A Framework for Product Lifecycle Knowledge Service

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***Abstract*—As the rapid development of modern economy and information technology, the development trends of modern enterprises increasingly clear. Knowledge-based enterprise has become an inevitable choice to expand the use of its resources. In order to respond to the industrial trend towards knowledge service, this paper presents the state-of-the-art of knowledge service research and development. Furthermore, in order to integrate fragmental product knowledge service solutions, this paper proposes a framework for product lifecycle knowledge service.**

Keywords-knowledge services; product lifecycle knowledge; product lifecycle knowledge service process

I. INTRODUCTION

Information technology has promoted our society gradually into knowledge economy from product economy. Services are a diverse group of economic activities that include high technology, knowledge-intensive sub-sectors, as well as labour-intensive, low skill areas. Knowledge Service is one of the forefronts of interdisciplinary subjects. Knowledge Services represent a merged field for knowledge and services in which knowledge serves as a resource to be provided for consumers so as to achieve the purposes of knowledge exchanging, knowledge sharing and task-based collaboration and problem solving. In recent years, with the rapid development of knowledge discovery, knowledge management, web service, service computing and cloud computing, as well as the growing demand for knowledge service, knowledge service becomes an important research direction emerging rapidly around the world. The promising field aims at turning knowledge assets into knowledge products and services, delivering them over the Internet, and providing the knowledge-based services through the interactions with customers.

In order to respond to the industrial trend towards knowledge service and better the research of this domain, this paper aims to give an overview of knowledge service research (such as the definition, evolution and application fields of KaaS),, and propose the framework of knowledge-service lifecycle management. At the same time, the key technologies of knowledge service in cloud computing are discussed.

The main characteristics of knowledge as a service are:

- Knowledge as a service is a user-centric service;
- Knowledge as a service are the service of knowledge value-added and knowledge innovation;
- Knowledge as a service is the service of content oriented and solution.

II. CURRENT RESEARCH STATUS REVIEW AND ANALYSIS

The product knowledge service is a new research area, majority of studies in these areas were conducted by researchers in knowledge management or service science. However, little research is focused on studying the product knowledge service, such as human cognitive needs, abilities and limitation, team situation awareness when engaged in knowledge acquisition, sharing and utilization. Sylvia C Wong [1] presents a prototype knowledge desktop suitable for the design engineer. They analyze and suggest relevant information from ontologically marked-up heterogeneous web resources. David Baxter [2] presents a framework for knowledge reuse in a product-service systems design scenario. Their project aim is to develop a methodology to capture, represent and reuse knowledge to support product development in a collaborative enterprise context.

AlSairafi and Filippia-Sofia Emmanouil [3] presents the Discovery Net architecture for building grid-based knowledge discovery applications. Their architecture enables the creation of high-level, re-usable and distributed application workflows that use a variety of common types of distributed resources. Qiu Yuan Fu and Martin G. Helander [4] define knowledge in product design, they identify and classify knowledge in product design based on design decision-making processes. Furthermore, how to improve the knowledge management process in collaborative decision making is presented in their work. Behrens and Shim describe [5] new Web Services that provide knowledge validation to panels of domain experts involved in the collaborative construction of models. Kim and Will [6] describe services provided in the active catalog system to support engineers in selecting and evaluating electromechanical components and subsystems. The services in their system include mechanisms for creating queries for parts based on their intended use rather than merely parametric specifications, refining those queries to take account of constraints imposed by domain knowledge, providing multimodal information to help engineers assess and compare candidate parts, and generating simulation models for candidate parts and integrating them to provide simulation models for candidate systems. Umapathy and Purao [7] describe a knowledge-base that represents the enterprise

integration patterns, infusing them with semantics derived from speech acts; and a set of heuristics, which can be used to retrieve enterprise integration patterns for a set of requirements.

According to the research listed above, we give a table about their contribution and shortage as following:

TABLE I. CURRENT RESEARCH STATUS ANALYSIS.

Knowledge service architecture	Researchers	Contributions	Need to improve
Knowledge service architecture	AlSairafi et al.	Presents architecture for building grid-based knowledge discovery applications.	The architecture should use in product service area.
	Wong et al.	Presents a prototype knowledge desktop suitable for the design engineer.	Need to address several key issues, in particular knowledge service .
	Baxter et al.	Presents a framework for knowledge reuse in a product-service systems design scenario.	Use the framework in knowledge service discovery or product knowledge service system.
Knowledge service mechanism	Kim et al.	Describe services provided in the active catalog system to support engineers.	The problem about new knowledge service identification.
	Behrens et al.	Describe new Web Services that provide knowledge validation.	To extend this model to support knowledge service collaborative modeling tools and collaboration.
	Umapathy et al.	Describe a knowledge-base that represents the enterprise integration patterns,	Performance evaluation of product knowledge service with experienced designers.
Knowledge service platform	Donald et al.[8]	Propose collaborative engineering environment in NASA to provide better aerospace systems life cycle design.	To extend this method to product knowledge service area.
	Xie You-bai et al.[9]	Propose the embedded knowledge service concept. Resource unit s were seamlessly integrated into the product development	To extend and developing this theory to product lifecycle knowledge service.
	Li Bo-hu et al.[10]	Propose the new cloud manufacturing concept and architecture.	To focus on this architecture to product lifecycle knowledge service.

This paper mainly focuses on knowledge service issues in product, knowledge management and engineering technologies. The study of product knowledge service technology should be broadly summarized into four aspects in this paper as following:

- Product knowledge service identification mechanism
- Product knowledge service transfer mechanism
- Delivery process of product knowledge service
- Performance evaluation of product knowledge service

III. A FRAMEWORK OF PRODUCT LIFECYCLE KNOWLEDGE SERVICE(PLKM)

A. Product Lifecycle Knowledge Service

According to the knowledge management processes and the main stage of product lifecycle, we divide the knowledge service in product lifecycle into: customer knowledge service, development knowledge service, production knowledge service, delivery knowledge service, and service knowledge service.

(1) Customer Knowledge Service

Currently, the main researches focus on the combination of knowledge management and customer relationship management and propose the concept of customer knowledge management. The main concern is data mining of information system. Some researchers have studied the conversion of customer knowledge into product development knowledge; they proposed a framework for sharing and also analyzed the main factors of customer knowledge.

(2) Development Knowledge Service

At present, research of this field focused on how to discover knowledge from existing systems; and how to integrate and analyze information system. Some researchers have practiced the system in some extent. A few researchers study on the transfer from product lifecycle knowledge to product development knowledge based on the concept of R&D collaboration and concurrent engineering.

(3) Production Knowledge Service

The research in this field focus on how to discover knowledge in manufacturing system and it collaborate with product development system. They concern the feedback of manufacturing and monitoring information.

(4) Delivery Knowledge Service and Service Knowledge Service

At present, we almost didn't find the research reported about delivery knowledge and service knowledge. Some researches about delivery knowledge field mainly involve marketing staff training system. With the service manufacturing developing, the research of service knowledge is arisen.

B. A Framework of PLKM

The product's lifecycle period usually consists of five major steps or phases: product development, product introduction, product growth, product maturity and finally product decline. Knowledge service involves distinct but interdependent processes of knowledge service requirement, knowledge service acquisition, knowledge service integration, knowledge service transfer, knowledge service application and knowledge service performance evaluation. The knowledge service process is shown in Figure 1. At any point in time, an organization and its members can be involved in multiple knowledge service process chains. As such, knowledge service is not a monolithic but a dynamic and continuous organizational phenomenon.

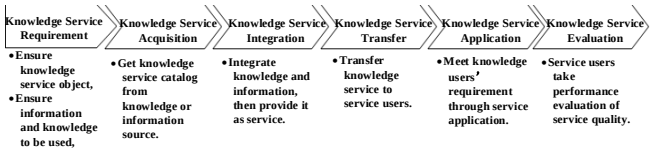

FIGURE I. KNOWLEDGE SERVICE PROCESS.

On the basis of product lifecycle knowledge perspective, a Framework for Product Lifecycle Knowledge Service is proposed in Figure 2.

IV. CONCLUSION AND FUTURE PERSPECTIVE

The paper presents a product lifecycle knowledge service framework. However, there is still scope for research in spite of the presence of numerous theories and methods. Future contributions will benefit firms in more aspects and in greater depth. For example, the fact that flexibility, knowledge service retrieval and reuse are useful to industry engineering is regarded as common. Academic investigations should provide more guidelines for it.

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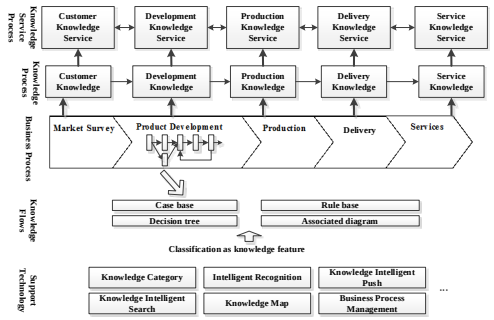

FIGURE II. FRAMEWORK FOR PRODUCT LIFECYCLE KNOWLEDGE SERVICE.

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