

# Critical Review of the Industrial Product Service System model for the Screw Air Compressor

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## Abstract

In the modern industrial context, where industries are being pushed into reconsidering their ways of production because of tough competition, environmental policies, risks, and pressure from consumers. An Industrial Product-Service System (IPS<sup>2</sup>) is characterized through a excessive integration of product and service shares. This implies that the presenting organization develops an IPS<sup>2</sup> consisting of product share, e.g. a particularly complex spare parts, and provider share to extend client value, improve the relationship between customer and company and eventually generate profit. IPS<sup>2</sup> entails an excessive degree of organizational effort.

IPS<sup>2</sup> Control Architecture is proposed to set the countless degrees of IPS<sup>2</sup> at some point of the operation segment into an ordinary context. Lifecycle level, Operation level, Process degree and Effect stage together have an impact on every different with the aid of controlling transport procedures or a total IPS<sup>2</sup>. Each stage is used to assurance the shrunk client price on a distinct level and with an extraordinary scope.

The study identified that the IPS<sup>2</sup> architecture is not used properly by the industries through it has a new way of presenting patron cost and therefore symbolize globally competitive manufacturing systems. The gaps in the study are customers foresee improved efficiency and a decrease in unnecessary work, operational interfaces were missed and the services focused on specific industry where the technological up gradations were discussed like Industry 4.0, Digital twin, Internet of Things, big data analytics etc.

The Screw air compressor is one of the important segments of the Industrial Product still there is no contribution for the IPS<sup>2</sup> model. The future scope for the study is that IPS<sup>2</sup> for the screw air compressor for building the B2B environment.

**Index Terms—Customer value, digital transformation.**

## I. INTRODUCTION

An Industrial Product-Service System (IPS<sup>2</sup>) is characterized via an excessive product and restore shares integration. This capability that the offering organization develops an IPS<sup>2</sup> consisting of product share, e.g., highly complicated spare elements and repair share to extend client worth, strengthen the connection between client and supplier and at last generate profit. IPS<sup>2</sup> includes a high degree of structure effort. "Product-Service System is characterized by the integrated and reciprocally determined designing, development, provision and use of product and repair shares as well as its immanent computer code parts in Business-to-Business applications and represents a knowledge-intensive socio-technical system."(H. Meier e.tal, .2020)

Today's organization required for offering IPS<sup>2</sup> should be a set out network structure. The provider will use third-party suppliers and sources of the IPS<sup>2</sup> patron to ensure the operation

of an IPS<sup>2</sup>. The provider and every one of his supplier's kind of the dealer Network. An IPS<sup>2</sup> is frequently thought of as a Large-Scale elaborate System: it's composed of various more minor constituents that serve explicit functions, share explicit resources, and are ruled by reticular goals and constraints and need over one regulator. Gazing the above-mentioned challenges in IPS<sup>2</sup> operation, An IPS<sup>2</sup> fulfills purchaser needs via offering such as diploma of performance. These degrees are regularly expressed in contractually outlined parameters, e. g., in phrases of comfort or satisfactory of output elements.

To supply the degree of performance arranged throughout the operation, the IPS<sup>2</sup> needs to be influenced on varied levels counting on its current state.

Industrial Product-Service Systems (IPS<sup>2</sup>) will offer insights to boost the environmental property and lower ecological impact. However, its self-made realization for preventing waste assembly, whereas increasing efficiencies within the uses of energy and human capital remains a highly convoluted drawback.

IPS<sup>2</sup> architecture is often influenced on the lifecycle level, Operation level, Process level, and effect level. The lifecycle level focuses on the client demands, business model development and implementation, continuous analysis, and fulfillment of buyer's desires. The operational level deals with performance, overall instrumentality effectiveness, and delivery processes. The interdependencies between product and repair share in an IPS<sup>2</sup> are visible on the resulting level and categorical; however, the IPS<sup>2</sup> management design will utilize each to achieve an impression. All instructions are linked through a regular goal; the command variables on all stages are derived. (H. Meier & E. Uhlmann et.al, .2020)

While the administration on the technique degree and, therefore, the ensuing crew is useless for one particular IPS<sup>2</sup>, the Lifecycle levels and consequently the Operation levels of various IPS<sup>2</sup> are interconnected and have a more comprehensive vary of influence. On the Lifecycle level, options and processes are developed for one specific client; however, the results are often accustomed style and implement an IPS<sup>2</sup> for an additional client. On the Operation level, methods for a couple of IPS<sup>2</sup> are deliberate centrally; however, the request for and technique for one IPS<sup>2</sup> in an up to date transport set up is issued by using each IPS<sup>2</sup> severally.

IPS<sup>2</sup> management design is planned to line the many levels of IPS<sup>2</sup> throughout the operation part into a general context. Lifecycle level, Operation level, process level, and effect level reciprocally influence one another by dominant delivery processes or an entire IPS<sup>2</sup>. Every class is employed to ensure the narrowed client worth on an individual level and with a unique scope. Whereas the Lifecycle level focuses on the overall IPS<sup>2</sup> and, therefore, the style of product and repair shares yet because of the necessary delivery processes, the operation level uses the IPS<sup>2</sup> target values heritable from the Lifecycle level to supply a structured setup for the execution of the delivery processes.

This paper is arranged as: Part 1 represents a background on Industrial Product Service Systems and its architecture, Part 2 presenting the forms of papers are available in the four different levels of the iPSS such as lifecycle, process, operations and effect levels. Part 3 presents the research methodology. The iPSS is the part of the PSS but only the difference that iPSS more focus on the capital product and their services. Finally, other parts present some conclusions and suggestions for future work.

## II. LITERATURE REVIEW

The authors of the commonplace manuscripts will be given a copyright structure and the shape must accompany your remaining submission. The industrial product-service gadget (iPSS) might also be a moderately gadget engineering methodology, integration theme, and commercial enterprise mannequin to recognize carrier charge by means of including intangible offerings inside the total existence cycle. However, the planning of the device entails quite a

few difficulties like not sure customer demands, sturdy judgment of the knowledge style, and lengthy debugging times. Strategies for dedication greater troubles are therefore essential. (Fei Zhang e.tal, 2021). The sales technique and additionally the project execution in industrial product-service systems place unit commonly sophisticated, appreciably for capital instrumentality with a long-operational existence at any place there are a unit absolutely distinct actors in charge for a number of transactions over the whole lifecycle. This is commonly regularly extra state-of-the-art due to the fact the company isn't always at once mercantilism to the 'end customer' (Felix Keiderling and Christian Kowalkowski e.tal 2020).

The complete approach of designing an iPSS can be divided into three steps. First, undecided customer wants is determined and standardized. Second, the features of the product-service system are investigated. Finally, the constructions of the system are determined. (Fei Zhang e.tal, 2021).

In this study, however client journey mapping will support building relationships in a very B2B setting for each sales and execution over the operational lifetime of instrumentality and examine each the product and therefore the services offered throughout the whole journey.

Companies' Profit margins quickly shift from merchandise to services, and therefore the producing sector industries try and shift from providing merchandise to providing industrial product service systems (IPSS) so as to stay up to now and guarantee their market position and economic success. IPSS may be an all-round answer consisting of the tangible half that is that the product associate degreed an intangible one being the service. IPSS are economical and beneficiary not just for the supplier however additionally for the user and even the atmosphere.

IPSS isn't a convenient technique of including offerings to historical merchandise alternatively a as an alternative extra complex integration technique of the mechanical product, sensors, and Internet of Things and software program package, that are let on my own confirming structures (resources and infrastructures) and additionally the involvement of heterogeneous stakeholders. Thanks to the excessive complexness worried inside the improvement and manufacturing technique of IPSS, tools for IPSS manufacturing designing and set up in very dynamic and cooperative surroundings are pretty crucial for producing corporations, on the other hand their however absent. (Dimitris Mourtzis, Evagoras Zervas, Nikoletta Boli & Pietro Pittaro e.tal 2020)

The business mannequin determines the complexity of delivery processes. Characteristics of Industrial Product-Service Systems permit overlaying all market demands.

In product-oriented Industrial Product Service Systems (IPSSs) the purchasers have the benefit of the mixture of a product that offers some functionalities and a group of services. IPSS supports the availability of services which might be offered by the merchandise manufacturer. The services can give a good vary of functionalities that may vary from guaranteeing the merchandise's original practicality to augmenting the initial practicality of the product. The shifting of a corporation to IPSS poses several challenges like the dynamic of the company's business model. One among the foremost vital challenges for the institution of IPSS is that the acceptable coming up with of the resources for production, deployment, and installation into the customers' web site.

However, firms that provide IPSS options location unit missing the right equipment for resources' coming up with throughout dynamic surroundings. During this work, a multi-criteria aid coming up with methodology and electricity for optimizing the assembly, delivery, and set up of IPSS is conferred. The projected decision generates a number IPSS's manufacturing and set up plans and evaluates them on overall performance measures for manufacturing and set up like time and value. Moreover, thru the mixing of the layout device with the IPSS sketch section, statistics for producing the Bill of approach and Materials is

conferred. They seem device has been designed mistreatment the Software-as-a-Service (SaaS) strategy and has been utilized and legitimate for the duration of a pilot case from the optical maser reducing enterprise. (K. Alexopoulos, Spyros Koukas, Nikoletta Boli, D. Mourtzis e.tal 2018).

In product-oriented Industrial Product Service Systems (IPSSs) the consumers experience the combination of a product that gives some functionalities and a team of services. IPSS helps the furnish of offerings which may additionally be provided by way of the merchandise manufacturer. The offerings can supply a giant fluctuate of functionalities which will differ from making positive the merchandise's unique practicality to augmenting the first practicality of the product. The moving of a company to IPSS poses various challenges like the dynamic of the company's commercial enterprise model. One in each and every of the fundamental crucial challenges for the organization of IPSS is that the perfect coming up with of the assets for production, deployment, and set up into the customers' net site. However, firms that provide IPSS options are missing the right equipment for resources' coming up with in very dynamic surroundings. (K. Alexopoulos, Spyros Koukas, D. Mourtzis e.tal 2017)

To continue to be aggressive inside the contemporary market, an corporation ought to differentiate itself supported greater really worth propositions. For this purpose, in view that elevating the merchandise or provider overall performance will attain some limits, one conceivable reply is to maneuver closer to new combos of merchandise and services. This evolution, referred to as servitization, outcomes in the era of Product-Service Systems (PSS). Servitization wishes no longer completely a obvious grasp of agency core commercial enterprise alternatively conjointly a obvious imaginative and prescient on the present day developments and challenges of PSS from every enterprise and technological factors of read. Additionally, the evolution route ought to be aligned with the employer strategy. Servitization performs vital in the industrial product provider enterprise model and delivery tactics. (Amir Pirayesh,e.tal 2018)

How an IPS2 network ought to be build up by considering the dynamic behavior of the IPS2 on its lifecycle. However, the network partner might participate and the way they assign their capacities are additionally mentioned as queries concerning the authorization whereas considering the business model.

It is standard that Industrial Product-Service Systems (IPS2) square measure providing additional price for each the client and therefore the supplier. Among innovative IPS2 business models, risks that square measure historically associated with the business processes of the client square measure transferred to the supplier by linking the revenue streams on to the usage, performance or price of a system.

However, the bulk of production firms in Germany keep of that business, despite the high potentials of IPS2 for gaining long lasting property competitive benefits. On the one hand facet the transfer of risks is that the key for brand new business models however on the opposite hand facet it's one among the foremost difficult factors that hinder the productive implementation up to currently. So, it's necessary to spot and manage each values and risks already among the first part of IPS2 style. Because of the non-uniformity and fuzzy understanding of the planning object and method itself, the role of uncertainties and risks during this encompassing isn't processed in the least.

By literature-based analysis this paper is in a position to contribute to the understanding of uncertainty and risk management in IPS2 businesses and proposes a brand new and holistic approach for desegregation the though first style part.

### III. RESEARCH METHODOLOGY

Many authors have listed different iPSS approaches with different emphases. However, a

clear link presenting the approaches and the iPSS lifecycle with a practical focus for the industrial context hasn't yet been explored but with very little work done in this area.

Regarding the approach, the research was conducted in different stages like literature review of the major databases such as Scopus, Science Direct, Web of Science and Emerald. The reason of the selection of the four databases is the availability of the research is very less in this context.

A bibliographical analysis was conducted, gathering papers published between 2018 and 2022. The search parameters are PSS, iPSS, servitization, productization etc. The complementary keywords found are circular economy, cybersecurity, block chain, IoT, Clean and Energy, digital twin, system engineering etc.

The research papers from ScienceDirect 235, Scopus 144, Web of Science 131 and Emerald 59 shortlisted out of that business management are refined to ScienceDirect 8, Scopus 25, Web of Science 20 and Emerald 29 are analyzed thoroughly by considering the year 2018 to 2022 time period.

An original sample of 122 papers was once cautiously analyzed, however solely 6 research seemed to focal point on industrial product service systems. Most of the remaining literature focuses on lifecycle level 6 papers are available discussing the customer demands, development, implementation, continuous evaluation, customer need fulfillment, customer value etc., operation level 5 papers are available explaining about the agent based approach, delivery, equipment effectiveness, performance etc., Process level 7 papers found which interprets the network of the processes involved in the execution, Effect level 2 papers are available which is dealing in to the service activities and technical system etc. The study therefore suggests for more research on the effect level i.e. course of action, IPS2 target values, customer need fulfillment moreover the business model approach.

Some of the gaps the authors pointed showed a lack of practical approaches to develop an iPSS. Aiming at fulfilling those gaps, the research focused on iPSS development supporting business model. A new search was conducted in Scopus, Science Direct, Web of Science and Emerald academic databases, searching for the iPSS approaches on articles published between 2018 and 2022.

In total, 5 papers were encountered. The title, abstract and keyword of the papers were skimmed, looking for those papers which would bring us the business model that we were looking for.

The Research Gaps are presented by the authors as follows:

1. Interaction between the individual management structures need to be analyzed in-depth. (Steven Alter e.tal.,2018)
2. Security cloud services are chiefly geared toward larger firms and not tailored for SMEs in terms of needed data, time and energy needed to stay the safety configurations up-to-date. (Lindström, John e.tal.,2018)
3. Use of Digital Twin technological know-how within the context of IPS2 and descriptions achievable applications for the levels at some point of a control system product existence cycle. (HaiwenZhang e.tal., 2019)
4. The ever-present nature of IoT permits for continuous client support, reinforcing higher instrumentality practices and increasing performance. (Osako e.tal.,2019)
5. Supplier aspect should modification significantly in terms of the business and structure set-up, that has been difficult compared to the required, tho' additional simply enforced, technological changes. (Rondini e.tal.,2018)
6. IPS2 customers foresee improved potency and a decrease in spare work if containers are empty on time. (Lindström e.tal., .2018)
7. Additionally, the core of the IPS2 looks generalizable and transferable to alternative

applications wherever assortment and analysis of knowledge are required to support decision-making. (Lindström e.tal.,2018)

8. Core of the IPS2 looks generalizable and transferable to alternative applications wherever assortment and analysis of knowledge are required to support decision-making. (Lindström e.tal.,2018)

9. Industrial Product-Service Systems (IPS2) are a brand-new strategy of offering customer price and as a result characterize globally aggressive producing systems. (Nag e.tal.,2022)

10. Multiple networked partners are worried within the delivery of the IPS2, i.e. the client, the IPS2 dealer and suppliers.

### **Result**

Industrial Product-Service Systems (IPSS) square measure associate more and more necessary and profitable a part of the vary of offerings of manufacturing corporations. Essential for the market success aren't solely specific style processes and ways however conjointly the appropriate integration of the client. Therefore, a large number of specific ways and processes are revealed up to now. Results to be conferred square measure

(i) A procedure to research the concrete style object as well as the goals and risks still because the basic conditions of the client integration,

(ii) A procedure to set up associate personal client integration method supported the analysis results and at last, to support the look procedure,

(iii) A group of current ways for client integration as well as a procedure to support the choice of appropriate ways consistent with the individual case.

## **IV. CONCLUSION**

The research had the purpose of congregating the main iPSS approaches existing in literature, presenting industry stakeholders with a complicate of tools, methodologies and processes that can be used to support the development of a iPSS offer considering its lifecycle business model. In order to do this, a bibliographical analysis was conducted to gather iPSS approaches presented in the literature. It was noted that there was a more significant number of approaches in the first stages of the iPSS architecture lifecycle business model will require.

One suggestion for future scope would be to explore more research in the stage of the iPSS lifecycle with the conceptual elements for the stages. This proposal could be of a model to iPSS development, encompassing the whole iPSS lifecycle. Also, more research could be conducted in order to develop different approaches for the customer fulfillment business model. Further scope of research will be there because most of the work done on few industrial products targeted; the major industrial product was ignored the study of iPSS.

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