

PJB Smart SCM - The Digital Supply Chain in Power Plant Industry

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PT Pembangkitan Jawa Bali (PT PJB), one of the biggest power plant industries in Indonesia, has a vision to become the leading and trusted company in Sustainable Energy Business in Southeast Asia. Businesses today are faced with VUCA World, which evolved into Volatility, Uncertainty, Complexity and Ambiguity [11]. COVID-19 pandemic has emerged as a perfect example of the VUCA landscape. The rapid changes have taken place in the social, economic, political and technological fronts in today's environment [11]. Dealing with this, a system that has high resilience is needed. Technological changes follow the industry 4.0 technology, where information is input into the system and can be accessed by interested parties in real time and access is open to authorized parties. This processed conformity with Big Data Analytics Pillar. Supply Chains can Increase Efficiency and Effectiveness, not only in the Product Delivery Process, but also in sharing information with all organizational networks [16].

Smart SCM is an integrated upstream to downstream information system that covers the entire (end-to-end) SCM business process within PT PJB. This study intends to show if Big Data Analytics could optimize cost, performance, and risk level as sustainability aspects. Smart SCM is developed by using System Development Life Cycle (SDLC) Framework Methodology. The first stage conducted in this study is identifying Supply Chain Framework using Requirement Analysis. Second, the requirement was transformed into IT System by Designing System Approaches. The following stage was System Implementation, where PJB Smart SCM is ready to use. The final stages were Result Analytics including Maintained Operational System and Design.

The Smart SCM Benefits are increasing the trust of partners and suppliers, rising the speed of procurement processes up to 23.98%, gaining better information system and database, capable to maintain Procurement Efficiency Average to 10.72%, Average of Inventory Value decreased by 2.70%, Service Level increase from 98.72% to 99.39% which lead to increasing EAF from 94.05% to 97.50%, can manage the risk level from High (E3) to Moderate (B3), make a faster decision-making, and participate in the sustainability of green innovation on paper use, as well as establish of a complying and transparent governance that meets the Good Corporate Governance rules.

Keywords: Digitalization, Business Process Re-Engineering (BPR), System Integration, Big Data Analytics, Enterprise Asset Management (EAM), Supply Chain Management (SCM), Power Plant Industry.

I. INTRODUCTION

Industry 4.0 has brought a new dimension to many industries in the world. The rapid development of the industry makes competition in quite a number of industries increasingly fierce, many companies are starting to look at various aspects as a follow-up in taking strategic steps forward for the sustainability of their business. The role of digitization which became the main focus in the existence of Industry 4.0 which then began to be in great demand. Industry 4.0 concept originated at the Hannover Industrial Fair in 2011, with the intention to raise the level of German manufacturing through the application of new technologies such as the Internet of Things [5]. In simple terms, the internet of things means the connection of all human objects and activities to the internet [10]. There are nine pillars that drive Industry 4.0, namely big data and data analytics, autonomous robots, simulations, horizontal and vertical system integrations, industrial internet of things, cloud computing, additive manufacturing, cyber security, and augmented reality [4].

Industry 4.0 and digitalization are present as a result of the disruption era which then led to the re-development of a term known as VUCA World, namely, Volatility, Uncertainty, Complexity and Ambiguity, encouraging Management to present a system that is able to survive in the midst of this VUCA. The acronym VUCA, which expands to Volatile, Uncertain, Complex and Ambiguous, was coined in the year 1987 on the basis of the theories of leadership given by Warren Bennis and Burt Nanus. Like many other concepts in management literature, the term VUCA also owes its origin to the United States defence forces. It expands to Volatile, Uncertain, Complex and Ambiguous, and was coined by the American military in response to the collapse of the bipolar world order. As long as the Cold War between the two superpowers of the world - the US and the former USSR - lasted, the Americans had an identified enemy. But with the disappearance of the erstwhile Soviet Union, the US Army became 'disoriented' in a way. Now the enemy could be anyone and could come from anywhere. In 1991, when the Cold War came to an end, the concept of VUCA was introduced for the very first time. The objective was to bring out the multilateral world which had become more volatile, uncertain, complex and ambiguous as the end result of the war (U.S. Army Heritage and Education Center, 2018) [12].

PT Pembangkitan Jawa-Bali is the largest company in Indonesia that manages Electric Power Generation with a

very large operating capacity, where the technology used is diverse and spread throughout Indonesia. The power generation business in this case is also affected by the current development of the industrial world. Asset management is the main focus so that the managed business can continue to run in a sustainable manner as stated in the company's asset management policy. In accordance with the company's vision is to become a leading and trusted company in the sustainable energy business in Southeast Asia. [13]. Opportunities in terms of encouraging business continuity, The arrival of the COVID-19 pandemic has added impetus to being able to build a system that has high resilience in terms of asset management, the COVID-19 pandemic is one concrete example of this VUCA World. [11]. remarked almost a decade ago that across many industries, a rising tide of volatility, uncertainty, and business complexity is roiling markets and changing the nature of competition; researchers and business leaders have long asserted that we now live in a 'VUCA world'. Given the rapid changes taking place on social, economic, political and technological fronts in the current environment, COVID-19 pandemic has emerged as a perfect example of a VUCA landscape [11].

In the management of PT PJB's asset management, there are important points so that assets can continue to run optimally, one of which is Material Management which is managed directly under the Supply Chain Management function [15] and [16]. Supply Chain Management itself has a role in addition to having a role in increasing effectiveness and efficiency in material management from upstream to downstream, which is not only in terms of delivering the product to obtain results but also in terms of managing information systems so that they can run transparently and according to needs [15] and [16]. In order for asset management to be more sustainable, and then continuous performance improvements can be obtained, one of the approaches taken is through digitalization of Supply Chain Management governance in accordance with the applicable technology in Industry 4.0, where in this case an Integrated Information system technology will be designed through the SDLC or System Development Life Cycle approach, which then this smart technology will be used to support the Supply Chain Management process. The SDLC approach is the approach used in the case of companies making acquisitions and or developments, obligations carried out in the context of controlling to produce information technology that supports the achievement of company goals. This SDLC is a system design that is arranged systematically (Waterfall), this SDLC stage has referred to ISO20000-1 on Information Technology – Service management contained in clause 8.5 [14].

PT. Pembangkitan Jawa-Bali as the largest energy generation company in Indonesia operates more than 20,000 MW spread throughout Indonesia and has 6 business concentrations that focus on managing electrical energy plants. For the service to be more optimal, a digitalized information system is needed, this is so that assets can be managed properly in the midst of the era of industrial disruption which is defined by the term VUCA World. In response to this, PT PJB is compelled to create a well-systematic material management because most of its governance, although it has been digitized but has not been integrated, will encourage an independent sub-system which will cause distortion of information from one field to another. The contribution of the research is to propose improvements to the work process that

was originally done manually and subsystem, which was then designed a digitized and integrated system which was later called PJB Smart SCM. the function of the PJB Smart SCM and its relation to the sustainability of asset management in the energy business, as well as the benefits obtained by the company on asset management that has been carried out. The purpose of this study is to determine how the framework of the development of applications and or systems in supply chain management, especially in the electrical energy business and how the role of the system in the sustainability performance of asset management as a benefit derived from the design of a digitalization system in supply chain management.

II. RELATED THEORY OF PJB SMART SCM

Based on the current phenomenon of the industry, supply chain management has begun to be regulated according to these needs, the system that was originally manual must be digitized, such as systems in processes related to vendor management, then there is a need for inventory management that can be monitored in real-time, digitization plays a role in helping these needs. Efforts are made to achieve better generation performance in line with Asset Management. The digital supply chain enables wider availability of information and infinitely superior interactions, communication, and collaboration, which lead to improved trust, agility, and productivity [7]. The rapid digitisation of industry, or Industry 4.0, is trending in supply chain management. The opportunities surrounding digitisation have made it possible for supply chains to access, store and process a large amount of data both from within a firm and externally. For example, manufacturing firms are now able to obtain individualized customer data to personalize the sales process, product design and service. One application of this is through smart devices which record and share data to identify opportunities using learning algorithms [9].

Digitisation also allows for demand information to be shared directly to actuators in manufacturing plants, leading to shorter changeover time and enhanced service level. The amount of data stored and disseminated has also enhanced both predictive accuracy and facilitation of prescriptive solutions. Specifically, forecasting applications of big data have recently proliferated in such areas as entertainment (Goel et al., 2010); auto parts (Choi and Varian, 2012), hotels (Yang et al., 2014) and the retail industry (Cui et al., 2017) [9]. Retail stores can now collect data from their consumers including an entire purchase history, where they can be subsequently identified through membership information or payment methods allowing the company to understand and analyse the characteristics of the shopper and predict consumer behaviour [9].

Digitalization has changed the ways in which people communicate and interact with their surroundings. Novel technologies and gadgets—including smartphones, computers, driverless cars, and smart wearable devices—have all transformed how we access and disseminate information. These novelties and digital transformations affect every industry, and supply chains are no exception. Digitalization in supply chains has come to encompass digital products and services as well as the handling of supply chain

processes within companies undergoing these rapid changes) [7]. In order to benefit from the digital supply chain, it is necessary to leverage novel approaches, including digital transformation with technologies. This study defines the digital supply chain as a bundle of interconnected activities, handled with novel technologies, involved in supply chain processes between suppliers and customers [7]. In other words, the digital supply chain is an intelligent, value-added, novel process that utilizes new approaches, specifically digital transformation with technologies, to create competitive value and network effects [7].

Many researchers have highlighted the importance of both internal and external relationship performance in managing the entire supply chain (Stank et al., 2001; Holweg et al., 2005). For example, Stank et al. (2001) observed that increased collaboration among supply chain participants reduces total costs and augments service performance. They also found that, ideally, collaboration begins with customers and extends throughout the firm—from the distribution of finished goods to the manufacturing and procurement of raw materials to work with material and service suppliers. Studies also have indicated that increased digital transformation has given rise to increased collaboration within supply chains [7]. The strategic adoption of digital technologies by firms is gaining relevance. A digital SC network is an interconnected network that facilitates the continuous flow of information and automation among SC partners. The digitalization process will create value and capture opportunities through real-time data access and data analytics [1]. In their study, Grover, Kar & Dwivedi (2020) addressed the application of artificial intelligence in operations management like product development, manufacturing, SC, and services. The application of digital technologies results in the generation of data inputs which facilitates effective control and planning by reducing cost and attaining environmental sustainability (Salgado, 2021). Gu, Yang & Huo (2021) studied the implications of the performance of information technology with partners in achieving SC resilience and found that the application of IT with customers and suppliers has a significant impact on SC resilience [1].

III. CONCEPT OF PJB SMART SCM

PJB Smart SCM is an Integrated System upstream to downstream which covers the entire (end to end) Supply Chain Management (SCM) Business Process within PT Pembangkitan Jawa-Bali formed into an integrated framework as a means of providing information to various parties involved in the implementation of the process. overall.

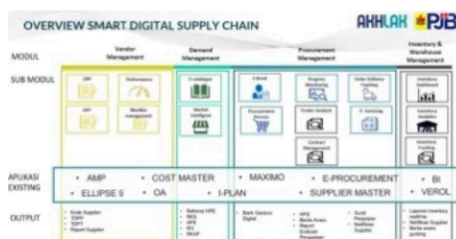


Fig. 1. PJB Smart SCM Conceptual

PJB Smart SCM is expected to be able to facilitate all internal and external needs within PT Pembangkitan Jawa-

Bali (PJB Raya) so that positive, effective, and transparent and sustainable relationships are established in accordance with applicable Good Corporate Governance rules to achieve an optimal comprehensive SCM process.

Fig. 1. Illustrates how the shape of each process is according to needs and requirement analysis along supply chain management, which is then designed into a digitized form, all information needed in the process is inputted into each function which is then integrated into an interrelated system, the data is collected in a centralized database so that the data can be monitored and analyzed in real time. In industry 4.0, there is one of the 9 pillar technology used, namely Big Data Analytics which is also the technology used in the development of this system. The advent of big data leads to data-driven smart manufacturing, which presents an unprecedented challenge as well as an opportunity for the supply chain management. Traditionally, the focus of supply chain management lies in the flow of tangible materials from suppliers to manufacturers, and in step via the distributor to end users. During the last two decades, the rapid development of information technologies enabled manufacturers to trace the intangible flow of information, which develops in parallel with the material flow. As the manufacturing process becomes increasingly data driven, it is imperative to explore the role of data in making a supply chain more intelligent, flexible, and adaptive [6].

In accordance with what is contained in the governance of the company's asset management, there are processes based on requirement and process analysis which are then digitized, namely, (A) Vendor Management, which consists of managing the Company's Vendor list and Vendor assessment report cards. (B) Demand Management, which consists of Catalog management and price analysis in the market as predicted price, (C) Procurement Management, which consists of managing procurement processes, progress, and analysis, then related to bank guarantee management, invoice processing, contract management and process of delivery of goods, (D) Inventory and Warehouse Management, which is an analysis of inventory in the warehouse as well as process performance management. These systems are then arranged systematically and integrated with each other.

A. Vendor Management System

Vendor management (external) has become a trend for the world's industry leader, and it is undeniable that very big role for PJB. Various national level management systems (e.g., Occupational Health and Safety Management System, Security Management) or international (e.g., ISO, Malcolm Baldrige) provide requirements on how a company should manage its suppliers. [16]

In practice in the power generation environment, suppliers have some of the roles include the following: providing primary energy, providing spare parts, providing construction and other services, providing consulting services, conveying information about technology updates that may be needed and provide information about availability of materials / spare parts in the market. [16]

In the PJB Smart SCM, Vendor Management System consists of four applications, there are:

- DPP, the function of this application is to maintain registered and listing of the company vendors.
- DPT, the function of this application is to maintain list of the company vendors in the specific activity area.
- Blacklist Management, in accordance to maintain the rule in the material procurement, vendor will be controlled and managed in this application in case if the vendors did something unnecessary that indicated out of the rules.
- Performance, vendor performance score will be managed in this application, the vendor will be scored by 9 aspects: Integration; Relationship; Quality; Time; Price; Occupational Health and Safety; Environmental; Security; and Energy [17].

B. Demand Management System

The need for materials is one of the most important stage important in the material business process, because the material business process begins by the existence of a need and will end with the fulfillment of to the needs (Demand & Supply). The quality of the need for materials greatly affects the success and success of the business process material.[16] Demand Management System consists of two applications:

- E-Catalogue, the function of this application is to provide the vendors to offering their materials (Spare Part) or services to PJB Raya.
- Market Intelligent, the function of this application is to give some price information, it will maintain all the predicted price of the materials.

C. Procurement Management System

Good management of the procurement process (procurement management) to meet the needs of the operation and maintenance as well as the administration of the unit generator is very necessary because at this stage a business bond (contractual) made with an external party (supplier) regarding purchase of goods/services or rent. [16]. The Procurement Management System consists of seventh applications.

- E-Bond, function of this application is to maintain the Bank Guarantee processes.
- Order Delivery Tracking, function of this application is to track the movement of materials from the vendor unit to PJB Raya.
- E-Procurement, the function of this application is to manage procurement processes.
- E-Invoicing, the function of this application is to manage invoicing processes.
- Contract Management, the function of this application is to monitor and control the contracts that's registered with the company.
- Progress Monitoring, function of this application is to monitor all the procurement processes.
- Tender Analysis, function of this application is to evaluate the tendering that registered on the company visually.

D. Inventory and Warehouse Management System

After the requirement's planning phase has passed, then what needs to be controlled is the level of material inventory in the warehouse, the optimal point must be found between service level and inventory value. There are two interests in inventory management, namely financial management and management maintenance. Financial management wants not to be to keep a lot of inventory in the warehouse, because it will be annoying for the company cash flow. Whereas maintenance management wants to increase the availability of materials in the warehouse to a safe level. Inventory and Warehouse Management System consists of three applications:

- Inventory Dashboard, the function of this application is to give some information visually about trend of materials in real time.
- Inventory Analytics, the function of this application is to give some information about Inventory KPI.
- Inventory Check, the function of the applications is to give information about material that is inputted to the system in detail.

IV. PJB SMART SCM DEVELOPMENT

In each process in the System Development Lyfe Cycle (SDLC) (Fig. 2) there is new data which then becomes documentation as material and literacy which is then developed in the process.

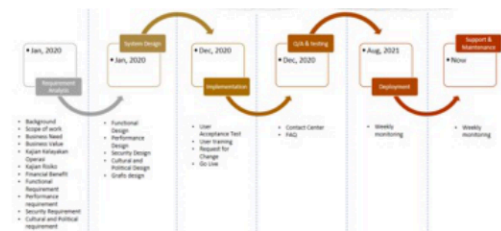


Fig. 2. PJB Smart SCM Development Processes using SDLC.

The Stage of Development PJB Smart SCM using SDLC Approach are [2] and [14]:

▪ Stage 1: Requirement Analysis

This Requirement Analysis stage is in the form of a requirements design in the form of a User Request Form and the form of a Business Requirement Statement (BRS). This BRS PJB Smart SCM is in the form of grouping activities which will then be developed into terms (C, R, U, D) as a form of systemized activity. transaction data will be defined along the PJB Smart SCM process flow. In the form of a digitized process definition, each of these activities will later be described in the form of a system design.

▪ Stage 2: System Design

This System Design stage is in the form of a Business Solution Design (BSD) plan, this BSD is a document that describes the process flow which will then be described in the form of a Flowchart (Use Case Diagram, Business Process Diagram (Workflow Design) and also User Interface Design or display - display that appears into the application and or software which is then implemented.

- Stage 3: Implementation

The form of source code, where the coding process is carried out to build applications or software. From this process will produce an information system technology that will be used which will then be equipped with a User Manual.

- Stage 4: Q/A & Testing

Be implemented needs to be tested or User Acceptance Test, users will be brought to use the application with the aim of evaluating and analyzing related to information system technology that has been designed, UAT output in the form of a Checklist report to evaluate the functionality of the system technology designed information.

- Stage 5: Deployment

Deployment is in the form of adding new services, the program is added to a new technology system which is then shared and published in the form of a guaranteed application, at this stage the application will Go Live, and the process will be documented.

- Stage 6: Support and Maintenance

Information technology systems will be included in the Information Technology Service Catalog, Maintenance and Monitoring is carried out as long as the service is in the form of a back-up database, Support and Maintenance is carried out so that it remains in the applicable functions according to the Service Level Agreement, at this stage will also always be monitored regarding development and also problems that might hinder the process, this process becomes important to mitigate the failure of the translation of the information data so that it can match the input.

V. IMPLEMENTATION AND BENEFICIAL OF PJB SMART SCM

The concept model of the PJB Smart SCM can be accessed at <https://smartsbcm.ptpjb.com/>. Users could operate all of the applications in accordance with the concept of PJB Smart SCM on this journal. Fig. 3 shown Homepage of PJB Smart SCM. Users of this application divided by third interest, there are: Vendor of PT PJB, User form Division of Supply Chain Management PT PJB and User in internal of PT PJB who are related to The Supply Chain Management business processes. Vendor could fulfill all the requirements needed and monitor their activities in accordance with the use case diagram which have been design on application development, this treatment also same as with Internal of PT PJB (from Division of Supply Chain Management and User that related on the Supply Chain Management Processes). Use case diagram is necessary to design well, it's because each user has contributed different beneficial values, User who use this technology could make optimalization of the processes in every function thoroughly. The data will be integrated into the interrelated applications.

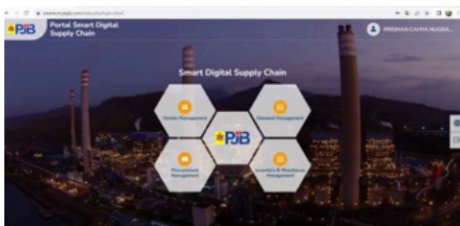


Fig. 3. Homepage of PJB Smart SCM.

The PJB Smart SCM produces quite a lot of benefits in the sustainability of asset management, improvements in the management of information systems in material management have led to an increase in the sustainability of Asset Management itself (Fig. 4).

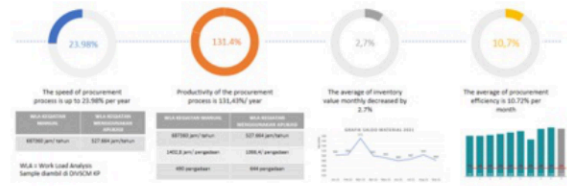


Fig. 4. Performance Result on Asset Management.

The PJB Smart SCM Benefits are increasing the trust of partners and suppliers, rising the speed of procurement processes up to 23.98%, gaining better information system and database, capable to maintain Procurement Efficiency Average to 10.72%, Average of Inventory Value decreased by 2.70%, Service Level increase from 98.72% to 99.39% which lead to increasing EAF from 94.05% to 97.50%, can manage the risk level from High (E3) to Moderate (B3), make a faster decision-making, and participate in the sustainability of green innovation on paper use, as well as establish of a complying and transparent governance that meets the Good Corporate Governance rules.

In addition, there are benefits in various ways, Increasing the trust of partners and suppliers, because the process is more transparent, The information system and database are getting better, because the data is inputted into a database that is large enough and also integrated which then has the impact of accelerating decision making where PJB Smart SCM allows the Helicopter View which can facilitate decision making where data is distributed in real-time, through PJB Smart SCM also the company joins Participation in sustainability green innovation in paper use which is based on a green study of the average use of paper For three years to spend 1 ton of paper, by recycling 1 ton of paper can save 682.5 gallons of fuel and 7000 gallons of water and also 4000 kwh of electricity, which is also equivalent to 17 good quality tree trunks equivalent to the ability to interfere with breathing as many as 34 people (Onondaga Resource Recovery Centre) 30%-40% of discarded paper is packaging paper [3], the use of digitization makes new a work culture by minimizing the use of working papers, The PJB Smart SCM can make the Compile process and realize more transparent governance so that it complies with Good Corporate Governance rules.

VI. CONCLUSION, DISCUSSION AND FUTURE WORKED

A. Conclusion

The Smart SCM could maintained an Integrated Upstream to Downstream Information System that Covers the Entire (end-to-end) SCM business Process within PT PJB, Including Supplier Management, Demand Management, Procurement Management, Inventory and Warehouses Management whose Systems are in line with Industry 4.0 Developments and Could Manage the Optimization of Sustainability of Electrical Energy Business Ecosystem as well as on Asset Management.

B. Implication

1) Theoretical Implication:

Digitization also allows for demand information to be shared directly to actuators in manufacturing plants, leading to shorter changeover time and enhanced service level. The amount of data stored and disseminated has also enhanced both predictive accuracy and facilitation of prescriptive solutions. Specifically, forecasting applications of big data have recently proliferated in such areas as entertainment (Goel et al., 2010); auto parts (Choi and Varian, 2012), hotels (Yang et al., 2014) and the industry (Cui et al., 2017) [9].

This function is also quite good in terms of business management of electrical energy generation, through this research improvements in the information system by digitizing the supply chain management, in this research also obtained new theories related to the benefits of Asset Management.

2) Managerial Implication:

This study shows an increase in performance related to asset management in the power generation business where there is a positive increase in the performance of the Generation EAF. The role of management in this case is to support the realization of digitalization through investment and or funding so that digitalization can be functioned properly and thoroughly and also using technology that is in accordance with the technology pillars in Industry 4.0.

This investment is needed in the future to carry out management and maintenance so that the PJB Smart SCM can run better and more sustainably, according to at least its development function.

C. Limitation and Future Study

The limitations of this paper for future developments are the need for analysis of development studies with a multi-criteria approach, namely cost, performance and risk which are the benchmarks in asset management according to ISO 55000, 2014 [15]. Then the System Development Life Cycle (SDLC) which is a method, The method used is based on User Requirement Analysis, where the use of this method is not good enough in mapping the entire business process, it is necessary to add another method that better in map the whole process, several main processes as example that is several function in the requirement management process according on the asset management policy not yet included in the PJB Smart SCM. Based on Industry 4.0 technology there are 9 Technology Pillars that could contribute to the digitization of this Supply Chain Technology, where in this study only using Big Data Analytics, so for the further this Smart SCM still could be developed in the further research.

According to the discussion of limitation, future worked of PJB Smart SCM are to analyze that focused on multi-criteria according to ISO 55000, 2014 (15), There are Cost, Performance and Risk. Another opportunity to complete the value of PJB Smart SCM is to analyze it contribution to three aspects: Environment, Social and Governance, and Economic value as Sustainability aspect that needed to be optimized. For future worked the User Satisfaction of this application also necessary needed to be describing as

feedbacks to evaluate the technology, based on case from the limitation for the further still have so many opportunities to re-engineering the business process of the offered concept, as example some of the feedback, give an statement if they want that the system it's necessary to redesigning again and the system must conform with the 9 pillars of technology that Industry 4.0 were offered.

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