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Innovative costing system framework in industrial product-service system environment

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Abstract

Product-service system (PSS) or particularly industrial product-service system (IPS²) is started to gain more attention as innovative strategy to face the competitive global market. Service aspect from IPS² offering is believed could provide more values for customer than the standalone physical product. This new concept is not fully developed yet. There are some particular areas around IPS² concept which are needed to be more explored and one of them is the cost dimension aspect. Cost is obviously important for company as basic information to support decision making process. Traditional costing system is no longer able to facilitate the company's transformation. The following work will present the analysis of current costing systems and a new assessment framework proposed to address the needs of IPS² environment, particularly for IPS² function-oriented business model. The proposed framework is developed based on the literature findings. Considering the specific characteristics of IPS² business model, lean accounting is the best choice from current costing systems to be adjusted into the proposed framework. Lean accounting with its value stream costing (VSC) is able to provide comprehensive cost information to support company's long transformation journey towards a fully and successful IPS² company.

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1. Introduction to the problem

Global market has entered to the new level of competition. Emerging industries particularly in developing countries, where production and labor cost are significantly lower, have changed today's competition to be more customer-based than product-based. Selling product is no longer an economic basis to determine company's success to compete with those emerging industries. In order to stay competitive companies have to change their mind-set from only selling products to selling integrated products and services [1]. Industries are very eager to involve services in their offering not only as a separate offering from their products, but more as an integrated or bundle of offering. This concept so-called Product-Service System (PSS) [2]. The transformation process from manufacturing company to be a PSS company is called *servitization*. PSS is expected to be a solution to face today's market by giving more values to customer and at the end giving the increased revenue and profit.

Industrial Product-Service System (IPS²) is a particular case in PSS. The distinguish nature between PSS and IPS² is their customer. IPS² is a case of mutual and integrated planning, developing and using of product-service share in business-to-business (B2B) application, when other industries are their customer. While the original PSS is dealing with business-to-customer (B2C) application, when the end users are their customer [3].

IPS² is believed could bring some benefits which encourage manufacturing companies to adopt this concept. Some of those benefits are company could increase the sales of its physical products; strengthen the partnership both with customers and suppliers; bring a new opportunities in very competitive market; deal with economic cycles effect using divergent cash-flows and meet the customers' demands of overall solution [4, 5]. But in other hand, this new strategy will bring some challenges. To be an IPS² company, it is required a long and tough internal transformation such as company's mind-set, strategic and operational strategy, organization structure, supply chain management and obviously their cost dimension assessment.

Cost assessment is important issue for company since it is one of the core competitiveness in today's market (beside quality, responsiveness and flexibility). Cost assessment becomes more challenge in IPS² companies considering limited research and practical example in this area. Furthermore, in real practice companies remain to use traditional costing which by nature gives emphasize for products and disregard costing of their services [6]. Studies show that manufacturing companies are in consistent journey to be more service or integrated offering provider, but in the same time there is no sufficient researches in their costing methodologies [7]. In line with this fact, it seems relevant to explore the cost assessment of IPS² companies.

The purpose of this research is to analyse and explore how to calculate cost in IPS² environment. In order to fulfil the purpose of the research, the research question intend to be answer is "considering the available costing system in literature, can it be employed for IPS² companies?"

This research will be specifically focus on function-oriented business model from IPS² continuum proposed by [8]. The research scope is intended to address the machine-builder manufacturing companies as the practical case of IPS² function-oriented. The research approach will be applied to answer the research question is a combination of literature review and case study analysis. At the first stage, review the related literatures is conducted to obtain theoretical understanding regarding the present cost assessment in IPS² companies. Based on this findings, it will be developed new proposed framework to calculate the cost in IPS² function-oriented. This same approach has been used by many researcher to build a research agenda or framework in accounting area [9]. Furthermore, a case study analysis will be used since the research question is an exploratory nature and deal with operational aspect, then a case study is recommended methodology [10].

2. Literature review

2.1. Industrial Product-Service System (IPS²)

IPS² is a bundle of offering consists of products and services which provides more values in use rather than ownership that apply in B2B application [2]. In this concept, there are four parties involved i.e. the IPS² provider or usually called as the Original Equipment Manufacturer (OEM), customers, suppliers and external society such as competitors and government [3].

Base on its business model, IPS² can be divided into three major types which are function-oriented, availability-oriented and result-oriented [8]. The first stage of IPS² continuum is IPS² function-oriented. In this business model,

the main focus stay in product but company provides technical services aim to ensure the product’s functionality. In availability-oriented, the range and variety of services are increasing. Its main performance indicator is the availability of product use by customer. And in result-oriented, IPS² provider will be the main responsible for customer production process. All the risks and uncertainties in product usage are shifted to IPS² provider [3].

The most common practice in IPS² area is machine builder manufacturing companies or high value machine producer. Their journey towards IPS² is started by providing technical services such as maintenance, spare part or user training. Function-oriented is good initiation to be more service provider. Even PSS and IPS² is not a new concept in academic literature and practice but particular topic around PSS and IPS² have not explored yet including their cost assessment dimension since this topic is very complex and remain evolving.

2.2. Existing Costing System

There is very limited researches conducted so far which discuss particular costing system (cost structures, cost assessment framework and model) in IPS² environment even costing system is a mature topic in academic life. Table 1 shows the most popular current costing system that has been adopted by many organization for so long time. But there is no specific researches which discuss whether they can be applied in IPS² companies or not. The most recent and comprehensive research about costing system in IPS² environment is done by [7]. They create cost modelling techniques for IPS² availability-oriented use model. They propose the combination of cost estimation techniques available in literature both for product and service, which vary based on life-cycle stages and availability of data.

With respect to the current costing systems, some interesting questions then arise. Can those systems encourage company to undertake continuous improvement towards the long journey of IPS²? Can those systems provide high value to company? It is clear that market environments are rapidly changing and in order to stay competitive company should be doing continuous improvement whilst traditional costing system or ABC cannot provide the sufficient information to support it [11]. The flexibility to adapt in new environment is no doubt a crucial key to keep survive in today’s market.

IPS² companies need a costing system which answer some critical requirements. It has to be straightforward in terms of time, cost and effort needed to build, implement and maintain without ignoring the complexity of company’s activities. It has to consider product and service aspect in whole life cycle in balance way. This point is important because company is providing a bundle and integrated solution which ensure the functionality of product during its life cycle. Furthermore, IPS² companies require a cost management methodology, which is easily updated and adjusted to meet continuous changes due to the customer’s variety demands to get more customized and overall solution. It has to consider risks and uncertainties as well as able to encourage company doing continuous improvement [12].

Table 1. Summary of existing cost estimation with its advantages and limitations (source: [7, 13-16])

Costing System	Advantages	Limitations
Activity-based costing	Based on the real and detail usage of resources Give sufficient relevancy and accuracy Provide very details cost driver Indicate clear potential profit for company	Needs a lot of time to be executed Expensive to be executed Difficult to implement as a standalone costing system Very complicated in overhead allocation
Time-Driven Activity-Based Costing (TD-ABC)	Company could report their costs on an ongoing basis for the time spent for that activities and cost of their business activities Flexible to be updated based on events Give degree of accuracy as good as ABC	It will work properly only in high repetitive job where profit margin is small Could not give information why this cost can be occurred and how the behavior of particular cost object
Process-Based Costing (PBC)	Could give fair result even with limited data Built based on process flow which visualized by flowchart. Flowchart is a tool in quality improvement	Doesn't really fit to calculate services since this method could not accommodate indirect cost

Based on those criteria, lean accounting with its value steam costing is a good candidate to be adjusted and implemented for IPS² environment, particularly for function-oriented use model. This method considers all the cost

within value stream (life cycle) in how companies provide its products and services. Furthermore, the implementation of lean thinking in costing system could encourage company to increase their efficiency and effectiveness in IPS² design, development, management and delivery toward the full *servitized* company [9].

3. New costing system framework for IPS² Environment

3.1. New costing system requirements

A function-oriented use model is the first continuum in IPS². Product is remain the main focus but IPS² provider includes services to guarantee product's functionality, it can be provided as the annual service contract or separate service offering. In the contract, there are detailed information about what services being performed and specific time for each service to be performed. Condition based maintenance (CBM) is mainly applied in this type of contract which actual condition of the product is the major consideration to plan and execute the maintenance strategy. Maintenance will be performed if there are relevance indicators show that product's functionality is decreasing. With regard to this condition, IPS² provider will be able to calculate the cost and determine the price of total offering. At the end, customer will pay a fixed amount for the service offering every year.

Based on that business model, information and knowledge exchanges between IPS² provider and customer play really important role. High degree of products utilization can be achieved if the product works well. To ensure the products functionality, maintenance should be planned and performed in appropriate way and time. Since maintenance will be accomplished based on the actual condition, customer have to provide actual and reliable information about the products condition to IPS² provider.

Further characteristics of IPS² function-oriented use model are explained by [17]. They define comprehensive operational characters of product-oriented PSS based on some unit analyses i.e. characteristics of operations-structural and characteristics of operations-infrastructural. This characteristics seem relevant with IPS² function-oriented where the main focus of integrated offering is product whilst service is proponent aspect to create more values to customer. Product-oriented PSS company deal with the end customer while IPS² function-oriented deal with another company as customer. Moreover, Meier, H., et al. [3] identify specification of IPS² function-oriented use model as shown in Table 2.

Considering those characteristics, in general IPS² function-oriented provider has relatively similar business model as pure manufacturing company since product is remain its main focus. But, services provision during the period of time which ensure the product functionality brings some different characters due to uncertainties and risk sharing.

Table 2. Specification of IPS² function-oriented use model [2]

Specification	IPS ² function-oriented use model
Production responsibility	Customer
Supply of operating personnel	Customer
Service initiative	Customer
Ownership	Customer
Supply of maintenance personnel	Customer/ Supplier
Service turn over model	Pay per service order

At the end, based on [18] it can be summarized that the specific characters of an IPS² function-oriented company are:

- Company focus on building the good knowledge sharing with the good information flow among all the supply chain parties
- The knowledge sharing and information flow will facilitate company to build the strong partnership among supplier, IPS² provider and customer
- Because of the service provision to maintain product functionality (particularly for maintenance agreement), there are risks and uncertainties sharing between IPS² provider and its customer
- Company is doing a long and tough internal transformation to be an IPS² provider
- One of the most important main goals of the company is to be flexible to the competitive market

- To support the transformation process, company need simple but comprehensive costing system rather than a complex costing system. The costing system should be able to be one of supporting tools to reach the *servitization* journey

All those characters will be consider to determine the appropriate costing system to IPS² environment particularly IPS² function-oriented.

3.2. Proposed costing system framework for IPS² function-oriented companies

It is understandable that *servitization* journey toward full application of IPS² business environment is long and tough. IPS² providers not only face internal challenges as mentioned earlier but also external challenges because of global competition. It is clear that market environments are rapidly changing. In order to stay competitive companies should do continuous improvement whilst traditional costing system or even ABC cannot provide the sufficient information to support it [11]. The ability to adapt is no doubt a vital key to keep survives in today's market. Considering this condition, continuous improvement become another important point to be considered into proposed costing system for IPS² function-oriented business model.

The proposed costing system for IPS² function-oriented is based on the proposed cost estimation technique for IPS² availability-oriented from [7] which combined with lean accounting and its value stream costing (VSC) explored by [19]. Figure 1 is the proposed costing framework for IPS² function-oriented companies [18]. Since cost is the result of company's actions to provide the values to customer, the company's offerings would be the first necessary information. In order to assess the company's cost, it is required to know what company's value creation architecture which drive IPS² delivery and use. Afterwards, the sequence steps of lean accounting could be applied to assess the cost with the detailed explanation as follows:

1. Collecting the numerical data of the processes which are relevant both for production and service provision
2. Mapping value stream for both production of products and preparation and provision of services. The value stream map (VSM) is created to address what and how products and services are produced and provided to the customer under the agreement
3. Costing the value stream. Integrate VSM and VSC can be used to measure operational and financial improvements. In Figure 1 it is shown the types of cost structures relevant in IPS² function-oriented companies
4. Cost of IPS² offering is accumulation of product cost and service cost

Based on the execution of IPS² delivery and use, customer could give the feedback and sharing knowledge. This information could be valuable basis to do the manufacturing and service redesign to identify, plan and execute improvement in operations.

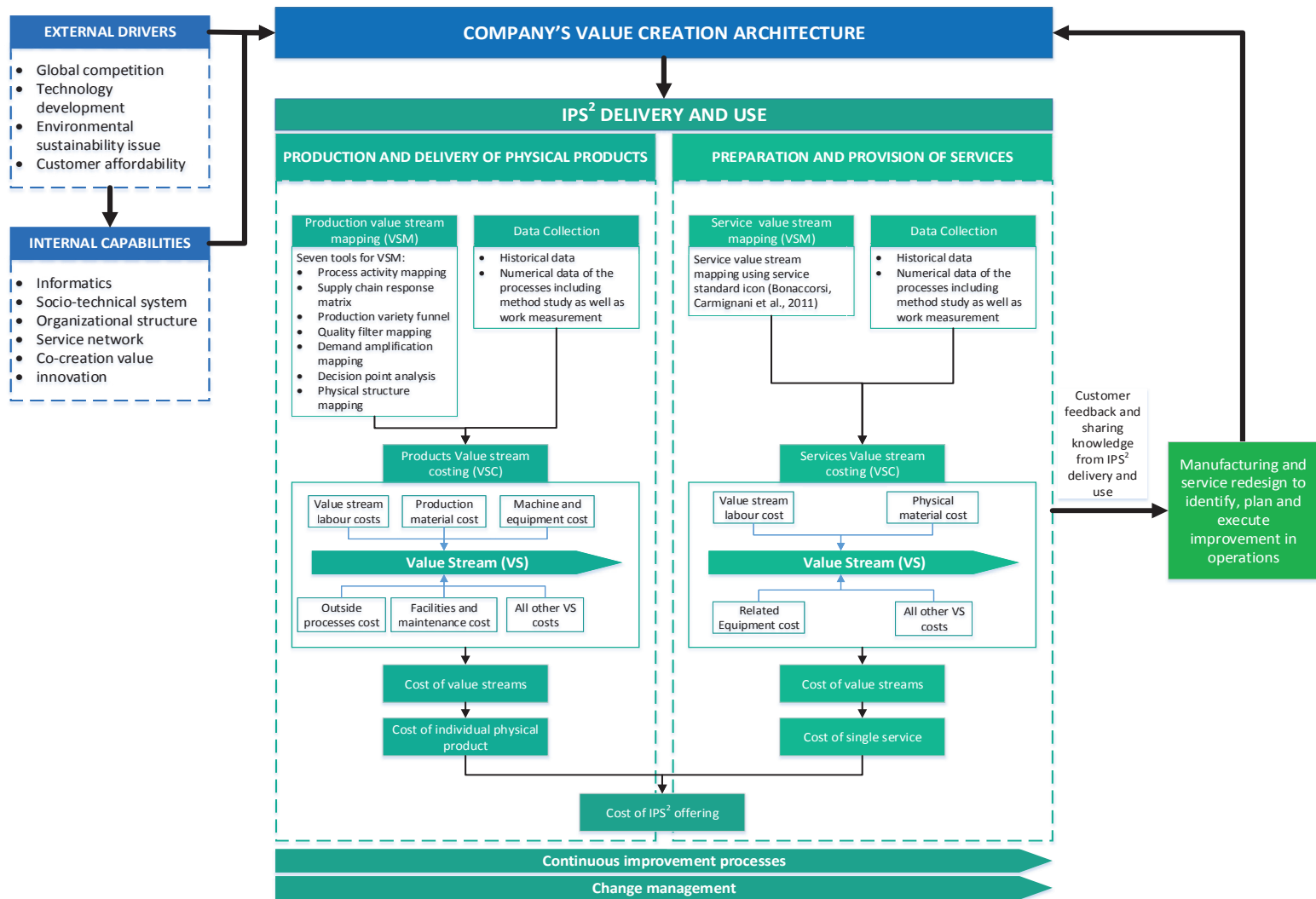


Figure 1. The proposed costing system framework for IPS² function-oriented companies

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