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Actor's and System Maps for Integrated Product Service Offerings – Practical Experience from Two Companies

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Abstract

The objective is to analyze how proposed Integrated Product Service Offering (IPSO) actors and system maps can be utilized in order to identify and access IPSO-related requirements. Furthermore, the objective is to identify and analyze how IPSO-related requirements are managed and transformed into product-related design aspects. Literature review, interviews and workshops were the primary research methods used. The conclusion is that participating companies have realized that there are several issues within their operations that can be improved, and proposed maps provide support for this. These maps provide useful detailed information compared to other approaches, and are easy to use.

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1. Introduction

The Integrated Product Service Offering (IPSO) business model, also called a Product Service System, implies that suppliers create an offer that best meets customer needs, from a life cycle perspective, with as few resources and costs as possible (see Bisgaard et al. [1]). Reduced resource use often results in a reduced environmental impact [2-4].

To effectively realize this, the use phase often accounts for a significant portion of the total life cycle cost, making suppliers, as opposed to traditional sales, often responsible for the product use phase, to include for example operation, service and maintenance costs (see Mont [4] and Bisgaard et al. [1]). This means, for instance, that maintenance and service that were previously sources of income now become costs. Neither does the supplier want the customer to come back after the sale wanting a new product, as this will only be an extra cost. Instead, there is a desire that the customer will use the offer and its component products as long as it is financially attractive for the supplier and the customer.

Previous research has shown that the physical products used for IPSOs should be adjusted exclusively to IPSOs, especially when used in customized offerings (see Lingegård et al. [5], Lindahl et al. [6], and Lindahl and Sundin [7]). If products designed for traditional sales are used, it is not possible to achieve maximum benefits; the reason is that they are designed after other basic principles and conditions that do not apply in the case of the IPSO. In addition, physical products cannot be developed separately from the services and information also included in the offer. Altogether, this sets new demands on businesses, requiring new or modified processes, methods and tools to support their work.

The above implies that IPSOs place new demands on products and how they are designed, especially when used in customized offerings. In addition, detailed products cannot be developed separately from the services included in the offer. Industry currently lacks knowledge on how this can be done effectively, and above all the consequences IPSOs should have on the structure of input products.

Several mapping methods exist, e.g. “Customer Value Chain Analysis (CVCA)” [8, 9], “Activity Modeling Cycle

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(AMC)" [10], "service ecology map" [11], "actor maps", "map of interaction" and "system organization map" [12]. Among others, CVCA is a methodological tool that enables design teams in the product definition phase to comprehensively identify pertinent stakeholders, their relationships with each other, and their role in the product's life cycle. AMC is a graphical information model, which prompts the analyzer to illustrate the activities of the customer – one focal stakeholder.

However, after reviewing the mapping methods listed above, the conclusion was that they lacked the features that were considered to be necessary and sufficient. Instead, the solution was to develop improved and modified methods that covered the desired features: that they should be easy for users to understand and use; that they should be easy to communicate (e.g. high level of visualization); and finally, from a clear IPSO perspective, that they cover actors, products, services, information (two levels – will be further explained later) and activities. Information flow is key to realizing effective IPSOs [13] and was thus included. Money was not included, as in CVCA, simply because it is not considered relevant, since the focus is on getting an overall perspective without too many details.

The objective of this paper is to analyze, using two leading Swedish companies with customized IPSO offerings, how proposed IPSO actors and system maps can be utilized to identify and access IPSO-related requirements. Furthermore, the objective is to assess, identify and analyze how IPSO-related requirements are managed, evaluated and transformed into product-related design aspects.

2. Methodology

Two leading Swedish companies with customized IPSO offerings were selected and involved in the project. The first step was to collect data about the current state-of-the-art in the participating companies. This was done through interviews and workshops. In the second step, after compilation of all data, verification-focused workshops were arranged with the participating companies. Since much of the collected data is sensitive or confidential, it was decided not to describe detailed data about the participating companies' processes; instead, the focus is on overall issues and data.

2.1. Interviews and Workshops

This section presents the main workshops and activities within this project. In addition, several smaller contacts were made and discussions and interviews performed.

2.1. Company X

A full-day, mixed semi-structured interview and workshop was performed at Company X. The first author of this paper coordinated the activity. In total, four key persons from the company participated, including the leading Project Manager and R&D Operation and Maintenance.

2.2. Company Y

Numerous interviews (more than 20), workshops and study visits were performed at Company Y. The third author of this paper was primarily responsible for and performed most of the data collection. The first author of this paper supported some of the data collection. Examples of respondents are managers responsible for remanufacturing, the service market, quality assurance, product development, product planning, IPSO sales, and engineering services, as well as staff from technical support and the service market.

2.3. Workshop with Participating Companies

This workshop was held at Linköping University in order to achieve a company-neutral zone to make participating companies feel more relaxed and equal. A third company (Z) with IPSO contracts and ongoing research in another IPSO-related research project was also invited.

There were two participants in the workshop from Company X: the Head of Product Portfolio, Business Area Support and Services and the Director and Head of Marketing and Sales. Four employees from Company Y participated, to include one method developer from product development and one manager from engineering services. Company Z had one participant, a manager responsible for the technical project portfolio.

Finally, five participants from the university, two with extensive knowledge about IPSO, participated in the workshop.

3. IPSO Actor's Maps and IPSO System Maps

Below, and in the order they are performed, the two types of IPSO map approaches used are presented. The first type provides an overall perspective, while the second provides a more detailed perspective.

3.1. IPSO Actor's Maps

When providing an IPSO, a large number of actors are normally involved (an actor can be an individual, group or organization); the aim of an IPSO actor's map is to provide a visual and clear overview of these actors, as seen in Figure 1. The purpose of this map is to support the identification of relevant actors and their involvement and requirements that could be important to consider when, for example, developing an IPSO. An IPSO actor's map could also support the identification of non-optimal distances (i.e. many actors) between actors. An example of this could be that the distance between the main actor with the most important requirements and the actors responsible for IPSO requirement management is excessively long, with the risk that important requirements are lost, filtered or changed along the way. An IPSO actor's map could also support the IPSO management, e.g. by indentifying non-value giving links in the chain of actors that can be omitted.

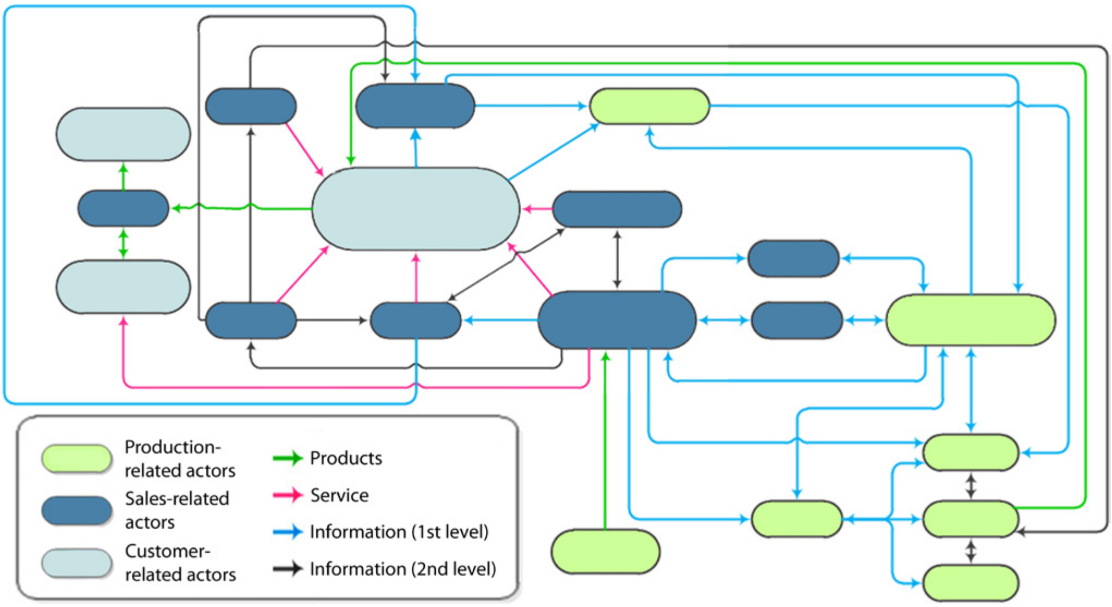

Fig 1: An example of an IPSO actor's map that illustrates participating actors and their connections. Since the original is based on a real IPSO and is confidential, this copy is blurred.

The actor resolution level depends on the situation, but is normally at quite a detailed level in order to be useful, e.g. down to different departments or functions/people involved in the IPSO. A risk of not making the map detailed is that important actors and interactions are not visible in a more aggregated and untransparent overview. Examples of actors are service technicians, users of the offering, sales staff, expendables providers, transportation staff, and the product planning and product development departments. The map could also involve actors that traditionally could be considered outside an IPSO, e.g. NGOs and legislative functions that might influence the IPSO. In order to distinguish between different types of actors, e.g. actors related to the customer and actors related to the provider, a color coding of the boxes can be used. Compare e.g. with Donaldson [9] and Tan [12] (Figure 4.12 on page 155).

An IPSO actor's map also illustrates the types of interactions (flows and direction) between different actors. Examples of interactions are products, services and information. A product is a tangible object that is transferred from one actor to another, while a service is e.g. support, education or calculations. Information is normally divided into two types, 1st and 2nd level information. 1st level information is directly related to the IPSO and the ability to provide it. 2nd level information is indirectly related to the IPSO and is e.g. about how to provide the IPSO process and future IPSOs.

The first task when creating an IPSO actor's map is to identify relevant actors. This can be done by asking actors within an IPSO about their view of how the IPSO is provided. It is quite common that different actors have different views. This implies that, when the actor's map draft is in place, it can be good to perform a workshop in order to verify it.

3.2. IPSO System Maps

What distinguishes an IPSO actor's map from an IPSO system map (see Figure 2) is that the latter visualizes in a detailed way the types of interaction of products, services and information, as well as the activities available to obtain interactions. An activity is the condition in which things are happening or being done and includes e.g. support systems, tools, methods and processes. Activities are spelled out and illustrated by boxes. Instead of just showing e.g. an interaction of information between two actors, it also shows what type of information is visible (spelled out and illustrated by boxes). Compare with e.g. Tan [12].

An IPSO system map is useful when communicating and developing an IPSO. Different life cycle phases of the IPSO imply different activities and focus, and that can be illustrated. Figure 3 illustrates actors involved in the sales process of an IPSO and what activities they perform. The flow in the system is illustrated with the darker, thicker lines.

4. Results

4.1. Identification of IPSO Customers/Actors and IPSO-Related Requirements

When asking actors within the participating companies how they identify customers, and more importantly how they identify their IPSO-related requirements, it becomes obvious that different actors have different opinions and thoughts about this. It also becomes clear that when discussing IPSO offerings, the traditional, classic, and still most used by participating companies concept, “the customer”, becomes misleading since in an IPSO, many more can be considered to

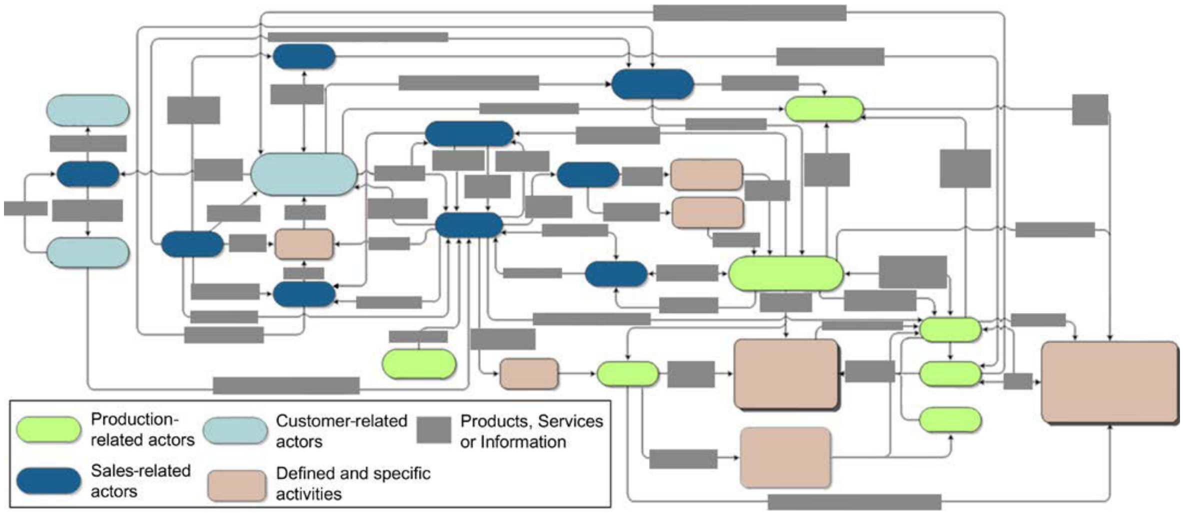

Fig 2: An example of an IPSO system map. Since the original is based on a real IPSO and is confidential, this copy is blurred.

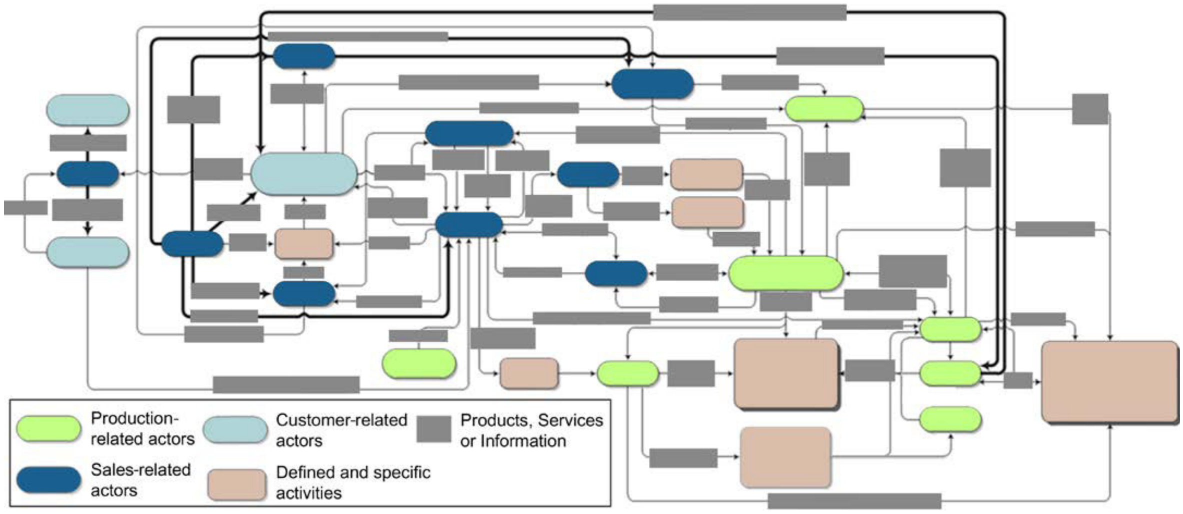

Fig 3: An IPSO system map that illustrates actors involved in the sales process of an IPSO. Since the original is based on a real IPSO and is confidential, this copy is blurred.

be "customers". Instead, it is more relevant to discuss and indentify actors involved in and affected by the offering, i.e. actors that could influence or will influence the IPSO offering. Important actors are often found within the provider, e.g. service technicians and those in refurbishment divisions. A reason for this is that the business logic when providing IPSOs is flipped; traditional sales companies, for example, generally earn money on spare parts and service. However, when providing IPSOs, service and spare parts are mostly included in the offering and instead become a cost for the provider. Furthermore, when providing IPSOs, it becomes more interesting to refurbish and reuse old products as well as to make used products more durable.

The participating companies did not have any common and well-structured methods for identification of IPSO customers and their IPSO-related requirements. Different actors' views on how this is done sometimes differ substantially within the same company.

However, after letting several different actors map their image of how their company identifies its IPSO customers and IPSO-related requirements and then morphing these images, it was possible to, after some verification activities, construct IPSO actor's and system maps, as seen in Figures 1 and 2. The participating companies have stated that these maps are very useful and much appreciated, as they had been lacking such support for their management and operations.

It was also realized after mapping participating companies' ways of identifying IPSO customers and their IPSO-related requirements that several actors that seemed to be highly relevant for this task were not, or were neglected in this process. Several important actors that need to communicate IPSO-related requirements were also in several cases far away

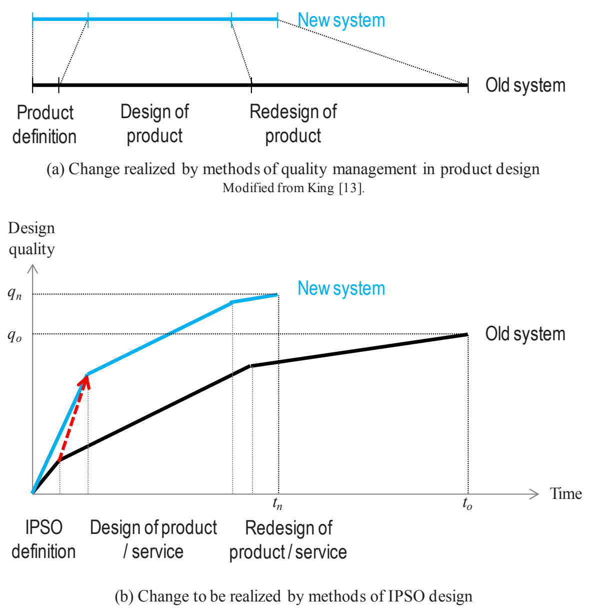

Fig 4: Analogy between US success in the 80s (a) and Swedish companies' current need for a new system (b).

from each other and with no direct communication. Furthermore, in several cases, a high risk of failures in the collection of requirements was identified. During the final workshop, the above was confirmed by those participating. One likely reason is that they had not been fully aware of the actors involved and the system in which their IPSOs are designed and provided.

Service technicians in particular are often neglected as a resource. Furthermore, an identified obstacle is that the lines of communications are in many cases quite long between the person/function within a company that could have relevant information, and the person/function that could get use of that specific data.

4.2. Methods and Tools for Transformation of IPSO-Related Requirements to Product-Related Design Aspects

The participating companies today, based on the interviews and workshops, currently use traditional methods for collecting requirements from their customers/actors, but they would like more suitable ones. They also actively work to try to modify and improve the methods they have.

However, it seems that the existing methods used are quite traditional and imply a risk that important actors are neglected, i.e. important requirements are not considered. In other words, they mainly focus on manufacturing costs and traditional issues in product sales, not issues more relevant in product service system offerings.

The conclusion is, based on input from the participating companies, that they would gain from more structured methods, enabling them to more effectively identify, collect and link actors' requirements and demands and evaluate them.

5. Analogy to a Solution Having Revitalized US Manufacturing in the 80s

It is well known that the methods of quality management helped to revitalize manufacturers in the USA in the 1980s; in particular, they learned Total Quality Management and Quality Function Deployment (QFD) from Japan. By implementing QFD, product definition may take longer, but the total lead time can be dramatically reduced, as depicted in Figure 4 (a). "In many of the cases reported, the use of quality deployment has cut in half the problems at the beginning stages, shortened development time from one-half to one-third, all the while assuring users' satisfaction and increasing sales" in Japan [14].

Swedish companies are facing a situation similar to that of US manufacturers before this successful revitalization. Different factors make the companies modify their ways of doing business. The consequence is an increasing need to integrate the service aspect into product design and to meet individual customers' requirements with reasonable cost. To efficiently develop IPSOs, companies should carry out a phase where a realization means is not determined depending on if it is a physical product or a service. It is an early phase that is used to create and evaluate various possible solutions at a more abstract level (than traditional product and service design) and, thus, is unique to IPSOs (depicted as "IPSO definition" in Figure 4 (b). Note that Figure 4 (b) is qualitatively drawn and the focus is on the "IPSO definition". In addition, "design quality" is assumed to be measured along the design process.). The support methods to realize this shift (depicted as a dashed arrow in Figure 4 (b)) are a solution for the current challenge of Swedish companies, similar to the quality management methods used by US firms in the 80s. The methods are expected to, for instance, manage requirements from different actors (customers, users, service providers, etc.) at different life cycle phases such as use and end-of-life, and then define the IPSO. This phase may take longer than it does now (assuming it exists at present), but it would decrease the lead time dramatically.

The difference with the American transition is the additional dimension – design quality. The "IPSO definition" phase's higher degree of freedom creates a source of innovation and therefore is expected to increase quality. Thus, this additional complexity should be seen as good news.

6. Concluding Discussion and Conclusion

This project has been useful for the participating companies, and they have realized that there are several issues within their operations that can be improved. Many issues have been realized to be confidential and sensitive for the companies; as a result, Figures 1-3 are blurred.

Great focus has been placed on life cycle thinking and life cycle costs/value issues, as well as participating companies' lack of suitable methods and tools that can support them in their development of customized IPSOs. In relation to existing traditional visualization methods, they stress a need for methods that also can show life cycle values for different actors within offerings, as well as those actors' requirements and the inter-linkage between different actors' requirements. The conclusion is that proposed IPSO actor's and system maps can provide support for this. This is in line with Tan's conclusion [12]. An important key is that the proposed approach provides quite detailed information compared to e.g. Donaldson *et al.* [9]. The proposed IPSO actor's and system maps approach is also easy to use.

Furthermore, the conclusions are that an increasing number of Swedish complex product manufacturers provide services (e.g. maintenance and upgrade) in addition to the physical products. Their offerings consist of an increasing number of combinations of products and services, and involve and engage, from a life cycle perspective, an increasing number of actors. The driver for companies providing these types of offerings is the increased number of customers who demand more for such offerings. However, those companies recognize problems that have already happened and will increase in the coming years.

The main problem is that conventional product development methodologies/tools/software are not designed to manage these types of new offerings that consist of an increasing number of combinations of products and services, and involve and engage an increasing number of actors. They lack support for the effective planning, development, and delivery of the offerings throughout the product life cycle. The reason is that IPSOs, with which both products and services are considered at an early development phase, pose new challenges in the development as compared to traditional offerings. The results are e.g. longer lead times, uneven workload, and sub-optimized, non-suitable and unsuccessful solutions (since they fail to meet customers' demands). Even here, participating companies experienced usefulness for the proposed IPSO actor's and system maps.

However, based on identified future development and competitiveness needs, the companies therefore urge for increased research and development regarding these new types of customized IPSOs. In particular, they need:

- Methodology support for systematic identification, evaluation and communication of actors/stakeholders' intermediate flows of information, products and services in a presumptive offering.
- Methodology support for systematic identification, evaluation and communication of actors/stakeholders and their needs/requirements (and interlinks between different actors/stakeholders) for a presumptive IPSO.
- Methodology support to, based on a life cycle perspective, develop, evaluate and visualize potential alternative IPSOs in relation to different actors/stakeholders' needs/requirements.

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References

[1] Bisgaard, T., Henriksen, K., and Bjerre, M., Green Business Model Innovation - Conceptualisation, Next Practice and Policy: Oslo, Norway, 2012.
[2] European Commission, A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy: Brussels, 2011.
[3] Tukker, A. and Tischner, U., New Business for Old Europe, Sheffield: Greenleaf Publishing, 2006.
[4] Mont, O., Product-service systems: Panacea or myth?, in International Institute for Industrial Environmental Economics, Lund University: Lund, 2004.
[5] Lingegård, S., Sakao, T., and Lindahl, M., Integrated Product Service Engineering - Factors influencing environmental performance, in Systems Engineering, B. Cogan, Editor, InTech: Rijeka, Croatia. 2012; p. 147-164.
[6] Lindahl, M., Sakao, T., and Rönnbäck, A.Ö. Business Implications of Integrated Product and Service Offerings. in CIRP IPS2 Conference 2009. Cranfield. 2009; p. 165-172.
[7] Lindahl, M. and Sundin, E., Product Design Considerations for Improved Integrated Product/Service Offerings, in Handbook of Sustainable Engineering, Springer. 2012.
[8] Ishii, K., Customer value chain analysis (CVCA), in ME317 dfM: product definition coursebook, K. Ishii, Editor, Stanford Bookstore, Stanford University: Stanford 2001; p. 1.3.1–1.3.8.
[9] Donaldson, K., Ishii, K., and Sheppard, S., Customer Value Chain Analysis. Research in Engineering Design. 16(4). 2006; p. 174-183.
[10] Matzen, D., A systematic apporach to service oriented product development, DTU Management: Kgs. Lyngby, Denmark. 2009; p. 186.
[11] Moritz, S., Service Design - Practical access to an evolving field, International School of Design, University of Applied Sciences Cologne. 2005.
[12] Tan, A.R., Service-oriented Product Development Strategies, in Danmarks Tekniske Universitet. DTU Management, DTU Management Engineering. 2010.
[13] Sakao, T., Öhrwall Rönnbäck, A., and Ölundh Sandström, G., Uncovering benefits and risks of integrated product service offerings - Using a case of technology encapsulation. Journal of Systems Science and Systems Engineering. 22(4). 2013; p. 421-439.
[14] King, B., Better Designs in Half the Time - Implementing QFD Quality Function Deployment in America, GOAL/QPC: Methuen, MA, 1989.