% (31). As mentioned above in the shipment of dangerous goods, the special test procedure should be completed for avoiding the mishap and

incident, so the cost of paperwork is sufficiently greater in this process secondly the time delays in clearance process enhanced this cost. Extra time and cost on the import licensing process which increase further expenditure of this process. Transparency and visibility of the whole process are also the major concerns for the governments. In below, just for clearing the idea the UN test standards before shipment of Lithium batteries has been attached.

Test Step	Test Type	Specific Procedures
Test T.1	Altitude simulation	Test cells and batteries stored at a pressure of 11.6 kPa or less for at least 6 h at ambient temperature (20 ± 5 °C).
Test T.2	Thermal	Rapid thermal cycling between high (75 ± 2 °C) and low (−40 ± 2 °C) storage temperatures, stored for at least 6 h at the test temperature, time interval between high and low test temperature change less than 30 min.
Test T.3	Vibration	The vibration is a sinusoidal waveform with a logarithmic sweep between 7 Hz (1 g_n peak acceleration) and 200 Hz (8 g_n peak acceleration) and back to 7 Hz; 12 times cycle, 3 mutually perpendicular mounting positions.
Test T.4	Shock	Subjected to a half-sine shock (150 g_n peak acceleration) and pulse duration (6 ms); 3 shocks cycling in the positive and negative directions for each of 3 mutually perpendicular mounting positions (total of 18 shocks).
Test T.5	External short circuit	Short circuit with a total external resistance of less than 0.1 Ω at (55 ± 2 °C), 1 h duration.
Test T.6	Impact	A 15.8-mm-diameter bar placed across the sample cell center, and a 9.1-kg mass is dropped from a height of (61 ± 2.5 cm) onto the sample.
Test T.7	Overcharge	Overcharging test should be conducted for 24 h with charge current (twice the manufacturer's recommended maximum) and minimum test voltage. The minimum test voltage is defined in two categories (a) when recommended charge voltage ≤18 V and (b) when recommended charge voltage >18 V: Both categories are further explained as:
		(a) the lesser of 22 V or 2 times the maximum charge voltage or,
		(b) 1.2 times the maximum charge voltage.
Test T.8	Forced discharge	Each cell is forced discharged by connecting it in series with a 12 V DC power supply at an initial current equal to the maximum discharge current specified by the manufacturer.

Figure 12 Certification standards for LIBs

As shown in SBN, the government has the legal relation with all of the stakeholders involved in the process, With the cell manufacturer, governments usually have concerns about sustainability, the suppliers and cell manufacturer have to procured the material from those which are not involved in the concerning processes. For environment, the zero emission policy and the association of carbon foot prints with the batteries, smooth management of the process of end life scenario of the batteries are also important areas of consideration for regulating authorities, as per the legislations EU has very strict point of view with respect to the sustainability issue. Additionally, health and safety standards, compliance of the labour law, licence management lists, costumer clearance documentations are also some of the painful areas for the institution authorities. The same is valid for the relation with EV manufacture, Dealers, Logistic operators and Aftersales providers.

In the whole SC of batteries, transparency in the capital disbursement and collection process is also the concerning areas.

Institutional Authorities			
Gain	Taxes transparency, Sustainability, process automation of compliance endorsement, Speedy costume clearance process, condition monitoring with respect to safety, visibility of dangerous good, smart auditing	Gain creator	Visibility of dangerous goods Increase in revenue of taxes and duties due to precise modelling. Network effect with inclusion of other stakeholder. Traceability of product in end life scenario with capability of track and trace. Easiness in calculating the carbon footprints associating value with IoT devices.
Pain	Counterfeit products, Hectic documentation, Fraudulent documentation, un-availability of product history and origin	Pain reliever	Expenditure cut, minimizing the counterfeit product and fraudulent behaviour by accessibility to product origin, one time click type of documentation, easiness in compliance and licence registry with smart contract.
Job	Enforcement of Regulations related to each stakeholder, i.e. logistics and transportation, sustainability, heath and safety for people and environment.	Product, Service	Access of Dapp containing Tracking dashboard, Cargo Management, Compliances management view, Taxes and Duties dashboard, Licence Management view, Ownership registry view

4.4.2 Supplier

After the car manufacturer, supplier of the cell has the most influential role in the value chain of the batteries, the one of the important area for the supplier is the compliance endorsement and proper communication of the procedure through out the supply chain, then building the good relation ship with his costumer i.e. vehicle manufacturer, the spread of flow of quality would be possible from supplier to end user, the real time demand could also be monitored by if vehicle producer embedded the batteries with 5G enables IoT devices as we. Lastly, as the lithium is the scares material so the cell manufacturer greatest concern on the long term level would be the development of stable raw material provider and also enhanced the application of reverse order logistics for possible of end life scenario of the battery.

Supplier			
Gain	Traceability of shipment, Payment clearance, Disputes resolution, quality control,	Gain creator	Track and Traceability, Speedy payment process, Real-time Condition monitoring, smart contract, Process awareness, smart contract
Pain	Trust issue, Payment delay, Hectic documentation, Upstream uncertainties, Downstream uncertainties,	Pain reliever	Expenditure cut,
Job	Costumer relationship management, Quality management, Reverse logistics,	Product, Service	Tracking dashboard, Online documentation management page, Compliances management, Taxes and Duties dashboard, Licence Management

4.4.3 Logistics:

To carry batteries, logistics operating companies may join the supply chain and earn from the movement of batteries. Manufacturers of batteries must learn about the logistics provider's

history of cargo theft and diversion, delays in delivering goods and the cost of transportation as well as the provider's adherence to federal and state regulations on hazardous materials transportation, availability of a fleet, and the number of incidents involving improperly loaded cargo that have occurred, with the perspective of the logistics operator for maintain their consumer satisfaction, the timely transfer of above mentioned stuff is essential, which increased the unnecessary transactions cost, so the adoption of the blockchain and IoT based solution, would become relieving point for the Logistics operator as well. (52)

Logistics			
Gain	Condition monitoring, Compliance adherence, Payment clearance Dispute resolution Effective coordination	Gain creator	Track and Traceability, Speedy payment process, IoT sensors-based condition monitoring, smart contract
Pain	Trust issue, long waiting time,	Pain reliever	Cost savings
Job	Transport fleet management	Product, Service	Tracking dashboard, Online documentation management page, Compliances management, Taxes dashboard, Licence Management

4.4.4 Vehicle Manufacturer:

Vehicle manufacturer is the main player who has the most bargaining power in supply chain and able to get many benefits, traceability and visibility of the SC and quality managements are the focus of interest for the VC manufacturer, the inclusion of tracking and real time condition monitoring of the batteries will have impact on the conventional processes of supply chain, vehicle manufacturer has the capability to propagates these benefits throughout the downstream and upstream.

Supplier relationship, mitigating the supplies risk, inventory management, Cutting the operating expenditures, obtaining the accuracy of demand forecasting, discovering the new consumer segments, sophisticated battery quality management will effect the future

profitability of the industry and helping towards maintaining the closed loop and sustainable supply chain.

Vehicle manufacturer			
Gains	Costumer satisfaction, Improved Buyer supplier relation, Cost efficiency, Disputes resolution, sustainability and green economy, Speedy payment process	Gain creator	Track and Traceability, smart contracting, real time condition monitoring, blockchain characteristics
Pains	Trust issue, Payment and delay disputes, Hectic documentation, disruption risks, Demand variation, compliance adherence, Part failure and difficult to identify the root cause	Pain reliever	Smart contracting, immutability of transactions, No need of third party, real - time health monitoring of battery
Jobs	Costumer relationship management, Quality management, Reverse logistics, product life cycle assessment, supplier relationship	Product, Service	Tracking dashboard, Online documentation management page, Compliances management, Taxes and Duties dashboard, Licence Management

4.4.5 Dealers/Aftersales

The areas of gain and pains are quite similar to the other stake holder, dealers would be able to maintaining the relation with actors like EVs, logistics and final costumer with more manageable way due to presence of visibility and transparency with in the chain. The cost efficiency can be achieved by lowering the documentation cost, absence of third-party would also solve the issue of trust present in supply chain.

For the aftersales market, reducing the counterfeit product is the top painful area which could be solved after using the proposed solution.

Dealers/Aftersales			
Gain	Traceability of shipment, Payment clearance, Cost Cutting, Disputes resolution,	Gain creator	Track and Traceability, Speedy payment process, Realtime condition monitoring,
Pain	Trust issue, Payment delay, Hectic documentation, Supply chain risk, counter-fiet product	Pain reliever	Expenditure cut, product originality
Job	Costumer relationship management, Quality management	Product, Service	Tracking dashboard, Online documentation management page, Compliances management, Taxes and Duties dashboard, Licence Management

4.4.6 Costumer:

For the end user, the perceived value of the product is utmost importance, availability of the monitoring of the health condition of the batteries, the presence of number of different related services provided by EV with help of business model innovation would also be attractive area for the end user.

End User			
Gain	Traceability of goods, Payment clearance, Disputes resolution, Real-time Condition monitoring, automated warranty claims, health and safety certification of batteries. Eco-system of services	Gain creator	Track and Traceability, Speedy payment process, Real time condition monitoring, Alerts generation

Pain	Payment delay, Hectic documentation, Supply chain risk	Pain reliever	Expenditure cut,
Job	Costumer relationship management, Quality management, Smart service offerings,	Product, Service	Tracking dashboard, Online documentation management page, Compliances management, Taxes and Duties dashboard, Licence Management, ownership management

Chapter 5: Uniform; Business model Canvas

As briefly describe above the objective of this phase is to standardize all the information which we got from the GO phase in the form of business canvas model, till now we have clear understanding about the challenges and benefits associated with the adoption of the technology, we enlisted all the factor associated with it via PEST and SWOT analysis, after sorting out the interaction of the different stake holders, we proposed the value proposition of main or influential stakeholders involve in the SBN, so from below we can further expand our work by presenting the business model of the implementation of the said technology in supply chain process. We also take the view of opening of future opportunities, because its necessary to cover all these aspects for gaining the maximum benefits or generating the new sources of revenues for the company by said adoption, organization can easily recover the heavy amount of initial investment for implementation of the devised change. For simplifying the situation, lets assume as an executive belong to Stellantis, the benefits of investing, adopting and implementing the 5G-enabled IoT devices with blockchain framework would be further clear with implementation scenario based on the input of Go Phase of the methodology the Business model could be devised as.

5.1 Business Model canvas:

5.1.1 Value proposition:

Value proposition	o Creating the of ecosystem of smart battery management, use in EV manufacturing. o Providing the sustainable and safe, mobility solutions. o Smart service offering. o Flexible business model and innovation.

The value proposition vehicle manufacturer would be the "creation of the ecosystem for the smart battery management," which referred to the possibility of trace and track with IoT based smart sensors in the context of blockchain, the condition monitoring of battery would provide the chance to sustainable, safe mobility solutions, the enhancement of quality, time, and cost efficiency for the stakeholders. Smart service offerings, such as battery health certificate creation for secondary market selling, maintenance alerts, payment subscriptions on charging

bundles, and so on, can enable the manufacturer to achieve extra advantages such as increased brand loyalty and new revenue streams.

The established business models have been mostly focused on the product as its own, with adoption of technology, new business models will provide some alterations and will also give opportunity to launch new services. The battery, automotive manufacturer and related general sectors will shift away from product-centric business models focusing on passenger vehicles, buses, and trucks toward shared ownership and usage-based revenue models. This opens a plethora of opportunities for the second-life battery market, allowing customers to remove their "market pain" by using a short-range vehicle equipped with reusing the batteries, or by connecting these batteries to systems of renewable energy and can also in other applications. These reuse of batteries, may become more appealing in smart services models, since client risk is decreased. Such business models may be activated via using of authentic data kept by the platforms based on blockchain, since the proposed value by the various services may be dependent on the degree of performance in case of the prime use of batteries, it would be feasible for the organizations to provide the smart service offering to accretive businesses such as mobility, circular economy, pre-owned cars, aftermarket, financial services, data as-a-service, and commercial vehicles use in public transport etc.

As the battery is the critical portion of the value of EV with respect to cost , price and volume, the sustainable business model of circular economy is also considered in the various research available on this topic, for enhancing the sustainability of this critical component, track and traces is essential requirement for knowing the product history throughout the product life, specifically considering the B2U applications of 2nd life, the product history is essential to access the origin, real time condition of the EV battery (53).

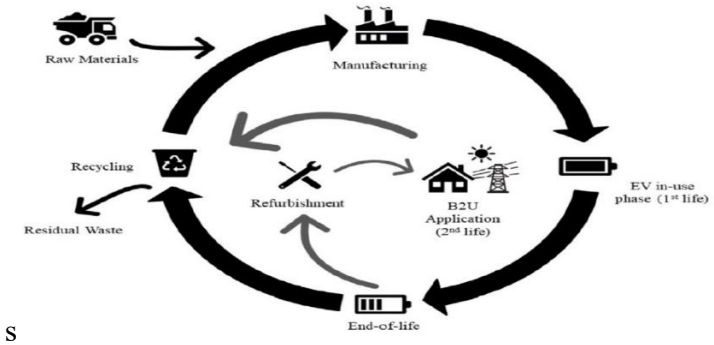

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Figure 13 Business modelling of battery SC in circular economy

5.2The costumer perspective

Costumer Segments	○ Dealers ○ Logistics ○ Aftersales market ○ Regulators ○ Insurance companies ○ Banks ○ Second life market ○ Unexplored niche segments
Channels	○ Dealers ○ Direct sale ○ Advertisement ○ After sales
Costumer relationship	○ Long term costumer relation ○ Integration of product and service offering ○ Co-creation (battery swapping or rent a car)

5.2.1 Costumer relationship:

The complementarity between a company's goods and services is referred to as "product-service offerings," and it results in stronger integration with customers and partners throughout the value chain, the implementation scenario of the blockchain and IoT based sensors equip the companies with the tools to pursue enhancement of integration, hence build the costumer relationship for longer extent. Real-time monitoring and visibility of the actual status of the installed batteries can be used to identify and correct problems or errors that occur during operation as part of an integrated product-service offering, it also include optimizing operations based on data capture from IoT sensors and supporting systems that provide the necessary

information, it will also automating the reordering of spare parts and availability of the new services.

To find new future paths, new collaborations, and new design ideas and solutions, co-design and value co-creation activities are helpful. In addition, consumers may have a long-term role in expressing and safeguarding their experience with the products throughout its life cycle, the business model of rent a car, car swapping for fulfilling the desire for exploring the new cars, battery swapping in case of robotics station, can manage with the help of trace and track the condition of the batteries.

5.2.2 Costumer Segments:

An improved awareness of consumers true requirements and challenges is gained, which has a major influence on designing the added value of a company. As a result, positioning clients in accordance with these demands is simpler and more efficient, ensuring that customers are satisfied with the goods and/or services, it also broaden the company canvas to new consumer segments having different needs, the company can fulfill those needs based on the additional capabilities of real time data analysis gathered from different segments of the value chain and most importantly final consumer, it also supports the exploration of the unexplored niche segments for increasing the consumer sales. For instance, the real-time monitoring of battery charging cycles and its integration through out the chain would be helpful for company to read and assess the attributes and behaviour of the different users present in the society, its also support the company to bring product and service personalization.

The pain and gain identified in the analysis of value proposition regarding the consumer segments such as dealer, Institutional Authorities, After market and logistics already gave us enough insight regarding the benefits proposition of these stakeholders.

The existing health of the battery is painful subject for the insurance companies through out the value chain, its even valid in the logistic phase starting from the tier 1 or 2 suppliers. Bank can also use the services of the company portal to access and record the equipment issued on the mortgages or lease. For the second-hand market the condition and product history of the batteries, is of extreme importance for transfer of the ownership to other user, in the same way, second life use demands to preserve the product history i.e. in case of presence of any incident in the product history, mitigation of the further danger would be possible.

From the perspective of infrastructure provider, we have already taken the insight from use cases to better understand the potential consumer areas that would be the pharmaceutical, Oil & Gas, Automotive and Smar Agri-Food sectors. These sectors have the most potential to implement the proposed architecture for betterment of their output. We can summarize the use cases discussed earlier as the functionality i.e. to know, product source and history, product originality, doing smart contract, automated process.

5.2.3 Channels

For increasing the sales of new cars and batteries the dealers are the deriving source of the traditional business model and company will rely on this business model until the fully development of the alternative distribution channel, the direct sale would be possible by deploying the integrated framework, with the help of issuing promotions to the sectors of nonconventional distribution channel such as banks, online sales etc.

The strong customer touchpoints and marketing campaigns is essential for firms to promote awareness of the innovative benefits supplied by the new technologies and to make the new services more desirable and interesting to consumers, at the correct moment, sales teams must be able to demonstrate the increased value from new innovations to clients and explain how these benefits may be achieved better value addition, It will also helps the customers to take advantage of a company's offerings and evaluate them through online platforms an equip the company will easily accessible performance metrics. Digital communication is an important feature of the present channel’s integration. It also helps with post-sale services because it enables immediate answers and reinforcements.

Another benefit of going digital for direct sales is that it requires less labour to negotiate and finalize contracts. Channels are becoming increasingly data-driven, which enables managers to gain visibility into their partners' performance and allocate training and marketing resources efficiently to the right partners in the right locations.

5.3 The Infrastructure

By including key activities, resources, key partners, the infrastructure portion represents the supply side of the business model, which is responsible for value generation and delivery to consumers.

Key partners	o Cell Manufacturer o TIM or IT infrastructure provider
Key Activities	o Tracing/Tracking o Condition monitoring o Managing and analysing battery health o Smart contracting o Smart Supply chain procedures
Key resources	o Infrastructure related to Blockchain and Information technology. o 5G enabled IoT devices attach to batteries o Technical personals

5.3.1 Key Partners

Cell manufacturer and Tim or IT infrastructure would be the key partners in implementing the proposed solution, the cell manufacturer has enough bargaining power in negotiating the terms and condition in their favours, as in electric vehicle the batteries is considered as main and expensive part. The strategic alliances would be favourable for getting the enough trust to integrate the supply chain system, same is the case of infrastructure provider, the data is considered as one of the key assets in this revolution of digital era, so acquiring the enough capabilities for the long-term period of time is the only viable option for obtaining the sustainable competitive advantage.

5.3.2 Key activities

Trace/tracking of the batteries through out the value chain is the prime activity which would be done by using the sequential transactions carried out with the smart contracts and blockchain as the data on the blockchain is immutable so the product history would be reliable and visible through out the value chain. Condition monitoring of the batteries from the transmission of the real time data would make process more transparent. Smart contracting is the main feature of this business model, as it will make the process automated and intelligent, which is helpful in

lowering the cost of the process and enhancement of the productivity, it can also configured to execute basic operations, allowing the payment process to be automated, at this present level of development. Decentralization, autonomy, and security are all part of the sharing economy's benefits that come with direct communication enabled by proposed solution.

5.3.3 Key resources

The establishment of an infrastructure capable of handling large volumes of data, as well as high-quality data, via sensors, massive servers, data centres, and trustworthy security measures will be required. There will be a requirement for network infrastructure in terms of both area and technical quality to execute proposed solutions. To ensure the stability and quality of the service, it is strongly advised to build the digital infrastructure. Installation of IoT based sensors would be essential which will need additional investment, the transformation of existing infrastructure present in the organizations will allow the efficient deployment.

Workforce skills in software development, information systems, and data analysis are critical to a company's success in the deployment of the proposed solution, with this system, organizations will require workers who are able to build new solutions needed to extend the business model flexibility, evaluation and manage new working environments based on data from customers and other data resources obtained from real time monitoring, further more it will need far-reaching organizational ramifications, not only in terms of technological shifts, such alterations will need major organizational and cultural shifts. As expected, the new working environment would be more open and creative, requiring more adaptability from employees. As a result, to assist this shift, individuals will need to acquire personal skills related to flexibility, willingness to learn and grow, and interpersonal and communication abilities.

5.4 The Financial solidity

Cost structure	o IT infrastructure and equipment acquisition cost (Fixed) o Operating cost (variable) o Human resource cost
Revenue streams	o EV Sales and Battery Sales o Cost savings (Transaction, coordination, Inventory)

	o Operations /Managerial efficiency enhancement o Transaction cost savings o Subscriptions

5.4.1 Cost structure

The cost structure mainly denote the initial investment of infrastructure acquisition cost, which is relatively less than traditional structure, the variable cost of the operations also includes in the cost structure, the literature suggest that the economies of scale and scope would easily be achieved in case of this investment, as future paradigm will evolve in the direction of the adoption of this technology, the emergence of new business models based on this technological advancement will be seen, which push the industries to move towards these advancements for remaining profitable in the market, on long term basis, this investment would be the only way to maintain the competitive advantage in the industry.

5.4.2 Revenue Streams

Since financial flows transition from an almost immediate return to a long-term usage time because of new product-service offerings and the transfer in ownership, organizations need to alter their financial and accounting practices to account for these changes. Then, companies should look to their partners for financial assistance, The cost savings due the use of the technology is dominant factor as the inventories to production process would be managed more effectively, the real time monitoring of the data lower the legal and dispute resolution cost, the ease of documentation is also the primary variable of utmost importance. The changing of the business model and allowing the consumer to take services via subscription model will allow the company to generate new revenue streams. In the narrative about the climate change, green and circular economy; the utilization of subsidies and tax deduction would also possible. The organization will save chunk of money by improving the efficiency of the process. The overall effect on the revenue stream would be enormous as per various studies.

Business Model Canvas

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Cell Manufacturer TIM or IT infrastructure provider	Tracing/Tracking Condition monitoring Managing and analysing battery health by Quality Management module Smart contracting Smart Supply chain procedures	Creating the of ecosystem of smart battery management, use in EV manufacturing Providing the sustainable and safe, mobility solutions Smart service offering Flexible business model and innovation.	Long term costumer relation Integeration of product and service offering Cocreation (battery swapping or rent a car)	Dealers Logistics Aftersales market Regulators Insurance companies Banks Second life market Unexplored niche segments
	Key Resources		**Channels**	
	Infrastrure related to Blockhcain and Information technology. 5G enabled IoT devices attach to batteries Technical personals		Dealers Direct sale Advertisment After sales	

Cost Structure	Revenue Streams
IT infrastructure and euipment aquisition cost (Fixed) Operating cost (variable) Human resource cost	Ev Sales and Battery Sales Cost savings (Transactions, coordination, Inventory) Operations /Mangerial efficiency enhancement Transaction cost savings Subscriptions

Figure 14 Business Model Canvas

Chapter 6: EVALUATE: Balance score card

6.1 Objective

Because we're using the GUEST methodology to define the business development model of implementing the blockchain technology and IoT in supply chain structure, the goal of this chapter is to come up with key performance indicators that will be use in Test phase of the methodology. The indicators should be aligned with the lean philosophy's standards, which include both quantitative and qualitative aspects like the cost saving, performance improvement, and customer happiness. Compatibilities that are required to bring about a shift in the digitalization paradigm should also be addressed, to improve the company's strategic stance in a dynamic business environment. The main aim is to establish a match between the business development process and the company's strategic objectives and finally to gain the sustainable competitive advantage.

6.2 Features of BSC:

Organizations, according to Kaplan and Norton, operate in complicated contexts in which knowing their objectives and techniques for achieving them is critical to their survival. The BSC, according to the concept given by Kaplan and Norton , assesses operational success from four perspectives: (1) Financial, (2) customers, (3) business processes, and (4) learning and development are the four categories.

6.2.1 Analysing the Cause-and-effect relation:

The strategy is defined by the set of assumptions based on cause and effect. The firm's vision and strategy will not be translated and conveyed until cause-and-effect relationships are adequately reflected in the BSC. One or more of the BSC framework's four views may be included in these cause-and-effect relationships. Internal company procedures, for example, are more likely to meet consumer expectations if service systems are adaptable to unique client needs (customer perspective). As customer expectations rise, businesses will be forced to produce more innovative products and services (learning and growth perspective). Market share and profitability will increase as a result (financial perspective).

6.2.2 Performance driver:

A well-designed BSC will have the appropriate mix of outcome metrics and performance criteria. Outcome measurements such as total supply chain cycle time are worthless without performance factors such as buyer–supplier relationship level. Furthermore, without outcome indicators, performance drivers may allow for short-term operational advantages but may not disclose if those improvements have been converted into financial gains.

A corporation may invest much in sustaining buyer–supplier connections and collaboration to enhance day-to-day commercial operations. The lack of a result indicator for buyer–supplier cooperation makes it difficult for businesses to evaluate the effectiveness of their strategy (e.g., flawless deliveries). Performance drivers are company-specific and frequently depending on the company's strategy. Performance drivers, on the other hand, are usually company-specific and based on a specific goal. (54)

6.2.3 Linking the financial drivers:

A balanced SCM scorecard's ultimate purpose is to aid management in enhancing the enterprise's overall financial performance, we must continuously remind ourselves that measurements alone are inadequate since management must utilize and act on them. The BSC is not merely a tactical tool; it can also be used as the foundation for a strategic management system.

6.3 BSC and performance indicators in SCM

The BMC is developed, for reflecting the clarity in the business development process within the organization, its needed to highlight important aspects of inclusion of said technology with the modelling by balance score card approach, some researchers have devised the layout and important parameters for aligning the organizational strategy in the context of industry 4.0 revolution, but these researches have been conducted in more general perspective of shifting the paradigm, the compatibility of the technology inclusion is heavily dependent on the opacity of the existing SCM practices and the interrelation with the devised changes. So for this, analysing the performance parameters based on the lean philosophy is also essential and thier’s relations with the objective of implementation of innovative framework.

The following figure is adapted from the research article in which author have mentioned the balance score card model in terms of industry 4.0 and related parameters.

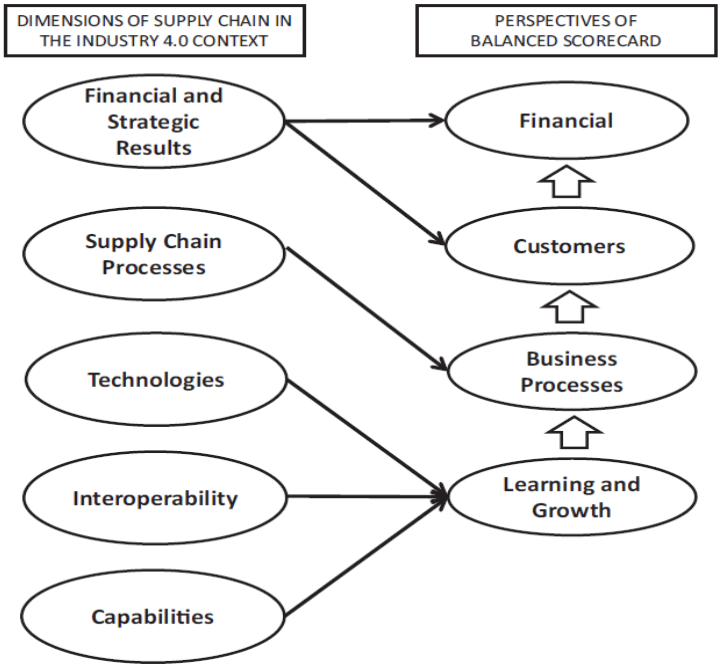

Figure 15 Model of BSC in the paradigm of Industry 4.0

In above figure; the relation with BSC model and capabilities, interoperability, technologies, supply chain process and financial and strategic results is shown.

Element of Capabilities can be defined as the existing information system architecture, human resource abilities, organizational expertise, leadership and organizational strategic vision.

Technologies are based on the innovative technological advancement such as implementation of Big data, distributed ledger and 5G enabled IoT and smart manufacturing equipment etc.

Interoperability is the extent to which company is vertically and horizontally integrated and the extent it can be integrated

Supply chain process is linked with the Internal business process, the elements such as flexibility, responsiveness, flexibility, visibility, efficiency and elements based on lean philosophy i.e. waste reduction, time reduction, optimum quality, optimum inventory management etc.

Finally, the improvements from the bottom up approached can be scene in terms of financial output such as cost reduction, enhancement of profit, shareholder and costumer value and satisfaction.

6.3.1 Key Performance Indicators in Industry 4.0:

The performance indicators in the context of digital supply chain are mentioned in below figure (55), these indicators are mostly derived from lean tools, so its best suited in the digitalization scenario as well, with the operational point of view the cost of performance evaluation will significantly decreased by the help of smart processes.

BSC perspectives	Supply chain Dimensions in the Industry 4.0 context	Measurement approaches for the Supply Chain 4.0 Scorecard
Financial	Financial and strategic results (result indicators)	Shareholder value Level of cost reduction Profitability EVA (earned value added) EBITDA (Earnings before interests, taxes, depreciation and amortization)
Customers		Level of market share Value-added perception Level of customer interaction on processes Level of customer satisfaction
Business processes	Supply chain – processes (impact and result indicators)	Processes efficiency Response time Level of flexibility Level and extension of transparency Level of collaboration Level of waste reduction Level and extension of processes integration
Learning and growth	Capabilities technologies and interoperability (impact indicators)	Adequacy and extension of technologies Adequacy of infrastructure to the new technologies Level of horizontal integration (information and technologies) Level of vertical integration (information and technologies) Level of people competences Adequacy to the compliance and legal requirements Level of leadership engagement Coordination effectiveness

Figure 16 Key performance indicators for Industry 4.0

Further elongation of the analysis based on the formation of our strategy map, some of the indicators from above would be useful to measure and monitoring the organizational progress in paradigm of proposed solution.

6.4 Strategic goals based on the BMC:

As per our business canvas model, we translate the strategic objective with the balance score card model as shown below.

For constructing strategy map, it is advised to build it top to bottom approach so that the vision and strategic goals of the company become coherent with the strategic objectives within the organization (56). Firstly, we take look from the insight of strategic goals of Stellantis from it vision 2030 first, then we have translated those strategic goals with in the four perspective of Balance score card after comparing them those strategic objective with our business canvas model, which would be arise after implementation of our proposed solution.

Balance score card	**Strategic Objective derived from BMC**
Financial	Enhance Share holder value, Revenue growth, Productivity growth
Costumer	Brand image, Brand Loyalty, Costumer satisfaction, Exploring costumer WTP, Product service model
Business Process	Visibility, Le-agility, Interoperability, Green, Circular economy, Product Personalization, Services personalization, Production optimization, Risk management
Learning and growth	Employee competences, Technological advancement and Corporate culture.

6.4.1 Financial Perspective:

As per press release of Stellantis, "Stellantis will manage the transition period toward electrification while delivering double-digit Adjusted Operating Income (AOI) margins and maximizing shareholder value"

i. Increase the share holder value:

The main aim of the business activity of every organization is, increasing the value of the shareholder, which can be define as the increasing the Stellantis return on the capital employed, the indicators of these could be company's actual return on the capital, company net margin compared with the rest of the industry.

ii. Revenue Growth:

The implementation of the blockchain with IoT sensors in battery supply chain will provide the opportunity to shift towards new business models related product and service customization based on the user experience. End to End connectivity is the main objective of Stellantis vision 2030, the integration of upstream and downstream of the supply chain will serve the foundation for achieving the plans of digitalization.

KPI: Revenue of new business models, increase in sales, Payback period of investment, Subscribers of services,

iii. Costumer Satisfaction and Exploring WTF

The possibility of the end-to-end integration with the devised solution, will help the organization to better understand and measure the level of costumer satisfaction, it will also enable the organization to prioritise and explore the key areas of consumer interests via help of surveys and smart analytics. The detailed view of this has also studied in previous section of BMC (5.2), meeting the costumer expectation is the most important goal of Stellantis and proposed solution is completely compatible with this strategic goal.

iv. Productivity Growth:

Finding the true operational excellency and simplification of the supply chain structure with the help of merger synergies is the important part of Stellantis strategy and lowering the cost of traditional distribution channel by replacing it with online sales platform, the operational excellency can be achieved the by the inclusion of smart supply chain processes, results in the cost reduction on the long-term scenario hence contribute in preservation of the competitive advantage.

6.4.2 The Costumer Perspective:

As per Stellantis vision 2030, the maintenance of the end-to-end relationship across the supply chain is primary goal of the company, Stellantis aims to carry out one-third of global sales via online medium in 2030; This may be accomplished by establishing a worldwide digital marketplace that provides clients with a unified experience throughout the full Stellantis galaxy of goods and services. As per theoretical point of view, Stellantis is willing to excel its expertise by pursuing three competitive strategies, the product leadership strategy is on the priority in

the sense of electrification of complete value chain and launching of whole sets of electric vehicles for different consumer market segments. The operational excellency is also on the front desk as Stellantis is willing to invest in the re-modification of supply chain practices in the view of Industry 4.0 or Supply chain 4.0, the financial objective of getting the productivity is, only possible by following the strategy of operational excellency. The strategy of costumer intimacy would be followed by the objectives of maintaining the end-to-end relation with the consumer and inclusion of side business models subjected to the feedback of costumer is the core of the costumer intimacy strategy. Typically, firms chose value proposition from one of the three above mentioned strategies, but in case of Stellantis due to adoption of merger synergies across its supply chain, will create the strong ecosystem for EVs and it could be possible by following the strategy mentioned above, we have further explained the benefits of the strategic objective for deploying the blockchain and IoT based smart sensors,

i. Brand Image:

By following the policies of green and sustainable economy, the brand image of Stellantis will improves, hence resulted in the enhancement of shareholder value or the goodwill of company, which also provide the opportunities to catch the investments for new projects, its also valuable to get the tax subsidies from the institutional authorities for adopting the policies related to sustainable growth.

ii. Brand Loyalty:

The end-to-end relation with the costumer on downstream and enhancement of relation with the supplier will lead to increase the quality of the product, hence costumer retention will increase, the formation of ecosystem of services will create the network effect which enhance the possibilities of diversification in the value proposition, hence further increment of the brand loyalty and shifting the costumer relation form one time to long term.

iii. Product -service model

Aside from the product sales, income streams are expected to be more indirect and comprehensive since there are several possibilities to increase consumer loyalty and hence revenue by providing those services. As a result, the point-of-sale is becoming more like the point-of-service that lasts for an extended period, for example, there is a trend toward selling

performance of products rather than the products themselves like the model of shared mobility and rent a car etc, as well as contracts that permits for repair and maintenance services, process optimization, leasing, licensing, subscriptions and modelling of customized services.

6.4.3 The Internal Perspective:

i. Visibility

Real-time location monitoring of products becomes possible in a blockchain-based supply chain system. For example, container freight management and transaction document processing may be kept and shared on the blockchain. Through blockchain technology, every transaction information can be verified in real time by key players throughout the cargo's movement route. As a result, a blockchain-based supply chain enables more transparency.

ii. Le-agility

Lean manufacturing has had a major beneficial effect on productivity in a variety of sectors. Lean manufacturing pioneers created a plethora of tools and procedures that enable lean professionals to address a variety of issues, remove waste, the tendency to implement and monitor the lean philosophy would become quite simple in the considered innovative environment. (57)

Real demand can be read and responded to via an agile supply chain. Organizations are becoming more demand-driven than forecast-driven because of recent technological advances in data collection and client engagement. With the use of sophisticated information technology, a virtual supply chain can be created in which data can be sent between partners and products can be tracked. Reduced inventory levels and lead times in the value chain are necessary to take advantage of the network's flexibility and to ensure optimal flow.

KPI, Level Flexibility, Level of waste reduction, Reduction in the nonvalue activities etc

iii. Green:

The increased in popularity of electric vehicles (EVs) raises concerns concerning raw materials use in Lithium batteries such as nickel, Lithium, aluminium, copper, manganese, graphite & cobalt, which are only found in a few parts of the world, have a fluctuating price based on location and availability of raw materials, since extracting them have the substantial

effects on the eco-system. That's why the Stellantis consider the assuring the green supply chain one of the important strategic goals, the option of back tracking the mean and methods use for extraction of these rare material will contribute in mitigating the issue of climate change and environment sustainability.

KPI : Carbon footprints associate with battery at each stage of the supply chain procedure.

iv. Circular Economy

Increased demands of the rare and scare raw materials because of increased demand for EVs might result in price inflation for the raw materials, limiting the adoption of electric vehicles as a low emissions mode of transportation, so for sorting out these problems researchers have widely suggested the solution of recycling and reusing of the batteries. If lithium is not recycled then expectation of the scarcity is mentioned to happen between 2021 and 2023, that's why EVs battery supply chain usually analysed by the closed loop supply chain. (58),

In case of the model based on reuse of the batteries, the value proposition is centered on maximizing the residual value of EV batteries via remanufacturing and reuse, while also providing consumers with inexpensive and innovative solution of battery replacement with the old one, the costumer relationship will be folded positively, additionally, there is benefit for consumers who keep things longer and for workers who get new employment as a result of reuse and recycling operations, hence creating the necessary environment for costumer growth, in this scenario, facility of trace and tracking and the health monitoring will simplifying the management of batteries, specially if the responsibility of the reuse and recycling would lie on manufacturer shoulder by the institutional authorities.

KPI "material recovery yield from battery recycling, Lowering of vehicle costs by establishing feasible post-use battery option," (59)

v. Interoperability:

Integration of IT systems on both the production and corporate scales is known as vertical integration, In order to build a physical cyber system, this is a crucial part of the puzzle. Due to the tight integration of production and corporate planning systems in new environment, factories will be very adaptable and changeable, it can also be defined as the propagation of the company's strategic goals through out the value chain.

KPI Level of vertical integration, level of system integration, effect of extent of the communication.

vi. Process Optimization:

Companies can keep an eye on the performance of their product-service systems to identify the maintenance that is needed and plan it ahead of time, as well as other process considerations, such as end to end engineering, end-user centric design, quality and cost control, resources, product and traceability and hence achieving the process optimization. The exogenous factors of uncertainties analysed in previous sections is decreased, the more accurate demand forecasting supplies ordering is possible by implementation of the said solution.

vii. Product and service personalization

The personalisation indicator measures the extent to which consumers' needs are met. Customers' happiness, product customisation, and service customization are all aspects of personalization that may be quantified. Standard objects may be made more distinctive by adding a person's name to them. Customers' specific product needs are met while also ensuring that essentials facilities are available to produce based that costumer need and this test examines as well that the supply chain have enough flexibility or not. Using customer service data to tailor a client's experience is known as personalization of services and product, its directly enhance the level of costumer satisfaction, the implementation of proposed solution will equip the company to take decision based on the precisely measured consumer requirement and these new technologies also help to induce the flexibility in the operational process. As per vision 2030 of the Stellantis, besides the traditional business model based on the product manufacturing and sales, company aims to introduce their services on the interconnected areas of business as well, like financial services, share mobility, data as service etc.

KPI; Level of development of Number of new services and product manufacturing based on feedback from the costumer.

viii. Business model innovation:

The induction of the flexibility in the existing business structure is the important capability which will adopted by the proposed solution, this is already discussed in detail in the section(5.1.1), the vision 2030 of the Stellantis is also aiming to follow the same strategic

direction by offering the various services in the seven additional sectors which would be related to the critical resource induction by the proposed solution.

ix. Risk Management

The ability of Blockchain to provide visibility, aggregate data, validate it, automate execution, and maintain system resilience is critical for crisis management, supply chain risk management, production and quality warnings system. Based on the real time condition monitoring would also be easy, the delay cost and management of lead time and total supply chain time of the product would be effectively managed in the presence of more visible and transparent supply chain, the intergeneration of AI and machine learning will eventually generate the capability of intelligence and automated decision making which would be beneficial for the company in translating the strategic goals from internal perspective to financial objective.

KPI, quality management, measure of inbound quality, level of defects, supplier reliability, buyer supplier relationship length, management of supplier profile, level of inventories effective inventory management.

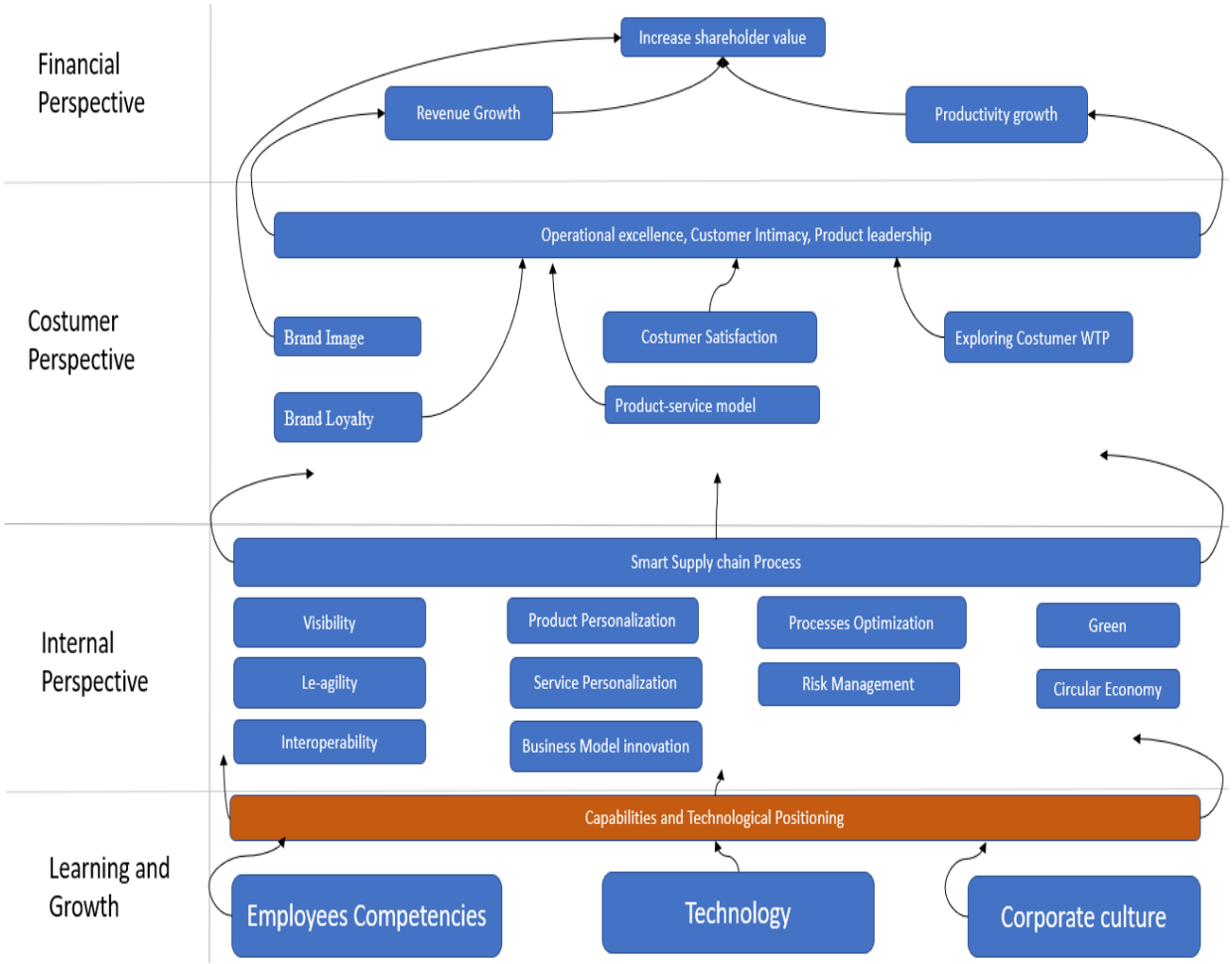

Figure 17 Balance Scorecard

The main theme of balance score card is given as; if we eager to improve the financial indicators than its not just the cost which need to cut, there is complete set of variable and organizational structure and culture which affects the performance indicators of financial perspective. Just to give insight about the phenomena of moving from bottom section of learning and growth towards the top perspective of balanced score card, the description of some main indicators is taken into account.

Chapter 7: Solve: Solution Canvas

Solution canvas is included in the 4th stage of the GUEST methodology, it equips the analyser to summarize the considered problem along with the solution based on the information derived from business model canvas and balance score card, we are presenting it just for the sake of presentation, very detail discussion has already been done in the previous sections. Reading of the solution canvas is simple for anyone who is following the GUEST from first step.

In below the solution canvas has presented for Stellantis and can be generalized for TIM as well:

Solution Canvas

Problems	Decisions	Decision makers	User/DMs Relationship	Customer Segments
Acquisition /Internal development of blockchain framework 5G enabled smart sensors Writing smart contract Integration with BMS Integration of apps with existing SCM software's Technical workforce Get the stakeholder on page Legal compliance for enabling global use	Tracing and tracking of batteries Condition monitoring of batteries Quality and performance assurance of batteries Safe and sound transportation	Board of director/CEO/upper management stakeholder i.e. Supplier, logistics provider, Infrastructure provider in case of strategic alliance. Institutional authorities (policies compliance)	EVs manufacturer with all stakeholders Institutional Authorities with all stakeholders Cell manufacturer to logistics to EVs manufacturer Dealer and Aftersales to EVs manufacturer and costumers	Supplier Dealers Aftersales market Insurance companies Regulator
	Information/ Resource		**Solution Channels**	
	Blockchain framework IoT sensors 5G subscription		Smart contract negotiation with stakeholders Dapp E-commerce	

Costs	Objectives
• Infrastructure acquisition cost Or • Internal development cost • IoT sensors • Front end application development • Operational cost • Cost of human capital	• Tracing, tracing and condition monitoring of batteries for visible and transparent supply chain. • Reducing the hectic transaction cost involve in global logistics by ease and automation of documentation process • Transparent tracking of fulfilment of safety and testing compliances. • Flexible and smart business positioning with respect to costumer needs.

Figure 18 Solution canvas

Chapter 8: TEST

The test stage of GUEST is dedicated to the monitoring of the proposed solution after application in real environment, which is not our area of focus right now, but its useful to add knowledge about the technical framework along with the schematic of battery supply chain which would be helpful for the practical aspects. Through out the implementation of GUEST methodology, we have enough information for application of our solution in the real environment, the insight from the research considering the interaction of the different actors in the practical dimension would be useful for deepening the understanding regarding the workflow of battery supply chain.

8.1 Technical Framework

The basic elements for the deployment of the considered framework are described in below table.

Services Layers	Service layer is the front interaction page for the stakeholders those would be the main user of the services, by this the stakeholder can access their respective module for using the services related to trace and tracking, smart contracting, visibility, ease of documentation by one tap transactions and compliance and certificate managements, these modules can also provide the chance to use blockchain in other services.
Processing and Data analysis	In a smart supply chain, data management is directly influenced by the current data sources. As a result, the adoption of tools capable of performing extraction of quality data and loading procedure, acceptable processing durations is fundamental constraint. In terms of cost and infrastructure availability, there are different structure and technique present, functioning on the principles of AI, machine learning and Big data with open or close -source framework for storing data and executing applications in clusters as well, these framework should have tremendous processing capability so that it can execute almost endless

	concurrent jobs, this layer brings the functions of automated and intelligent supply chain.
Blockchain Layer	The Blockchain layer can described with the help of different elements, starting from the data acquisition which is based on the working principle of conversion of the data with different encryption mechanism and store it in the form of hash, the data will also come from the IoT based smart sensors attached with batteries, due to the elements of networking layer, the blockchain's nodes can communicate with each other through both physical and virtual connections. Another feature is its ability to distribute data chunks throughout the network. Each node oversees that the received block is valid before spreading it to its neighbours. Then the consensus mechanism which maintains the trust of the network, this layer is already defined in section(2.4.1), the Incentive layer is main element in case of open blockchain, as due to these incentives the mining process can be taken place based on the reward mechanism to finding the valid solution keys at participating nodes, at last service layer usually consists of the smart contract due to which transaction would take place, this smart contract will also use as service in the implementation phase. (60)
Computational storage	In existing organizational data centre, a data network transports and stores data from the data capture layer, which is in a virtual server. Sending data to the cloud, whether public or private, is another option for data storage. Most traditional companies keep their data in a single location from which all their systems may be accessed. In case of our case several of the services will need to be kept in cloud storage for data analysis because of the introduction of IoT, the vast of amount of data could promote the formation of hidden layer of data and secondly in future paradigm with inclusion of Industry 4.0, the quantity of data will be maximized, so it is devised to store data hashes in blockchain and rest of the data should be store in off chain data servers or existing cloud facilities, there are strategies and processes that usually use to protect

	this information. In case of storing the data related to BMS, the inclusion of this facility would be essential to handle vast amount of data and further processing.
Interaction and capture events	It is the first layer of the real environment the data and real time events will be captured by the deployment of the 5G enabled IoT based sensors with the batteries or with the help of transaction based on smart contracts carried out with in the chain. The research widely suggests the creation of the digital twin of the battery is more innovative solution defined in the section (2.8), sensor data from BEVs is being logged and processed by BMS, using lower order models and some offline processing has also been explored by researchers. BMS data is often kept on-site, but researchers are now proposing cloud-enabled solutions for off-chain data and blockchain based network for on chain data, to both reduce local processing requirements and combine big data sets for boosting the performance.

8.2 Schematic of Battery SC

The opportunity of attaining flexible business model and innovation and the strategic alignment of this flexibility with the company long term strategic goal, has broaden the canvas of the inclusion of said solution from the downstream of battery supply chain to the complete product life cycle. The green and circular supply chain is one of the main strategic goal for the STELLANTIS as discussed in section (6.3), following we can represent the schematic of battery supply chain from the raw material to the second life scenario and then end life scenario.

For the future prospective, when corporation shifts responsibility for recycling to whom the battery is sold (downstream in the battery's supply chain), this is referred to as the liability transfer model. If the responsibility transfer model is used, responsibility for battery recycling would be shifted from the cell maker to the battery manufacturer at the time of cell sale. Transferring responsibility for recycling is critical at this point since the material gets activated during cell construction, suggesting that it is subject to compliance of hazardous material regulations. In this respect, blockchain technology may aid in the creation of new business

models by distributing responsibility proportionately to the profit earned by each participant from the sale of the final product and its market position. (52)

In the below schematic, product certification body represent the essential test require from the international standards, set for the use of the lithium batteries in the EVs, the manufacturing process of batteries is so sensitive that the minor negligence can cause the incident which would be costly with respect to the human life and infrastructure, so maintenance of the standards from the raw material to final product require extensive tests and generation of certification, blockchain based solution reduce the complexity of the process, specifically the availability of the real time data precisely at the time of needs, through out the each stage of the battery manufacturing. (52)

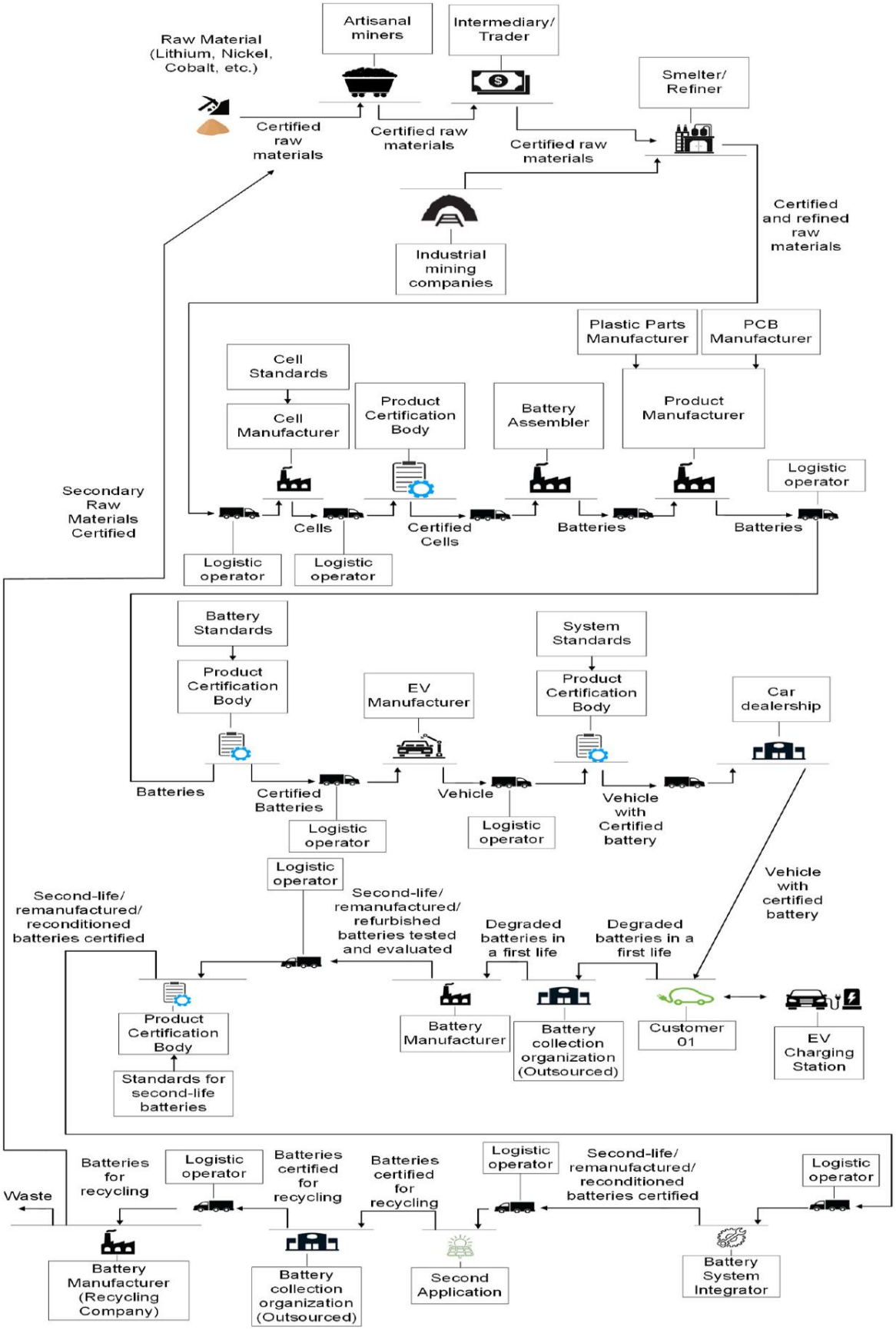

Figure 19 Schematic of battery SC

Chapter 9: Thesis Conclusion

In the view of objectives of the thesis, mentioned in introduction section, the GUEST deployment proved to be useful framework for the research purpose, it helped to remain stick on the business development view while going through the variety of the literature and the publications, the adoption trend of the new technology which is not entered in the commercialization phase of business development, can be predicted with the help of this methodology because it comprises of simple qualitative tools, which can easily use for the literature overview while remain intact with the factors which is most concerning for the executives and managers for the future profitability of the organization.

The tools included in GUEST gave us further insight of the political, economical, technological and social factors which are surrounding and highly linked with the adoption of this new paradigm and the future profitability, by taking insight from the existing competitive forces inside the industry, its easy for the executive of the company to reach the decision related to alignment of the strategic goals for getting the sustainable competitive advantage. Its also become clear that long term competitive advantage can not be based on the cost superiority but it also linked with the deployment of business model innovations inside the organization for becoming compatible for fulfillment of the varying consumers demands, the implementation of Blockchain and IoT based sensors proved to gain the operational excellency hence the reduction of incurred cost in the process of EV manufacturing along with enhancement of productivity, it also assist the organization to acquire the flexibility of business models, such as data as service, product service business model, second life scenario etc. The integration of supply chain from source to final consumer will increase the customer satisfaction and loyalty, which increase the chances of community build up for the prospect businesses in the new consumer segments, the attainment of core capabilities related to the data management till the final users will open various opportunities for the company to deploy co-creation relationship in those businesses such as rent a car, ride sharing with sustainable means, luxury drive etc. The modelling of business canvas model has increased our insight of these possibilities and formation of balance scorecard relates the strategic goals of the company with the said adoption of the solution.

Besides the presence of challenges like scalability and initial investment, the uniformity of regulatory challenges is very critical for the existing technologies to become so dominant for

creating the ecosystem by community building, on the other hand the maturity of technology considering the policy making is gradually making progress, which we have analysed through PEST in Go phase.

Additionally, the use of blockchain technology enables the tracking of all battery materials and components, enabling network participants to make data-driven decisions about the source of inputs, input materials extraction, manufacturing, certification, first use, second use, and recycling. The properties of transparency, immutability, security, authenticity, and auditability support the deployment of this technology to prevent players in the battery market from engaging in opportunistic activity.

Strategically, vendor collaborations or partnering relate to organizations' collaborative & increasingly specialized ties with their supply chain and downstream consumers. Many corporations have taken dramatic moves in recent years to understand through both inter- and cross - functional and cross restrictions in order to create partnerships, with the goal of lowering ambiguity and improving control over distribution and supply channels. These partnerships are often formed to improve each connection member's performance and profitability via resource and inventory savings and greater knowledge exchange, in case of Stellantis via BSC we got that the merger synergies is specially included in company strategic goals, the pace of process related to implementation of blockchain and IoT sensors solution would be increased with such type of merger synergies secondly it will solve the problem of benefits distribution among the involved stake holder, though we got clear view of benefit distribution with the social business network analysis, it entails that the focal beneficiary of this solution is manufacture of main product, but merger synergies and strategic partnership with the other stake holders will help to reduce the problem of conflict of interest and equal favourable environment for technological adoption.

The analysis of the use cases and deployment of GUEST on the case of Stellantis, gave us the insight for the opportunities and challenges that is present for TIM in the market. The investment in the infrastructure development would be recovered due to availability of potential consumers in the automotive, food, pharmaceutical, logistics, transport and industry related to product life cycle management, recycling and reuse, we can ascertain that the economies of scale will be reach along with the economies of scope due to diversification of the consumer segments, we got clear picture with the solution canvas model, the functional

use of the business would solve the problems like trace and tracking of the product sourcing, certifications, real time condition monitoring through out the supply chain process, which ensure the enhancement of company profitability by reducing the transaction cost involves in the process also provides the space for the company to move towards new business models which are quite flexible to meet the varying consumer demands and tastes.

The functional use of the proposed solution in the supply chain of the different industries can be described as follows:

- **Product order history:** Using blockchain and IoT technology, both the corporation and the customer can follow the full product life cycle across the supply chain. Integration of blockchain with IoT, can precisely save the history of all communications between IoT devices. It gives users fast access to all product information, such as the date a fish was captured, registered, and sold, comprehensive record of the fish's journey from ocean to end user could be traced. (61)

- **Ease in documentation**: Together, blockchain and IoT provide secure freight delivery, even in cross-border commerce. The system functions as a smart agreement between all parties engaged in a transaction. It is possible to say that the contract's terms and conditions are inscribed in computer codes, permitting financial transactions between unknown parties without disagreement. (61) For reducing the complexity of the process blockchain framework with 5G enabled sensors would be beneficial and extensively suggested.

- **Product quality:** Product quality can be monitored by integration of the upstream and downstream via IoT based smart devices across different sectors within the supply chain for getting the superior positioning of company with respect to cost and revenue structures.

- **Product originality:** Blockchain may be used to identify counterfeit items, reduce paper load processing, and facilitate provenance tracing in the studied use cases, considered solution have a capability to solve the pains presented across the industry in supply chain for the different stakeholder along with the tendencies to generate the gains as well.

9.1 Limitations

Though we have deployed state of the art methodology of the business development for doing our research work and reaching the above-mentioned conclusions related to the implementation, but we can summarize the limitation of this research work as below, which also point out the possible areas of future research with more resource's deployment.

- The GUEST methodology is mainly comprising the qualitative tools, so the chances of presence of the researcher biases in the research work is present, before carrying the heavy investment the market analysis would be useful for further evaluating the benefits for the stakeholders in terms of quantitative means.

- For the use of the technology, the technical side of the EV and blockchain and IoT sensors has not been touched in depth, as the standardization of the blockchain and IoT technology, EV batteries is needed to enhance, so the limitations related to technical deployment should be taken into account.

- This research mainly use those research articles which did the systematic literature review for reaching the valid conclusion, but systematic literature review can also be done with using the framework of the GUEST, as the systematic literature review is very detailed job in its own domain and require the very detailed view for sorting out the peculiarities linked with the characteristics of the involved variables in the process, that's why we took insight from the articles related to systematic literature review rather than to do this literature review in this research work.

- The interviewing the stakeholders present in the Italian markets is one of the basic steps of GUEST deployment, tough we have taken in depth insight from the research articles related to such surveys but for the Italian markets it would be beneficial to counter check the result of this work with the GUEST deployment in the practical scenario involving the managerial elements of different stake holders.

9.2 Future scenario

The deployment of Big data and artificial intelligence with the use of this technology will push the organization to move towards the Industry 4.0 paradigm, in which main area of focus would be the M2M communications, hence lowering the chances of human errors and inefficiencies present in the process, so necessary framework with respect to managerial point of view could be studied based on this research work, the adoption of creating the digital twin and related technical expertise is the separate topic of the research which also open the new markets for the companies by attaining control of strategic resource related these technological advancement.

The economical analysis can also be done based on this research work specifically considering the whole view of implementation scenario described in this thesis work, the formation of BSC will give the business executive the overview of involved KPIs which should be focused on the monitoring phase for checking the improvements in the business process.

The deployment of GUEST for getting the business development can be translated into the other industries mentioned in the section of the use cases, the strategic alignment would be equally beneficial for the other cases and this step can directly implement in the case of supply chain related to other products and services.

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