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A study related to product service systems (PSS), SERVQUAL and knowledge management system (KMS) – A review

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ABSTRACT

PSS is a growing field of research in industry practice in today's global economy. It is a new trend that has an impact on both the production and consumption of resources. PSS aims at a more profitable and conservational usage of products. While in the past providing services was one of the strategies attained to differentiate in competition, however today providing a product together with many services has become a standard practice in the product industry. To remain competitive, manufacturers are forced not only to produce a competitive product however rather a superior PSS.PSS are outlined as life cycle bound combinations of a product and completely different services, having sophisticated networks, that comprise a manufacturer as a provider and also as a repair partner. To enable the applicability of a PSS in an industry, it is essential to evaluate the system using metrics – the SERVQUAL MODEL, which defines "The quality as the difference between the customers' expectations & perceptions concerning the services delivered to them" [1]. It is catered to measure quality by capturing the expectancy – confirmation paradigm which suggests the consumer's perceived quality of how well a given service delivery meets their expectations of that delivery. So this SERVQUAL metric is used to determine the level of quality in the industry and the five dimensions are such as tangibility, reliability, responsiveness, assurance & empathy are measured using a five-point Likert scale. Since, organizations are more and more moving towards knowledge-based strategies, developing and managing knowledge is essential for improving the organizational performance as well as for enhancing decision-making process. This paper presents a review on the use of a knowledge management practice in PSS for industries to store, share and utilize knowledge for enhancing creativity & innovation in their service systems. An efficient review of the literature has been conducted in the academic and scientific databases taking into account the date of publication of the articles titled PSS, SERVQUAL and KMS from 2009 to 2020. To achieve the review process, all selected articles have been categorized by publication year, the objectives of the research, the methodology used, the results, conclusion and future scope of their research are presented on a broader scale [16]. Therefore, this paper presents an overview of the literature on PSS and the evaluation methods using SERVQUAL MODEL and the role of knowledge management in PSS and the appropriate ideas for conducting research in the future.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Nanoelectronics, Nanophotonics, Nanomaterials, Nanobioscience & Nanotechnology.

1. Introduction

In the present business scenario, the industries have to improve their business strategy in order to gain and retain their customers. Hence the drive towards customer-oriented business philosophies and quality management approaches in managing and sustaining their business is essential. In this context, PSS plays a pivotal role in determining the crucial aspects for the development and success of any industry, in addition, to support this statement we gather some of the more predominant definitions from the literature, as it describes that PSS is "A marketable set of industries are products and services capable of jointly fulfilling a user's need"[2]. Another common definition of PSS is that it is an "Integrated bundle of products and services which aims at creating customer utility and generating value"[3].Fig. 1-3Tables 1 and 2

On the whole, PSS encompasses "A system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models" [4].

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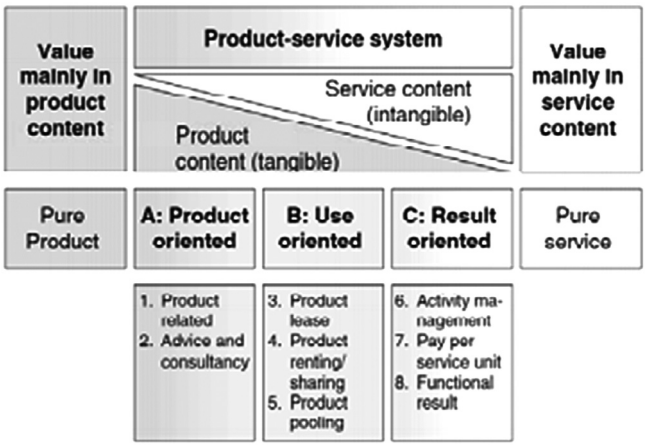

Fig. 1. Different types of Product Service Systems [5]

Table 1
SERVQUAL Dimensions [10].

Dimensions	Definition of servqual dimensions
Tangibility	It is the appearance of the physical facilities, equipment, personnel and communication materials of the service provider.
Reliability	It refers to the ability to perform the assured service as guaranteed correctly and reliably.
Responsiveness	It emphasizes attentiveness and promptness in dealing with customer's requests, questions, complaints and problems.
Assurance	The acquaintance, knowledge and courtesy of employees and their ability to motivate trust and confidence.
Empathy	It is the delivery of individualized and adjusted care and attention paid to customers.

PSS evaluations should be performed to obtain data with invaluable knowledge about customer's needs, priorities and expectations [23]. This will help industries to bring about customizations in products and services, if required, or plan for investments in a new product or service in order to meet the expectations of the customers. On the other hand, Estimating and surveying PSS is a key issue as the customer's behavior towards products and services are consistently changing making it more difficult for the service providers to assess and manage services effectively and efficiently [25–31]. At present when studying the literature, PSS is more than a combination of just products and services that is the value comes significantly from the products as it significantly comes from the service [32–39].

The outline of PSS including various trends and approaches towards the development of any industry includes:

- The use of the product service instead of the product itself[6],
- The shift towards a "leasing society"[7],
- The replacement of commodities through services[8],

2. PSS advantages

The PSS concept is capable of bringing changes in production and consumption models that stimulate and advances the shift towards more viable practices in society [40–47]. According to some researchers, the above-mentioned approach is favorable for some organizations including commercial businesses and consumers [9].

Benefits of PSS in manufacturing and service companies include:

For manufacturing companies, a service component adds/ enables:

- Adding value to a product, for example, budgeting plans, forecasting plans, renovation and modernization.
- Developing and enhancing the growth strategy of the industry.
- Bringing Incremental Innovation to a mature industry.
- Improving consumer relations due to increased contacts and information flow on consumer preferences.
- Improving the total value for the customer through increased servicing and service components, such as:

Activities and programs that extend the life of the product, extend its functionality like upgrading or providing renovations, and make the product and its materials useful once after the product reaches the end of its life cycle, recycling and reusing the product parts or the entire product itself can be done.

For service-oriented companies, the product component enables:

- Extending and diversifying the service.
- Preserving the product markets by incorporating the service component into an offer.
- Providing quality, which is very difficult to achieve, modify and manage.

3. The SERVQUAL scale

Customers receive value-added products through customized offers of high quality (from product/service per delivery/supply). Since the service component is flexible in nature, it entails the integration of new products and services, which can better be catered to bridge the gap between the changing needs and conditions. Implementation of total quality management principles is comparatively more complex because of the way that nature and quality of product services can't be defined and characterized unbiasedly. This paper highlights the implications of the SERVQUAL scale, which is considered as one of the most widely used models for assessing PSS.

The SERVQUAL model was proposed and developed by [6] to measure Service quality. SERVQUAL measures perceptions of service quality across five dimensions: tangibles; reliability; responsiveness; assurance and empathy.

A customer's expectation of a specific service is decided by factors like recommendations, personal needs and past experiences. The expected service and therefore the perceived service sometimes might not be equal, thus leaving a niche.

The service quality model or the 'GAP model' developed in 1985 highlights the foremost vital necessities for delivering high service quality.

It identifies five 'gaps' that cause unsatisfactory or unsuccessful delivery of products and services.

Customers generally match the service they 'experience' with the service they 'expect'. As a means of emphasizing expectations, this approach to measure service quality is generally seen as an expectancy-disconfirmation paradigm and also as the dominant model within the consumer behaviour and marketing literature [11].

4. Knowledge management system

The knowledge management system is important to boost the efficiency of an industry to make better decision-making capabilities. In the past due to increasing magnitude of information in an organization and the need to make effective use of them in an organizational decision-making process led to the increase in

Table 2
Summarizes the various research findings related to PSS, SERVQUAL and KMS used in different fields in the past.

Authors	Year	Objectives/Methodology Used	Result/Conclusions	Future scope
David Baxter; Rajkumar Roy; Athanasia Doulttsinou; James Gao; Mohamad Kalta. [13]	2009	Proposes an integrated knowledge framework with three core elements: design knowledge, manufacturing capability knowledge, and service knowledge from an industry study, and a knowledge base structure is developed and validated.	The results inferred from the case study show that the organization gradually shifts from a product-centered approach to a service-focused approach.	The design challenge is one area that changes drastically with nature, hence further research is required in investigating the needs of new product introduction and the challenges of developing new PSS are to be carried out.
C. Durugbo, O. Bankole, J.A. Erkoyuncu, A. Tiwari, J.R. Alcock, R. Roy and E. Shehab.[14]	2010	Proposes an Industry Classification Benchmark (ICB) model in which PSS components are categorized as tangibles and intangibles and two sources are derived based on this identification as (i) actors, relationships between actors and networks, and (ii) delivery packages.	The results obtained are twofold: (i) Firstly, a description of network and relationships among them defines the way by which actors, roles and scenarios are built and customized to provide a PSS is obtained. (ii)Secondly, it defines a way of how products and services can be merged together to obtain the desired PSS solutions.	The future research needs and challenges are involved in focusing on the scope of PSS with a broader spectrum in part flows and interdependencies between actors and PSS design.
John P. T. Mo. [15]	2012	Proposes a model based on CEPSS which in turn is used for creating PSS enterprise and three interdependent subsystems are developed from it.	Investigation using the case study approach shows that how PSS can be assessed and evaluated and how its service elements and expected performance of the service system are calculated.	Case study approaches to be carried out on a wide range of engineering products and evaluation of CEPSS with a quantitative, evidence-based approach would be considered.
GokulaVijaykumar and Rajkumar. (Gokula Vijay Kumar, Annamalai Vasantha, Rajkumar Roy, Alan Lelah Daniel Brissaud. A review of product–service systems design methodologies. International Journal of Engineering Design., 2012)	2012	Proposes a maturity model to visualize the current state of development in PSS design and derives twenty different dimensions of PSS realization.	Results show that the initial stage of PSS design is at the development phase and considerable amount of research is required to develop a practical PSS design methodology.	The gaps identified within the model stresses a substantial amount of research is still required to develop a systematic and structured PSS design methodology.
Sebastian Waltemode, Carsten Mannweiler, and Jan C. Aurich. [17]	2012	An OMEGA model for quality assessment of PSS is developed in which the material and nonmaterial resources are applied directly to every process step and investigations on customer and its production environment are done.	The result of PSS realization using OMEGA model sets out the requirement for developing a system for measuring the PSS provider. PSS quality criteria are evaluated by means of establishing a long-term business relationship between a PSS provider and consumer.	Applying the proposed model to some distinct branches inside the capital goods companies is proposed for future work.
Michael Abramovici, Youssef Aidi, and Hoang Bao Dang. [18]	2013	A PSS lifecycle management approach is developed and the key factors required for supporting and managing PSS are identified. The three knowledge based assistants (KBA's) address the PSS ontology that integrates PSS relevant data via predefined rules and axioms.	The ontological approach for PSS knowledge exploration provides a suitable platform for the KBA's and allows the decision-makers to support a PSS executive DSS on tactical and strategic levels and also collects enterprise data from different sources to provide a high transparency in the PSS lifecycle processes.	–
Margherita Peruzzini, Eugenia Marilungo and Michele Germani. [37,19]	2015	The proposed method is (QFD) technique which correlates the customer promises, with the market needs, and PSS functionalities with the ecosystem constraints from three industrial case studies taken into consideration, and then various factors relating to customer satisfaction are measured.	The results obtained after the validation and testing of customer satisfaction and comparing the results with traditional testing demonstrate that the proposed method to a PSS model supports different kinds of operating procedures in different sectors and highlights the improvement of customer satisfaction.	Future research will be focused on the further developments in the methodology and defining a robust method that is able to dynamically answer the customer queries and fulfil their needs.
YutaroNemoto, Fumiya AkasakahiandYoski Shimomura. [20]	2015	A framework is proposed for using and controlling design knowledge consisting of the key components: need (Ne), function (Fu), entity (En) and actor (Ac) of the three targeted PSS design models, and a prototype system is developed consisting of the three modules: (1) a design workspace; (2) a design knowledge base; and (3) a catalog viewer.	The analysis performed on results obtained on the prototype system with an example case study shows that the developed framework will be useful for the design engineers to perform new PSS design processes.	It includes the evolution of an evaluation method to select the optimal range of available options for supporting and maintaining design knowledge.
Dimitris Mourtzis, Sophia Fotia and Michael Doukas.[21]	2015	The KPIs of four general classes such as Business, Customers, Leanness, and Sustainability are grouped and measured using the SERVQUAL scale	At first, PSS design models are collected and the KPI's are identified. Secondly, the KPIs are classified based on customer-focus, career-	It involves a structured grouping of assessment methodologies for the design process of PSS and employing mathematical expressions for the

(*continued on next page*)

Table 2 (*continued*)

Authors	Year	Objectives/Methodology Used	Result/Conclusions	Future scope
		& IPA. Then the sustainability indicators are weighed using the Analytical Hierarchy Process (AHP).	orientation, and sustainable PSS.	formulating KPIs.
Shahram Guilaninia, Mohammad Taleghani Elham Rouhi. [22]	2016	Uses a SERVQUAL Model to assess the perceptions of service quality across four dimensions and knowledge management involves process refinements to enable the development of new systems for competitive success.	A highly efficient system is evolved after the uncertainties of future and marketing challenges are met and also facilitates the insurance companies to use its knowledge management strategy for its survival.	Future work to be carried out by deriving a set of actions to analyze the service quality gap between customer expectations and understanding.
Yan Xin, Ville Ojanen, Janne Huiskonen. (Yan Xin*, Ville Ojanen, Janne Huiskonen. Knowledge Management in Product Service Systems – A Product Lifecycle Perspective. Elsevier., 2018)	2018	The proposed framework in PLC includes three models BOL, MOL and EOL phases and in each phase knowledge creation and transformation are done.	Product concept is generated using the BOL phase which includes design and manufacturing, transportation including logistics, and maintenance are included in the MOL phase. Reuse, recycling, remanufacturing, and disposal are carried out in the EOL phase.	Future works would include investigations to be done on PSS by employing case studies covering a wide spectrum of attributes in order to attain more understanding of implementation and application of knowledge management in PSS would be obtained.
Andressa D'gostin, Janine Fleithde Medeiros, Gabriel Vidord, Maikielli Zulpoa and Cleide Fátima Moretto. [24]	2020	A framework is developed after Identifying the drivers ("environmental concern" and "healthy lifestyle") and barriers ("unavailability of PSS") for acquiring use-oriented PSS.	Analysing the data after proper evaluation it is concluded that the drivers integrated with experiential factors hinders the application of use-oriented PSS in an organisation.	Future work involves investigating rapid switch over in consumer views and their expectations with respect to its associated drivers.

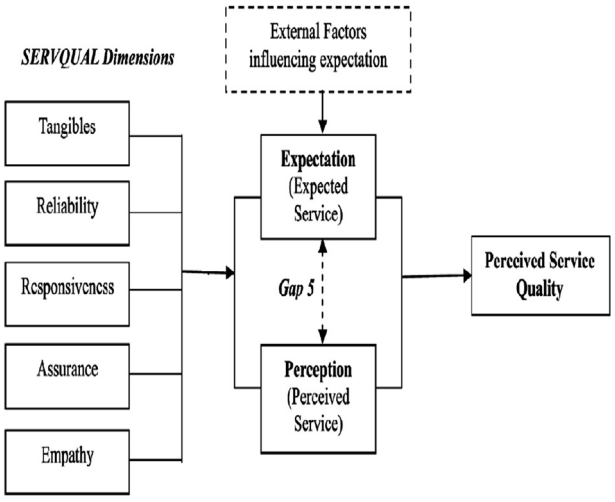

Fig. 2. Measuring service quality using SERVQUAL model (Kumar et al, 2009).

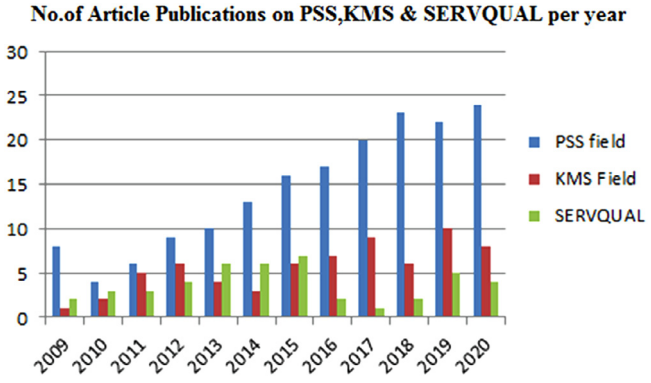

Fig. 3. Number of Publications on PSS, KMS and SERVQUAL per Year.

knowledge management aspects. Since the organizations go through high uncertainties due to the massive market competition, the probability of losing their valuable customers is one of the biggest threats that the organization faces. The main reason which causes this problem is due to the organizational constraints to meet several challenges and difficulties and also in responding to the rapid changes of the market. Knowledge has driven organizations towards the application of KMS. It is considered as an important asset to the organization as it is the key for the organizations to stay competitive in today's business environment. It serves as a tactical source for organizations to sustain their business. In order to implement and make full use of knowledge management, it is necessary for the organizations to have a clear understanding of how knowledge is created, developed and circulated within the organizations. Knowledge is acquired from various sources, translated into strategies, and then applied within organizations and then preserved for long-term use. At first, knowledge management is involved in capturing and storing the past expertise and utilize them to unravel the new issues, as well as each new improvement that is brought to the available products [12].

Knowledge is a multidimensional concept and it can be discovered in many corporate databases comprising of information such as the organizational culture, strategies, policies, procurement and all documents related to the organization. The process of acquiring knowledge, advancement of new knowledge resources and application of new knowledge obtained by means of learning, ensuring in order to keep absolutely indispensable knowledge at all levels, applying necessary knowledge in all levels of problem solving and decision making enables knowledge management to be the most critical factor influencing the organizations, Raeesi et al. 2013. The knowledge management field is continuously rising nowadays in small and large scale industries as well as in several societies around the globe.

5. Search strategy

Based on our objective of the study, references were collected from online databases such as Science Direct, Research Gate, IEEE Xplore, Online journal content platforms like Taylor and Francis, Online Journals Archives like Springer and Elsevier, to identify per-

tinent journals and conference papers which are published between the year 2009 to 2020 with the letters and words mentioned as 'PSS', 'product-service system', 'service metric', 'SERVQUAL', 'KMS', 'knowledge management system', 'implementation of the knowledge management system as the search criteria.

Based on few similarities in the titles and abstracts, it was further reduced to 24 articles. By analysing these 24 research articles keeping in mind the research objectives, inferences and their future scope we get a clear picture of the research papers which are closely aligned with our area of interest. The earliest article with 50% relevance to this research paper was published in 2009, and there are only a few papers published on 'PSS' and 'KMS' from 2009 – 2020. Therefore, 24 journal articles and conference papers published between 2009 and 2020 were used to perform this study.

6. Review of selected authors

The investigation of academic and scholarly publications is followed by a process of a systematic review, which adopts the models, principles, techniques and frameworks developed for the PSS and KMS fields. The systematic review is considered as an analytical step in the PSS research. The review covers a broader spectrum by taking into account those selected papers that explicitly refer to methods and tools for decision-making adopted in the PSS process and the role of KMS in PSS.

7. Analysis

The identification of similar papers that focused on the PSS, structured requirements elicitation for PSS, PSS quality assessment, managing and utilizing PSS, and identifying various performance indicators for the evaluation of PSS in different dimensions by concentrating on various industry sectors including consumer goods industries, manufacturing industries, automotive, construction, retail, management, marketing industries and different service industries including education industry, hotel, tourism, airline, transportation industries and information processing services are considered for analysis. The drive towards sustainable production and consumption of products and services is the main focus for most researchers. The design methodology proposed by the researchers consisted of a questionnaire which was designed using the SERVQUAL metric and circulated to the targeted audience in order to measure their view and expectations of service quality. Continuous assessment and benchmarking of service quality and performance are other key factors derived out of their research findings. The review also provides a clear understanding of the critical success factors that involve customer-driven learning and continuous improvements carried out in their organization, stimulates the competitive advantage of that organization. The objective to perform a literature review in the field of KMS arose due to the growing issues and challenges evolving in day-to-day business patterns in the global economy and the need to take timely decisions at the right time is very important for the survival of a business and moved to problem-solving and decision-making process which is not possible without KMS. The scope of this review is fulfilled in this article. From selected ample scientific articles in these fields, some major similarities and controversies, as well as research gaps, were discovered.

The list of factors which are analysed and shortlisted after the review of past journals in PSS includes the following:

- Technology
- Senior management support
- Human resource management
- Business management
- Organizational transformation
- Communication
- Market Orientation
- Sustainability
- Competitive advantage

The list of factors which are analysed and shortlisted after the review of past journals in SERVQUAL includes the following:

- Service transformation
- Performance appraisals, rewards and recognition of employees.
- Employee involvement
- Employee satisfaction
- Employee Retention
- Productivity
- Flexibility
- Customer satisfaction
- Customer loyalty
- Profitability

The list of factors which are analysed and shortlisted after the review of past journals in KMS includes the following:

- Knowledge acquisition and development
- Knowledge behaviour
- Knowledge management strategy, process andenvironment.
- Information query service
- Information query service
- Knowledge sharing guideline
- Knowledge use and reuse
- Collaboration
- Enterprise portal

8. Discussion

The objective of this review is to identify the valuable information from the researches titled 'PSS', 'SERVQUAL' and 'KMS' and reviewed their emerging trends. Using this information and assessment, we have tabulated the information about the research conducted by various researchers using various models and frameworks on evaluating PSS from 2009 to 2020. According to that assessment, we have learned some important information about design frameworks incorporating products and services in PSS and the role of knowledge management in PSS lifecycle and its applications across several industries including small and large scale industries such as industrial sectors, basic materials, utilities, and financial sectors. Some researchers through their extensive case study approach, conducted on various complex products like spacecraft, petrochemicals, and automotive support service systems have brought out the point that in order to yield the best productivity, the present information sources in an organisation need to be refined, and because of the rapid switch in customers perceptions and expectations takes place every now and then, the necessity to offer new products, along with attractive services packages are designed and catered the overcome the uncertainties of the future and marketing challengesleads many companies to choose a strategy of knowledge management to survive. While some researchers have used appropriate models and techniques in their research to solve their research problems on addressing many types of societal issues. Hence PSS aims to provide the boundary conditions and tailored approach for the transition through a suitable evaluation process, only then a successful conversion can occur and drive our focus towards PSS sustainability. This study further enhances our knowledge of PSS, SERVQUAL and KMS. Therefore, this review offers valuable recommendations for

researchers doing research on the topic of PSS and the evaluation methods using SERVQUAL MODEL and the role of knowledge management in PSS in any industry.

9. Conclusion

Considering the nature of PSS as a complex and multi-disciplinary approach, the use of KMS gives an ease to make sure efficient verbal exchange among engineers from numerous domain and to save cost and timewhile handling unique customers' requirements. The result of the review process is that even if there are some differences in the field regarding knowledge and KM most authors agree on the identification and classification of the more appropriate knowledge representation is important to develop a KMS. Hence PSS and knowledge management had been taken into consideration as it is one among the essential constraints to beat a competitive businesses in contemporary enterprise. Introduction of knowledge is essential for businesses to stay competitive. It is treasured as one of the useful assets that permit the businesses to have a sustainable advantage and optimized performance.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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