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Territory based Industrial Product-Service System design

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Abstract

The research field of Industrial Product-Service Systems (IPS2) is not fully mature and there is a need to expand research directions to improve design models. Despite the current IPS2's potential as a business model for a more sustainable production and consumption system, a generic model at global level does not necessarily brings improvement in sustainability. One way of giving a more accurate meaning to sustainability is the territorial understanding of the term. Thus, shifting design level from global to regional or local levels could interpret sustainability more articulate, current, and pragmatic. The present paper discusses territorialisation as a new approach for supporting the design of Industrial Product–Service Systems. To respond to such a need, designers need to access geographical information that able them to integrate territorial specifications in a proper way. In such a context, ontology could play a relevant role to analyse and discover the relation of geographical information system (GIS) in the life cycle of a product and the related service networks. Improvement in sustainability could be a result of this integration. The focus of this paper is just on environmental pillar.

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1. Introduction

Realization of information retrieval processes represents one of the basic functions of the IPS2 components. It represents the basis for a continuous improvement of both product and service offerings as well as corresponding processes and resources by complementing the already existing knowledge of the manufacturers [1]. Although the information aspect plays a key role, no information dimension of IPS2 is related with geographical information system (GIS) [2]. The design parameters concerning product life cycle phases could be highly different due to the multiple possibilities for using a specific product depending on the territory of the industry [3] and the industries are already working with very similar understandings of this term but geographical information system support does not exist in their decisions. These lead to a new academic challenge that has to be solved. How geographical information could territorialize the design of IPS2 and what impact on sustainability can result out of this new design approach? As this research is currently at a rudimentary stage, the development of a robust ontology model that is visualized by Unified Modeling Language (UML) would be helpful to answer these questions. The primary objective of this ontology development is to aid clarity to the top-level concepts of IPS2 and GIS integration which would help to communicate these concepts better between researchers and practitioners. This development included the collection of IPS2 and GIS concepts, the definition of each concept, the grouping and structuring of the concepts hierarchically as well as the identification of the relationships between these concepts.
The 'Introduction' section described the context of this paper. The next section, 'Methodology', explains the methodology adopted in writing the paper. This is followed by the Industrial Product-Service Systems' section, which presents its concept available in the literature. The 'Sustainable development for territory' section then addresses opportunities for increasing environmental sustainability by using geographical and environmental information. The

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"Proposed model" section describes the model and finally "Conclusion".

2. Methodology

As this research is in its infancy, review of literature reveals that the terminologies used to describe IPS2 vary considerably. Therefore, in order to start and define the proposed idea, development of an ontology is employed as the methodology, which is defined as an explicit formal specification of the terms in the domain and the relations amongst them [4]. Ontology may take a variety of forms, but necessarily it will include a vocabulary of terms, and some specification of their meaning. This includes definitions and an indication of how concepts are inter-related which collectively impose a structure on the domain and constrain the possible interpretations of terms [5]. The challenge is not in building a totally different information technology structure but to develop common representation within the IPS2 community. The purposes of developing a standardized ontology are that it could help researchers and practitioners to communicate and share their views without ambiguity and thus encourage the conception and implementation of useful methods and tools. In this paper, an initial structure of IPS2 ontology from the design perspective is proposed.

3. Industrial product-service systems (IPS2)

Business-to-business and business-to-customer markets have a tendency to offer integrated and mutually determined planning, development, provision and use of product and service which are sold in one package to meet the customer's needs. These combinations of products and services are called product-service systems (PSS) or industrial product-service systems (IPS2), in the case of industrial applications [6]. Meier defined IPS2 as a combination of tangible products and intangible services, providing a value to the customer via the complete life cycle [7]. From the point of view of the IPS2 manufacturer, the product life cycle starts with industrial product design, followed by product manufacturing, servicing and remanufacturing. From the customers point of view, it consists of product purchase, usage and disposal. Taking these perspectives into consideration, the manufacturer has to design physical products optimized for manufacturability, servicing and remanufacturing as well as non-physical services that support his customers during product purchase, usage and disposal [2], [8], [9].

3.1. Product Model

The demand for higher quality and lower cost products with shorter development lead-time for the dynamic global market has forced industries to focus on various new product design strategies. Although each product design strategy has different focuses and approaches, they all share one fundamental requirement: the need for advanced information technologies to integrate and coordinate life-cycle considerations during product design activities [10]. A central issue among these information technologies is product modeling, which generates an information reservoir of product data to support activities at different product design phases [11]. In order to introduce the idea of product models into industrial use, a pragmatic approach is necessary to realize the application benefits progressively.

Different modelling languages are adopted to represent different product information, for example EXPRESS for geometry as seen in STEP, and UML for beyond geometry information as defined in Core Product Model (CPM) [5]. STEP (Standard for the Exchange of Product Model Data) [4] is an inter-lingua for defining and specifying products. The primary motivation for STEP is to achieve inter-operability and to enable product data to be exchanged amongst different computer systems and environments associated with the complete product lifecycle. CPM model provides a core representation for product development information, which can form the basis of future systems [12]. Recently it has become apparent that the initial CPM possessed some of the key characteristics needed to support a broad range of information relevant to Product Lifecycle Management (PLM). Therefore the initial CPM is extended to CMP2, based on two principles; first, the key object in the CPM2 is the artifact. Artifact represents a distinct physical entity in a product, whether that entity is a component, part, subassembly, or assembly. Second, the artifact is an aggregation of three objects form, function and behaviour.

3.2. Service Model

A good starting point for elaborating a service development methodology can be borrowed from product development requirements, but when attempts are applied these requirements to service development, very quickly a basic problem of definitions within the service sector is faced. Although different classification schemes have been proposed, no categorization has been either as pervasive or as useful as the process type classification provided in the production management literature [13]. Bullinger et al. [14] argue that a typical service can be characterized by three different dimensions: a structure dimension (the structure determines the ability and willingness to deliver the service in question), a process dimension (the service is performed on or with the external factors integrated in the processes) and an outcome dimension (the outcome of the service has certain material and immaterial consequences for the external factors). These three dimensions must be taken into account whenever services are developed. Logically, suitable models and concepts should be provided for each of these dimensions in the development process. The outcome dimension can be represented by means of product models, which typically comprise a definition of the service contents and a structural plan of the service products. Whereas product models map what a service does, process models describe how the outcomes of a service are achieved.

4. Sustainable development and Territory

Sustainable development as a road-map is an action plan to solve the problem in any activity that uses resources and where immediate and intergenerational replication is demanded. Unfortunately so far sustainability plays a minor role in design education and practice, and design is not recognized as a relevant factor in the sustainability discourse. Therefore, design and redesign of products based on the concept of sustainable development could be a solution to