TESIS - TI42307

METODOLOGI MANAJEMEN BIAYA UNTUK *INDUSTRIAL PRODUCT-SERVICE SYSTEMS*

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This thesis is conducted to fulfil one of the academic requirements to obtain the degree of Master Teknik (MT)
at
Institut Teknologi Sepuluh Nopember

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Date of the Thesis Defense: 15th of July 2015
Graduation Period: September 2015

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METODOLOGI MANAJEMEN BIAYA UNTUK *INDUSTRIAL PRODUCT-SERVICE SYSTEMS*

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ABSTRAK

Persaingan global telah mendorong perusahaan manufaktur untuk merubah pola pikir mereka dari hanya menjual produk menjadi penyedia produk dan jasa yang terintegrasi. Strategi baru ini dikenal sebagai *Product-Service System* (PSS). *Industrial Product-Service System* (IPS^2) merupakan kasus khusus dari PSS di mana konsumen utama dari perusahaan tersebut adalah perusahaan lain (*business-to-business*). Konsep IPS^2 menjanjikan banyak keuntungan tetapi juga akan membawa tantangan khususnya yang berkaitan dengan perhitungan biaya. Biaya merupakan aspek yang sangat penting bagi perusahaan untuk merencanakan dan menjalankan bisnis. Tapi penelitian terdahulu menunjukkan bahwa sangat sedikit referensi yang tersedia yang membahas mengenai perhitungan biaya untuk perusahaan IPS^2. Tesis ini ingin menentukan teknik perhitungan biaya apa yang paling sesuai untuk perusahaan IPS^2 khususnya model bisnis *function-oriented*. Penelitian ini menggunakan kombinasi metodologi *literature review* dan analisis studi kasus. Pada tahap literature review, situasi terkini dari perusahaan IPS^2 dan sistem biaya yang paling umum seperti *Activity-Based Costing* (ABC), *Time-Driven Activity-Based Costing* (TD-ABC), *Process-Based Costing* (PBC) dan *Lean Accounting* dipelajari untuk menentukan sistem biaya mana yang paling sesuai untuk dimodifikasi untuk memenuhi kebutuhan perusahaan IPS^2. Kerangka perhitungan biaya baru berdasarkan prisip *lean* akan diusulkan dan diverifikasi pada tahap studi kasus. Secara umum perusahaan IPS^2 *function-oriented* masih mengunakan perhitungan biaya tradisional (*standard costing*). Padahal, sistem ini tidak lagi mampu menjawab kebutuhan perusahaan dan mendorong untuk melakukan perbaikan berkelanjutan dan transformasi menuju perjalanan *servitization*. Kerangka biaya yang diusulkan terdiri dari elemen biaya apa saja yang mungkin muncul di perusahaan IPS^2 *function-oriented* dan tahap untuk menghitung biaya total dari penawaran terintegrasi.

Kata kunci: *Industrial Product Service System (IPS^2), Product Service System (PSS)*, Sistem Biaya, Teknik Perhitungan Biaya, *Lean Accounting*

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ABSTRACT

Increasing competition has encouraged manufacturing company to shift their mind-set from only selling product becoming an integrated products and services provider. This new strategy is called as Product-Service System (PSS). Industrial Product-Service System (IPS^2) is specific case in PSS when the major customers are another industrial companies. IPS^2 is promising some benefits but it will also bring challenges particularly in terms of cost assessment dimension. Cost is certainly one of important considerations for companies to plan and direct their businesses. But studies show that there is remain very limited researches for cost assessment in IPS^2 companies. This research intends to analyze the present cost estimation in IPS^2 company particularly function-oriented business model. The research is conducted by using the combination of intensive literature review and case study analysis. During the literature review stage, the current situation of IPS^2 companies and the most common used costing system such as Activity-Based Costing (ABC), Time-Driven Activity-Based Costing (TD-ABC), Process-Based Costing (PBC) and Lean Accounting are studied to find the most suitable costing system to be adjusted to meet the needs of IPS^2. A new cost assessment framework based on lean principle then being proposed and verified during the stage of case study analysis. Currently most of IPS^2 function-oriented companies remain use the traditional costing (standard costing) whereas this costing system is not appropriate for IPS^2 companies and particularly could not support company's continuous improvement and transformation toward the long *servitization* journey. The new proposed cost assessment framework is developed to address all the IPS^2 function-oriented characteristics. The framework consists of the cost structures occurred in IPS^2 function-oriented company and the sequence steps to obtain the cost of total offering.

Key words: Industrial Product Service System (IPS^2**),** Product Service System (PSS), Costing System, Cost Assessment Technique, Lean Accounting

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ACKNOWLEDGMENT

This master thesis becomes the most important achievement of my academic life. I would like to convey my deep gratitude for all people who made this research is possible to be accomplished.

Foremost, I would like to give special thanks to my supervisor, Prof. Américo Azevedo for his continuous support, encouragement, enthusiast discussion throughout this research journey. I could not imagine a better supervisor for this research.

Second, I am grateful to Dr. Maria Anityasari as co-supervisor from my home university for helping me since the beginning, for her warm discussion about all research possibilities to be carried out before I came to Portugal. Thank you for the continuous encouragement and ideas to fulfil this master thesis. You are the best teacher I have ever had during my academic life.

I would like to convey my thanks to Prof. I Nyoman Pujawan, Dr. Erwin Widodo and Mbak Rahayu for all their assistance during my first year of my master degree at ITS.

Thank you very much also for Prof. João Falcão e Cunha, Prof. Lia Patrício and Mrs. Isabel Ribeiro who welcome, give assistance and continuous support during my mobility at Master in Services Engineering and Management, Faculty of Engineering (FEUP), University of Porto, Portugal.

To all my friends in FEUP who welcome, help and support me since I came here for the first time. Helping me a lot to adapt and always cheer me up to learn in a new academic and social life in Portugal. Very special thanks for Sara Ascenção and her lovely family, Teresa Queirós, Pedro Roseira, Rita Monteiro, Andre Fernandes and Diego Rodrigues – for his willingness to be my proof-reader and everyone in this lovely city. Thank you for all unforgettable memories.

Big thanks to all my Indonesia best friends Jun Hammady, Yuita Arum Sari and Ria Dhea – for all your support and jokes to keep me strong during our Erasmus life in Europe, all Indonesia students in Portugal and my best friend Dewie Saktia Ardiantono in Indonesia.

Finally I would like to dedicate this thesis for my beloved family for their tirelessly advice, support and pray I could conduct and finish this research project.

Obrigada and terima kasih

Porto, 15th of July 2015

Mar'atus Sholihah

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CHAPTER I
INTRODUCTION

1.1 Background and Research Context

As continuous increasing of global competition which force industries to provide more values to their customers, nowadays western economics have shifted their orientation from only selling manufacturing-based products becoming more product-service oriented systems (Martinez, Bastl et al., 2010, Neely, 2008, Wise and Baumgartner, 1999). Industries are keen to add services not only as "add-on" of their products but more as a bundle of total offering. This strategy is called Product-Service System (PSS) where companies are offering an integrated products and services which emphasizes on value in use rather than ownership (Baines, Lightfoot et al., 2007). The organizational transformation experienced by companies is called *servitization* (Martinez, Bastl et al., 2010). *Servitization* commonly happens due to financial aspect, strategic aspect and marketing aspect (Baines, Lightfoot et al., 2009). Moreover, (Datta and Roy, 2010) explain that at least there are five underlying purposes in recent studies why industries intend to involve more services in their offering. By providing PSS, industries could increase the products sale; strengthen their customer relationships, make a new opportunities in red ocean markets, deal with economic cycles effect using divergent cash-flows and answer customers' demands of more integrated and customized service solution (Brax, 2005, Xu, Chen et al., 2006).

Industrial Product-Service System (IPS^2) is a specific case under PSS area. It is defined as a mutual and integrated planning, development and usage of product and service in Business-to-Business (B2B) applications, whilst original PSS is Business-to-Customer (B2C) applications (Meier, Roy et al., 2010). PSS companies are dealing with the end user as their customers while the major customer of IPS^2 companies are other companies who use the IPS^2 offering to run their business.

PSS and IPS^2 are believed as an innovative strategy which help company to stand out in global competition. But, the adoption of this concept will give some challenges for company's internal organization, particularly in respect to its cost

dimension assessment. Cost as one of the core competitiveness dimensions, beside quality, responsiveness and flexibility, should be appropriately estimated and calculated to keep competitive in today's market (Azevedo and Sholihah, 2015a). In contrast, in real application an IPS^2 company has high tendency to remain use the traditional costing systems which focus on the estimation and calculation of physical products and ignoring costing of services (Hansen, Mowen et al., 2007). Manufacturing companies are in the consistence way to add more services in their offerings but there is limited information about their costing system or methodologies (Datta and Roy, 2010). In line with those facts, it seems relevant to study the challenges of cost assessment in IPS^2 companies.

1.2 Research Goal and Scope

Cost is certainly important consideration for companies to set and direct their businesses. Cost could be a base to make the price policy in order to stay competitive in external environment. While in internal environment, cost is one of basic insights (the others are revenue and profit) to determine the success of the business. It remains as a powerful source for decision-makers to evaluate, control as well as to innovate their businesses to be more efficient and effective. Good cost estimation will give clear idea which products or services are the truly best offering to gain profit for company. It is clear why companies are really eager to estimate their cost as accurate as possible.

There are a lot of cost estimation available in literature which have been practically used by companies up to present, especially for product-based offering. Traditional Costing System, Activity-Based Costing (ABC), Time-Driven Activity-Based Costing (TD-ABC) and Process-Based Costing (PBC) could be considered as the most popular methodologies and recently used by product-based manufacturing companies to estimate their costs. Whereas, for service company there is less number of cost estimation available. But, ABC is deemed as potential candidate to be applied for service organization since, in common, service organization deals with more indirect cost which could be traced very well by ABC system.

Machine builder product-service oriented business is a good example how service has merged with product to be an integrated solution. This business implements what is called as technical product-service system. The physical product value is enhanced and customized by mainly non-physical service (product support) during its product life cycle (Aurich, Fuchs et al., 2004). By giving non-physical service during its life cycle, the company is creating a further relationship with its customer in order to create a new revenue stream (Neely, McFarlane et al., 2011). This business is one of IPS^2 examples because they provide the integrated offering to the other companies (B2B context).

The main purpose of this work is to analyze how to assess cost in IPS^2 companies. In particular this research is intended to identify and determine a suitable method for machine builders manufacturing company as the real case of IPS^2. The main research proposition is:

How could a cost management system be applied to meet the IPS^2 concept of a machine-builder manufacturing company?

In order to address the research proposition, the following work aims to answer the research questions as follows:

1. What is the current situation of cost assessment in IPS^2 companies?
2. How to assess the cost of IPS^2 machine-builder manufacturing industry using given existing costing system?

Considering the research focus of this research which is machine-builder manufacturing company, the research scope will be particularly focus on IPS^2 function-oriented, related to the first type of IPS^2 business model proposed by (Tukker and Tischner, 2006). IPS^2 function-oriented is the most common implementation of PSS concept in industries nowadays. Accordingly it seems to be relevant to discuss and explore it.

Since to be an IPS^2 company is very long journey, there will be some challenges to be faced and overcame, for instance the increasing of business complexity, urgency to change organization's mind-set and behavior or even its structure. But not only are those internal challenges the main issue, IPS^2 company should be flexible enough to adapt with the rapid change in external market. It has

to be stay competitive. Continuous development somehow is the answer of both internal and external challenges. How company continuously try to improve and optimize their internal organization and to be flexible to external movement. Within this work, it intend to identify what proper cost estimation which could address those minimum requirements to be a successful IPS^2 function-oriented in today's market.

1.3 Thesis Structure

The present work would be structured into six chapters which briefly describes as below.

Chapter 1. ***Introduction***

Explains the research background as well as the research context followed by the research question intended to be answered. The research methodology used to fulfil research conducted is presented as well in this chapter.

Chapter 2. ***Literature Review and Findings***

Presents the review of existing studies related to the main research topic. The review is started from the evolution of product service system, the cost estimation for both product and service industry and the latest costing system dedicated for IPS^2 or PSS industry.

Chapter 3. ***Reference Model and Framework***

Within this chapter, it would present the analysis of supporting model and framework. This reference would be basis to develop the new cost assessment framework based on the literature findings for IPS^2 function-oriented business model

Chapter 4. ***New Cost Assessment Framework***

Presents the proposed framework to assess the cost of integrated product-service offering which is adjusted and fitted to this particular industry's characteristics and needs.

Chapter 5. ***Case Analysis***

In this chapter, it would be explained about the case study analysis. The proposed costing system will be compared and validated with the real company of the machine-builder product-service industry.

Chapter 6. ***Conclusion & Future Work***

Present the conclusion from the overall research conducted followed by the proposed further steps to accomplish this research topic completely as future work.

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CHAPTER 2
LITERATURE REVIEW AND FINDINGS

According to the research intend to be developed, the following chapter will present the review of existing studies related to IPS2 as well as costing system available in literature. The literature findings from this review would help to construct the theoretical understanding based on the current studies in order to obtain comprehensive overview within this research topic.

2.1 Industrial Product-Service System (IPS^2)

The basic idea when manufacturing companies thought to add more services in their product offering had been started in the end of the 80s. At that time, manufacturing companies started to recognize the important role of services in their value proposition and began to involve services in their offerings. This concept was rapidly evolving due to the increasing competition in global market. Selling product could not be a sufficient valuable economic to determine the company's success, particularly because of innumerable threats from emerging companies in low cost countries. The manufacturing company starts to switch its focus from product-oriented offering becomes customer-based offerings which involve more services (Rese, Karger et al., 2009). This movement from product oriented to service oriented is called *servitization* (Wilkinson, Dainty et al., 2009b). (Baines, Lightfoot et al., 2009) give clear definition of *servitization* as "*the innovation of an organizations capabilities and processes to better create mutual value through a shift from selling product to selling product-service system (PSS)*". PSS offering which consists of physical product and its related services started to gain more attention in manufacturing industries.

There are three main drivers which force manufacturing companies to undertake *servitization* i.e. financial drivers, strategic drivers and marketing drivers (Baines, Lightfoot et al., 2009). The most often financial drivers mentioned are revenue stream and profit margin. In some industries, additional services could bring higher revenue than the sale of new products (Wise and Baumgartner, 1999).

Some companies like GE, IBM, Siemens and HP are the examples of the successful practices how services have given stable profit when significant decline of their products sales happened (Sawhney, Balasubramanian et al., 2003). By nature service is more difficult to imitate by competitor hence service aspect is used to differentiate the company offers among its competitors and give competitive opportunities (Baines, Lightfoot et al., 2009). This competitive advantage is one illustration of strategic divers for *servitization*. The service aspect of total offering could influence customer purchasing decision and becomes very important topic in literature of marketing (Baines, Lightfoot et al., 2009).

Product-Service System (PSS) is one special case in *servitization*. PSS is defined as "*an integrated product and service offering that delivers value in use*" (Baines, Lightfoot et al., 2007). PSS gives more emphasize on assets utilization and performance rather than ownership. By providing PSS offering, company will provide a bundle of products and services that gives more values to customer.

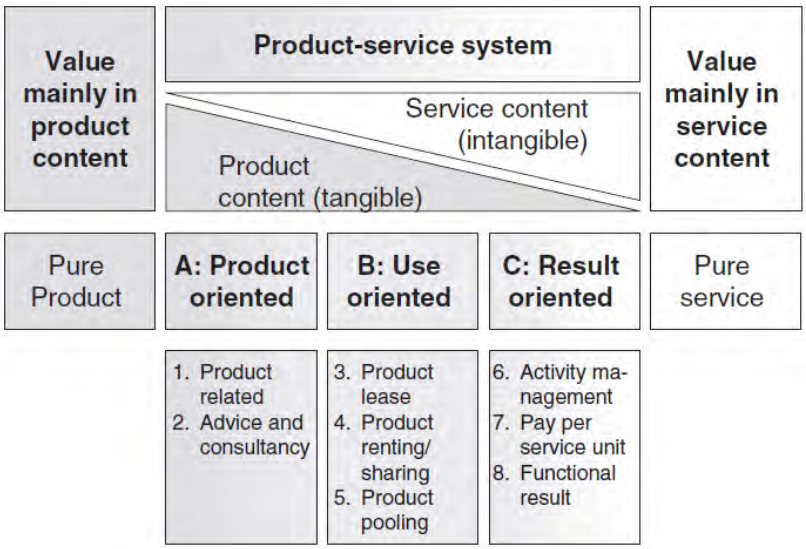

Figure 1 - Main and subcategories of PSS (source: Tuker, 2004)

PSS is classified into three main categories based on service portion involved in each PSS package. Those three main categories are detailed into eight types of PSS with different economic and environmental characteristics (Tukker, 2004). Figure 1 presents a clear flow how PSS classification follows the *servitization* pattern, started from pure product-oriented and ended as pure service-oriented.

Under PSS field of study, there is a particular case where customers of PSS Company are other industries. This case so-called Industrial Product-Service System (IPS^2). IPS^2 is defined as an integrated offering of products and services which gives values in use that apply only in business-to-business (B2B) application (Baines, Lightfoot et al., 2007).

There are four main stakeholders in IPS^2 environment which are identified as the original equipment manufacturer (OEM) who is the IPS^2 provider itself; customer; supplier and society which includes government and competitor (Meier, Roy et al., 2010).

IPS^2 business model vary from function-oriented, availability-oriented, and result-oriented use models (Tukker and Tischner, 2006) based on how many services being included in company's offerings.

The brief description of IPS^2 business models is presented as follows:

1. Function-oriented business model

   The first stage of IPS^2 continuum is function-oriented business model. In this model, product is still the main focus of company but company starts to add more services in its offerings. The most common services being offered along with products are after sales services or maintenance services. IPS^2 provider delivers necessary services to guarantee the functionality of its products could be based on the contract agreement or separate offering

2. Availability-oriented business model

   Under availability-oriented business model, an IPS2 provider will deliver more various types of services. IPS^2 provider will guarantee the usability of the means of production during the period of contract time. The main performance indicator in this business model is the availability for use by customer.

3. Result-oriented business model

   IPS^2 provider will responsible for the whole customer's production process. The customer only need to pay the price of the final result which will be specified in contract agreement.

In more detail, (Meier, Roy et al., 2010) differentiate three IPS^2 business models in technical, organizational, qualification and financial specifications (Table 1).

Table 1- Specification of IPS^2 business models

	Function-Oriented	Availability-Oriented	Result-Oriented
Production responsibility	Customer	Customer	IPS^2 provider
Supply of operating personnel	Customer	Customer	IPS^2 provider
Service initiative	Customer	IPS^2 provider	IPS^2 provider
Ownership	Customer	Customer/IPS^2 provider	IPS^2 provider
Supply of maintenance personnel	Customer/IPS^2 provider	IPS^2 provider	IPS^2 provider
Service turn over model	Pay on service order	Pay on service availability	Pay on production

(Source: Meier, Roy et al., 2010)

In the real practice, the most common implementations of IPS^2 concept exist in machine builder manufacturing industry, the particular industry which produce high value and advanced machines, equipment or tools for industrial companies. This industry starts the transformation journey to be the *servitized* company by providing standard after sell services or maintenance services around their products. In particular case, this additional services commonly are called as technical services. Technical services have been seen as an interesting business. It have contributed up to 18% of German discrete part manufacturing industry's total income (Aurich, Fuchs et al., 2006). This practice is considered as IPS^2 function-oriented because they provide technical services to support product functionality during product usage period.

In machine tool builder manufacturing industry, IPS^2 concept helps company to survive in strong competitive market, particularly because of competitors from low cost companies, by providing more customer-oriented solutions. IPS^2 provider could increase customer loyalty by enhancing its product functionality and performance with services. The key competitiveness is no longer

based on product price but the value of the product. Customer will experience benefits from IPS^2 concept because it could increase their production quality, flexibility and productivity as well as reduce risks, cost and lead time at the same time (Biege, Copani et al., 2009).

An example of machine builders manufacturing companies who adopts the concept of IPS^2 function-oriented is Mori Seiki, a company based in Japan. Currently, Mori Seiki offers and provides standard after sales services to increase its customer's value and satisfaction. Field service, spare part business and customer training are types of its service offerings (Meier, Roy et al., 2010). To the present, Mori Seiki is in consistent way to define, design and deliver more suitable integrated product-service offerings to address its customer's need.

From this example, it is obvious that the journey toward a full IPS^2 provider is not an easy task. Providing combination of product and services will bring risks, uncertainties and increase complexity in company because it will involve many stakeholders. Implementing IPS^2 function-oriented is a good starting point for a company who wants to take part in PSS business environment. There are some specific areas in IPS^2 which have not received sufficient attention and remain as the interesting topics to be further studied including the cost assessment dimension.

Implementation of IPS^2 concept by manufacturing company is increasing due to the wide range of IPS^2 benefits. IPS^2 would give significant benefit not only for producer, but also for customer. In producer's perspective, providing an integrated product-service offering means giving more values for customer and at the same time it helps to differentiate its business within the tough market. From customer's point of view, IPS^2 concept will facilitate them to get more values but liberate them from ownership, maintenance and control of products (Baines, Lightfoot et al., 2007).

Besides giving wide range of benefits, implementation of IPS^2 will bring some challenges as well. Some studies have been conducted to explore and identify challenges, obstacles as well as problems might be occurred during *servitization* of manufacturing companies, for instance research has been done by (Brax, 2005), (Baines, Lightfoot et al., 2009) and (Martinez, Bastl et al., 2010). (Martinez, Bastl

et al., 2010) propose an architecture of challenges in *servitization*. This architecture shows how a manufacturing company which wants to be a product-service oriented organizations face five main challenges during its *servitization* journey. Those challenges are embedded product-service culture; delivery of integrated offering; internal processes and capabilities; strategic alignment; and supplier relationships. One important issue from those challenges is internal process and capabilities. By providing a combination of products and services, company will be required to have the new capabilities that help them to successfully run the new business model. (Datta and Roy, 2010) define those capabilities as informatics, socio-technical system, organizational structure, service networks, co-creation of value and innovation.

Another challenge which has been an important issue in *servitization* is cost assessment dimension of IPS^2 provider. There is limited experiences in practice which explain how to assess the cost as well as to set the price of total offerings (Goedkoop, 1999). Company should be able to estimate the cost of total offerings as accurate as possible and then set the competitive price. Pricing policy is one of the most important decision in a company. The final price offered to customer should give the desired profit but remain competitive in market. Moreover, the complexity of IPS^2 implementation will increase because of high number of uncertainty. Those uncertainties could be happened due to high interaction among diverse customers, high uncertainty of customers demand and uncertainties inside the organization itself (Priya Datta, Christopher et al., 2007). All those uncertainties should be taken into account when estimate cost of the IPS^2 offering since all those activities will give impact, directly or indirectly, to the company's total cost. Company should be able to obtain the profit growth promised by this new concept (Datta and Roy, 2010).

2.2 Configuration of IPS^2 Function-Oriented

By nature, cost is dependent factor that highly related with other factors. Cost could be seen as the result of sacrifices aspect of company's actions to deliver value to customer, either by delivering products or providing services. In order to be able to propose cost assessment framework, it is required to understand

characteristics and cost structures owned by IPS^2 companies, particularly for IPS^2 function-oriented business model.

In line with this point of view, the following work will present key information in IPS^2 function-oriented companies which will help to construct cost assessment framework for this kind of business model.

2.2.1 Service Classification in IPS2 Function-Oriented

The distinguish factor which differentiate each IPS^2 business model is service proportion in its total offering. Service could be involved in company total offering as "add-on" which support product's performance (functionality and durability) during product life-cycle, but in another case, service could be the main aspect since company's focus has been shifted to be service provider. Different service proportion will cause different cost structure as well as cost behavior. Therefore, it is important to identify what services that possible to be offered by IPS^2 function-oriented companies for their customers. This service identification and classification could be the basis input to identify the relevant cost structures.

The major and most common type of service being performed by IPS^2 companies is technical services, particularly for function-oriented business model. Technical services or product related services, for instance maintenance, repair or upgrading of physical product components, are performed during product's usage phase to increase the economic performance of industrial product (Aurich, Fuchs et al., 2004, Aurich, Schweitzer et al., 2007). Traditionally, this type of services will be provided by company as a separate offering. But in IPS^2 concept, technical services are integrated and aligned with products. (Azarenko, Roy et al., 2009) introduce service configuration for product-oriented technical-PSS as shown in Figure 2. In this model, MT supplier or IPS^2 provider offers a bundle of technical service solutions to support product/machine functionality during its life cycle. Technical services mentioned in this offering are tool management, refurbishment, monitor, e-maintenance, etc. But types of services being provided will be based on agreement with customer. It could cover all the services possibility or only small part of that.

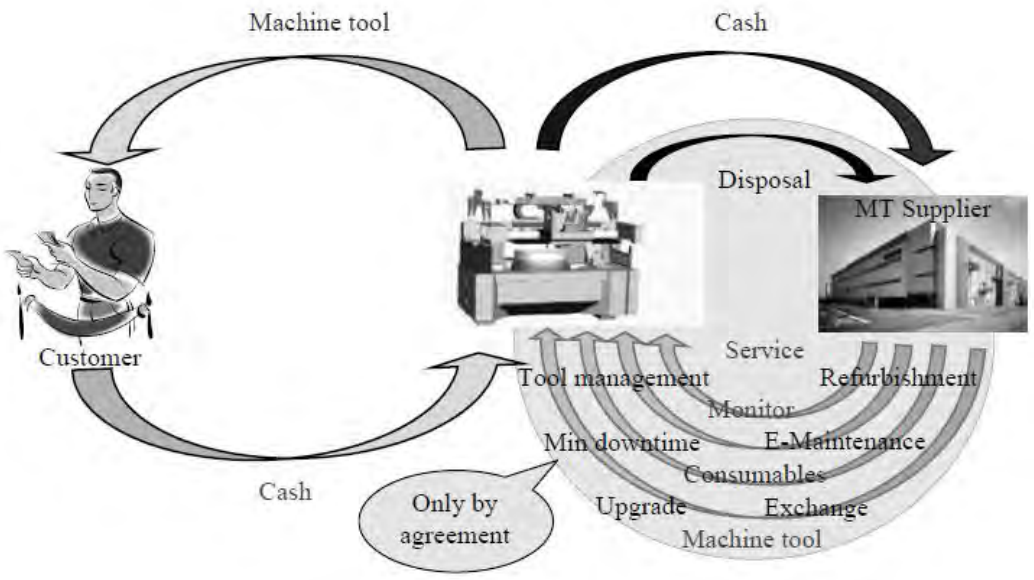

Figure 2 - Product-oriented t-PSS proposed by (Azarenko, Roy et al., 2009)

Beside technical services, there are two other service classifications offered by IPS^2 companies. They are planning services and advisory services. Different with technical services, both planning and advisory services could be provided in all the product stages and not directly dealing with the industrial product. IPS^2 companies could perform this services even before customers place their order. (Ribeiro, 2012) makes a compilation of detailed services categorized into advisory, planning and technical services based on (Aurich, Schweitzer et al., 2007, Aurich, Fuchs et al., 2006, Azarenko, Roy et al., 2009, Biege, Copani et al., 2009, Tukker, 2004), as follows:

1. Advisory services, e.g. feasibility analysis, concept analysis
2. Planning services, e.g. maintenance plan, modernization plan
3. Technical services, e.g. system configuration, module configuration, preventive maintenance (online and physical)

Furthermore, (Kortmann, 2007) identifies seven types of services which could be involved in IPS^2 offering:

1. Planning services, e.g. material flow planning, factory planning
2. Counselling services, e.g. calculation support, personnel counselling

3. Training services, e.g. operator training, determination of the need for training
4. Logistic services, e.g. replacement part service, machine implementation
5. Function creating services, e.g. start-up. Ramp up management
6. Function maintaining services, e.g. maintenance, repair
7. Optimizing services, e.g. process optimization

In some points, it seems there is no difference between IPS^2 function-oriented companies with traditional manufacturing companies who provide technical services after warranty period end. In IPS^2 function-oriented business model, service is part of total offering not as a separate offer. IPS^2 function-oriented provider tries to bring an overall solution for customer to experience the functionality of the product by providing necessary services during given period of time. Since customer has lack of knowledge about the product, this overall solution becomes more interesting in customer's point of view.

IPS^2 provider could provide a simultaneous and continuous services during product life cycle or only performs certain service solution in certain time and condition, it depends on the contract agreement. Consequently the agreement between IPS^2 provider and its customer will be very important issue because it will define what services are included in offering, in what condition those services will be performed (it could be preventive, scheduled, intelligent maintenance/e-maintenance service) and certainly the contract period (Azarenko, Roy et al., 2009). Based on all those findings, it could be concluded that there are three main service categories which are possible to be involved in total offering under IPS^2 function-oriented business model. They are planning services, advisory/ counselling services and technical services. Figure 3 shows the detailed types of each service category. Even though there are various services it does not mean that IPS^2 provider will provide all those services. The actual services to be performed will be specified in a contract agreement between IPS^2 provider and customer with considering abilities of both parties. Because in function-oriented business model, service provision is based on customer actual order.

2.2.2 Life-Cycle of IPS^2

Life-cycle perspective has been widely discussed in literature particularly for product life-cycle. Product life-cycle is defined as the transformation of product, start from when it was designed, introduced to market for the first time, growth, mature and finally entering the decline phase (Datta and Roy, 2010). This information matters for company to understand the product stage particularly in terms of its movement in market. Consequently, it could be a decision making tool, by integrating other information for instance sales volume, and finally facilitate company to plan and execute relevant strategies. In another condition, product life-cycle could be a basis of decision making to replace an old product with a new product.

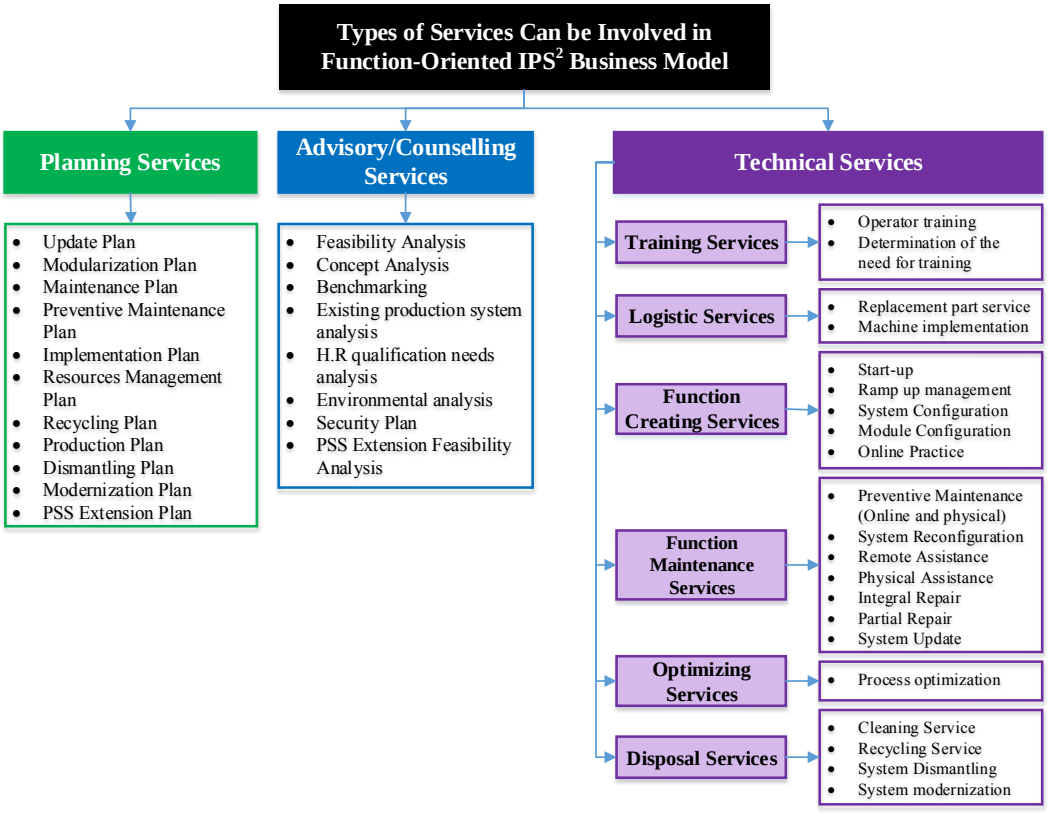

Figure 3 - Types of services could be involved in function-oriented IPS2 business model (based on Aurich, Schweitzer et al., 2007, Aurich, Fuchs et al., 2006, Azarenko, Roy et al., 2009, Biege, Copani et al., 2009, Meier, Roy et al., 2010, Ribeiro, 2012, Tukker, 2004)

Life-cycle of IPS^2 offering is obviously different with pure product as well as pure service life-cycle because the offer is an integration of products and services. (Aurich, Fuchs et al., 2006) describe IPS^2 as customer life cycle-oriented combination of products and services which aims to create more values to customer through integrated network of IPS^2 provider, supplier and service partners. IPS^2 companies intend to enhance product's functionality during its life-cycle by delivering non-physical services. There will be two life-cycle perspective in IPS^2 offering i.e. IPS^2 provider's perspective and customer's perspective. From IPS^2 provider's point of view, product life-cycle is started with product design, then proceeded by product manufacturing, product servicing and will be ended by product remanufacturing. But, in customer's point of view, product life-cycle is started with product purchasing, product usage and finally disposal (Aurich, Schweitzer et al., 2007). Considering these perspectives, IPS^2 provider is required to identify and perform non-physical services to support its customer throughout product purchasing, usage and disposal. Figure 4 shows how service in IPS^2 offering being seen differently by IPS^2 provider (manufacturer) and customer (user).

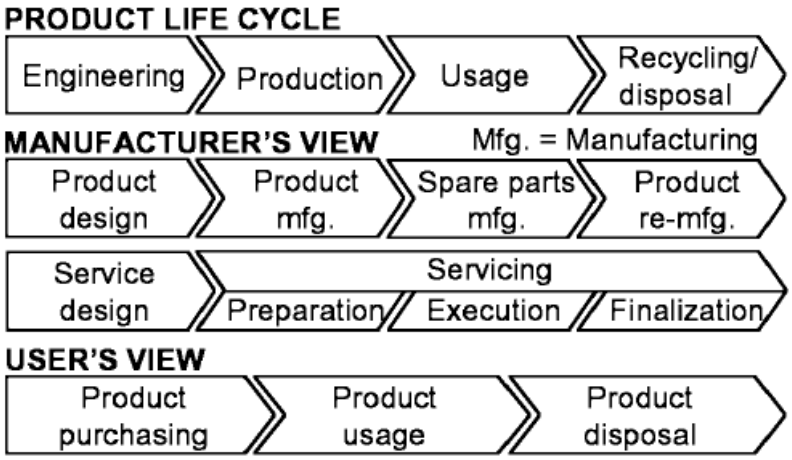

Figure 4 – Different perspective of product life-cycle in IPS2 company (source: Aurich, Schweitzer et al., 2007)

There are some studies that have tried to identify life-cycle of IPS^2 offering. The proportion of services involved in IPS^2 offering will cause the difference life-cycle. In consequence, it is possible for different IPS^2 companies to

have different life-cycle of their offering. (Sundin, 2009) describes life-cycle for integrated IPS^2 consists of design stage, manufacturing stage, delivery stage and adaptation stage which involve remanufacturing, recycling as well as value engineering. (Roy and Cheruvu, 2009) propose a life-cycle perspective for result-oriented PSS as sequence stages started by design stage, delivery stage and will be ended by adaptation stage. Adaptation stage is specific stage which feasible in result-oriented PSS. Adaptation is defined as a stage to revise or modify the product that aims to address specific needs of customer. This stage is important issue for both companies since in a result-oriented PSS, PSS provider will provide services during more than 5 years contract. The adaptation of product/service package in order to meet customer needs will help to maintain overall performance as well as customer satisfaction. (Aurich, Schweitzer et al., 2007) divide three main stages for product service system as order fulfilment, operation and dismantling. (Ribeiro, 2012) modifies that proposed life-cycle by adding one stage which is pre-sales. Hence, his proposed life-cycle for IPS^2 companies is sequence stages of pre-sales, order fulfilment, operation and dismantling.

Considering the research scope which is IPS^2 function-oriented, the proposed life-cycle for IPS^2 offering by (Aurich, Fuchs et al., 2004), (Aurich, Schweitzer et al., 2007) and (Ribeiro, 2012) seem relevant to be modified and used in this work. IPS^2 is defined as customer life cycle-oriented, the life-cycle of IPS^2 offering will be focus on the customer perspective.

Finally in this research, life-cycle for IPS^2 function-oriented offering is defined as pre-sale stage, product purchasing stage, product usage stage and product disposal stage. Further explanation of this modified life-cycle perspective is as follows:

1. Pre-Sales, is the stage before buyers place their order. In this stage, IPS^2 provider provides advisory service that allow potential buyer knows better its offerings
2. Product purchasing, is the stage where finally buyer place its order and IPS^2 provider deliver the required product based on customer's order (specification, volume). Since IPS^2 provider offers an integrated products and services, during this stage relevant services will also deliver to

customer. The relevant services such as advisory services, planning services and some other technical services concerning personal training, implementations and configuration of product could be performed

3. Product usage, is the stage where the product being used by customer. This phase is the critical stage for IPS^2 provider to ensure product functionality during its life-cycle. Some services could be required by customer are advisory services, maintenance, spare parts and others technical services
4. Product disposal, is the stage when the product has reached the end of it life-cycle. IPS^2 provider could provide technical solutions to customer to dispose the product or to renew the product

Taking into consideration all possible services, it could be identified certain types of services to be performed in each stage of IPS^2 offering life-cycle as shown in Figure 5. From this figure, it could be known that during product life-cycle, in customer's perspective, IPS^2 provider could offer and provide related services to support product's performance. This effort will give an overall solution to customer. Because IPS^2 provider not only selling product but also trying to offer services which help customer to gain the value from product that has been bought.

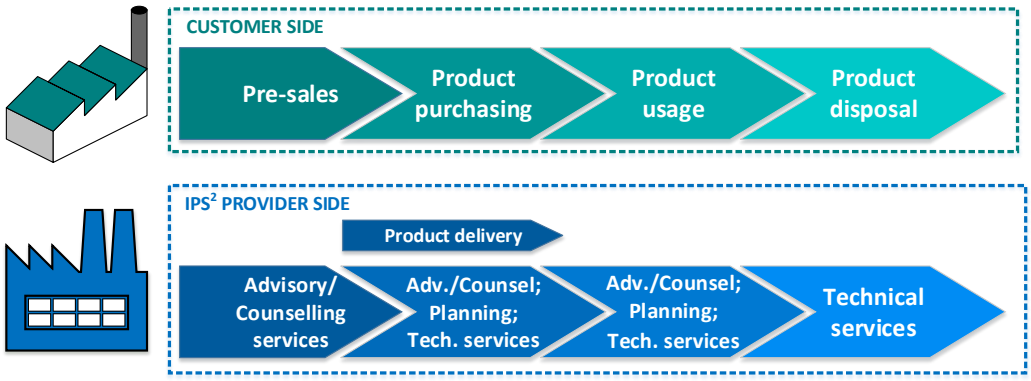

Figure 5 - Life-cycle of IPS^2 function-oriented offering with related services possible to be provided (based on Aurich, Fuchs et al., 2004, Aurich, Schweitzer et al., 2007, Ribeiro, 2012)

2.2.3 Cost of IPS2 Function-Oriented

One of the most powerful drivers to be an IPS^2 provider is financial driver. A manufacturing company who wants to be an IPS^2 provider expects to obtain higher revenue and profits because of the service provision. But on the contrary, some cases of IPS^2 implementation could not receive higher profits even though they could generate more revenues. It happen particularly in large industries (Neely, 2008).

This incident could happen because of many possibilities, one of them is an inaccurate cost assessment process. An IPS^2 company is obviously different with traditional manufacturing company. The changes in its business process and offering will affect the company's cost structure and cost's behavior which could not be addressed accurately by traditional costing. Moreover, the combination of products and services will bring a new challenge in defining and assessing the relevant costs due to the risks and uncertainties particularly in contract-based offering. Identifying all costs in the whole life cycle will be very important issue in IPS^2 concept. Some previous studies have tried to define relevant cost elements occurred which is summarized in Table 2.

Table 2 - Cost element in IPS^2 environment

Cost Elements of IPS^2	Sources
Relevant cost of IPS^2 is related with total cost of ownership which includes cost of capital investment, manufacturing activities, logistics activities and customer life cycle support	(De Coster, 2008)
Key cost elements of IPS^2 could be identified and categorized as 1. Recurring costs (RC) which includes labor cost, materials cost, machining costs and logistics & sub-contract costs 2. Non-recurring costs (NRC) which includes investment on company's equipment, facilities, capital goods, design and development efforts 3. Overheads (OH) which includes salary, development of personnel, infrastructure and administration cost 4. Hidden costs and risks/uncertainties costs (R&U). This costs are related to relationship management,	(Datta and Roy, 2010)

communication cost, cost due to lack of detailed level data, cost of reverse logistics and flexibility to response customer's request, cost of cultural changes or change management	
Another cost element is cost due to product obsolescence and disposal. Under IPS^2 contract, IPS^2 provider is required to manage the obsolescence of products. Hence, it is important to include all the related costs which are used to deal with obsolescence into the agreed fixed cost paid by customer	(Meier, Roy et al., 2010)

From Table 2 it can be deducted that the most relevant cost elements of IPS^2 companies are costs which occur over the whole life cycle of products and services. It is started from the design phase until the disposal stage by adding hidden costs and risks/uncertainties costs. Taking into consideration cost structures of PSS/ IPS^2 that have been determined in literature, the cost elements for IPS^2 function-oriented could be identified as shown in Figure 6.

This cost structures seems similar with cost elements in traditional manufacturing company. But there is a particular cost element which does not exist in traditional manufacturing company i.e. hidden cost & risk/ uncertainty cost (R&U). This additional costs happened due to the organization transformation from manufacturing company to be service provider. Along with the transformation process, company should undertake necessary changes as well as change management in its internal organization that obviously costly. Furthermore, providing PSS will require company to have and maintain long-term partnership with its customer. The relationship with customer goes deeper than only seller-buyer relationship. By providing an integrated solution during the whole product life-cycle, company should maintain its performance and partnership with customer. This action will require cost as well but sometime it is not directly and easily to be traced. Detail types of each cost structure from one IPS^2 company to the others could be different depend on their business model.

2.3 Existing Cost Estimation

Costing system is no doubt an important issue in company's business life. A continuous research is done in this area to find more appropriate costing system

that could provide less error in estimating and calculating the cost. It is one of key elements used to design and execute company's strategies, decision and policies. The appropriate costing system, includes cost assessment techniques, plays very important role to determine the company's success in this competitive market (Niazi, Dai et al., 2006). Improperly information constructed from inappropriate costing system will lead to misleading decision.

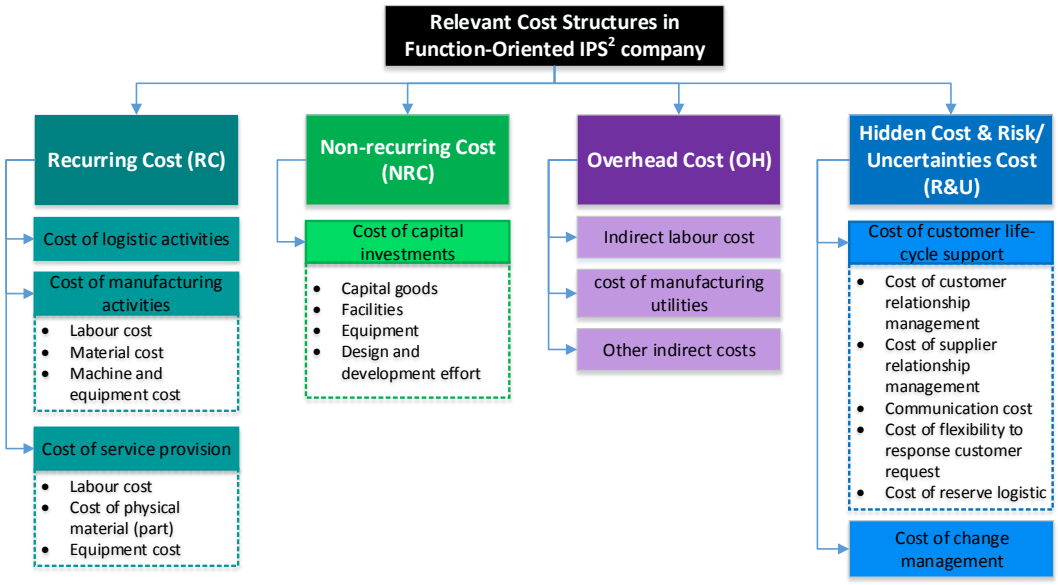

Figure 6 - Relevant cost structures in IPS^2 Function-Oriented company (based on: De Coster, 2008, Datta and Roy, 2010, Meier, Roy et al., 2010)

There are many different cost estimation classifications could be found in literature. But in general, some researchers agree that cost estimation could be categorized as product cost estimation and service cost estimation. Table 3 provides a comprehensive summary of common product estimation techniques used in practice with its advantages and limitations. Whereas to estimate cost of service there are five general steps should be followed. The steps are shown in Figure 7.

Product cost estimation in some conditions could be adopted to calculate cost of services with some adjustments. But the major consideration used to calculate the cost of services are the total quantity of resources used to provide the service multiply by the unit cost of those resources (Drummond and McGuire, 2001).

Table 3 - Product cost estimations with its advantages and limitations (source: Datta and Roy, 2010)

Product Cost Estimation	Brief Explanation	Advantages	Limitations
Parametric	Using an analytical function of product characteristics to estimate cost, without giving comprehensive description about the process. It is known as top-down application	• Easy and fast to be used • Objective and able to be repeated • Requires less information compare with analytic methods • Good as baseline assessments for companies budgets	• Excludes parameters which could be the important information • Good to combine with other cost estimation techniques • Too simplify to estimate costs • High uncertainty due to unavailable specification
Analogy	Estimates are based on the similarity between the new product with another product which its cost has been estimated before	• Needs less data • Fast in implementation and generated based on actual information • Company will know the baseline of the cost estimation • Does not require full understanding of problems • Give accurate result for high similarity products • Appropriate for cost estimation with insufficient data	• Using subjective adjustment • The accuracy of cost estimation relies on the degree of similarity • Give difficulty when company implements design change • Does not consider cost drivers • More difficult to be implemented than parametric method • Could not consider innovative strategy
Analytical	Cost estimation is based on the detail analysis of elementary tasks in	• Gives higher degree of accuracy than analogy and	• Takes longer time to be executed

	production processes. It is considered as bottom up technique cost estimation	parametric methods • Gives benefits for any negotiation because of the detailed work • Very good method if all the product's characteristics and production process are known	• Difficult to get all the detailed data needed • Not suitable for cost estimation in design phase and determine overheads allocation
Activity-based costing	Cost of product is the accumulation of cost of each activity needed in its production	• Based on the real and the detailed usage of resources • Gives higher degree of accuracy and relevancy • Provides very detailed cause of costs • Indicates clear potential profit for company	• Requires a lot of time • Expensive to be executed • Difficult to be implemented as single costing estimation • Very complicated in overhead allocation
Expert judgment	Estimation is based on the expert estimator's opinions and experiences	• Very flexible and fast to be implemented • Requires less effort in terms of time and cost • Could provide the same degree of accuracy as expensive techniques	• High possibility to give bias and error estimation • Considered as unstructured and inconsistent process • Nondeterministic method because each expert could give different estimation

2.3.1 Activity-Based Costing (ABC)

Originally Activity-Based Costing (ABC) is developed to address the costing requirement in product-based manufacturing companies, but nowadays ABC has been adopted and adjusted to be applied in service organization. ABC is the most widely used costing system both in practice and literature. It is also considered as performance management tool.

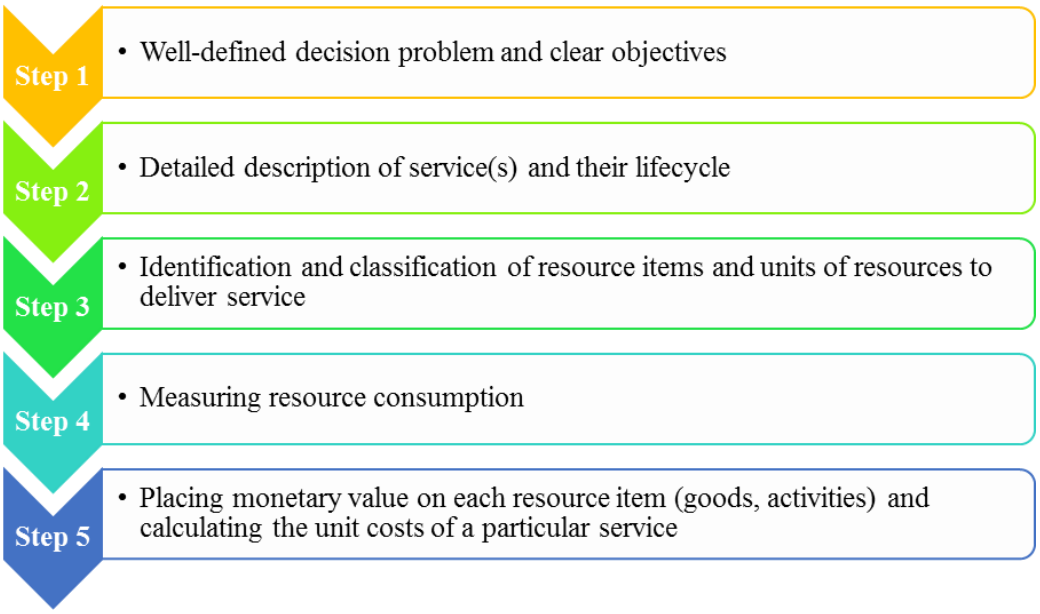

Figure 7 - Five steps of service cost estimation (source: Datta and Roy, 2010)

ABC helps organizations to trace and allocate the expenses, direct and indirect costs, to the cost object based on cause-effect relationship. The expenses which will be allocated to a cost object is the cost of resources that are particularly consumed. In ABC system, activity is defined as collection of different tasks, events or unit works which lead to the resource consumption. Different with traditional costing system which generally uses volume based cost driver to allocate indirect costs, ABC uses both volume based and non-volume based cost drivers. For instance, companies could use number of set-up and number of inspection as cost drivers to allocate their indirect costs. The usage of non-volume cost drivers will provide more relevant and rational allocation and give appropriate cost information to manager.

In order to design and implement ABC, there are four steps should be performed as follows:

1. Identifying activities
2. Assigning cost to activity cost center
3. Selecting appropriate cost drivers for assigning the cost of activities to cost object
4. Assigning the cost of the activities to product

Furthermore, (Drury, 2008) describes there are two allocation stages in ABC which is shown in Figure 8.

ABC gives high degree of accuracy to estimate cost since it provides very detailed cost information which incurred in company. It is able to trace the source of indirect cost more relevant and rational due to its cause-effect relationship. ABC helps manager to see that not all revenues are good revenues and not all customers are potential customers (Drury, 2008). Hence, it plays as strategic decision as well. ABC is believed as a potential costing method for service organization. By using activity-based allocation to trace indirect cost, this system will be suitable to be employed in service organization where the most common costs occurred are indirect costs. But in other hand, a lot of companies had given up to fully use ABC as their costing system because it requires a lot of resources (people, time and money) to implement and maintain this costing system (Huntzinger, 2007).

2.3.2 Time-Driven Activity-Based Costing (TD-ABC)

ABC is obviously a reliable costing system which gives wide range of benefits for company, particularly because it is not only an operational tool but also a management supporting tool. Practical application occasionally is not as simple as its theory. In practice it is very difficult to design, implement and maintain ABC. In the real practice, many companies have been dealing with a great complexity from this system. One of the biggest obstacles to use ABC is the difficulty to obtain the necessary data. The bigger organization the bigger and more complex data will be required. To accomplish this task, company should assign more resources to manage the data collection, processing and reporting. Consequently, it will not only require a lot of time but also a lot of money. Then, an interesting question will arise whether this system is worthy enough for company or not.

Time-Driven Activity-Based Costing (TD-ABC) is proposed to cope the weaknesses of ABC by using the simplification to allocate the overhead costs. Time is used as the main driven to allocate the overhead cost is believed could give the more accurate cost allocation.

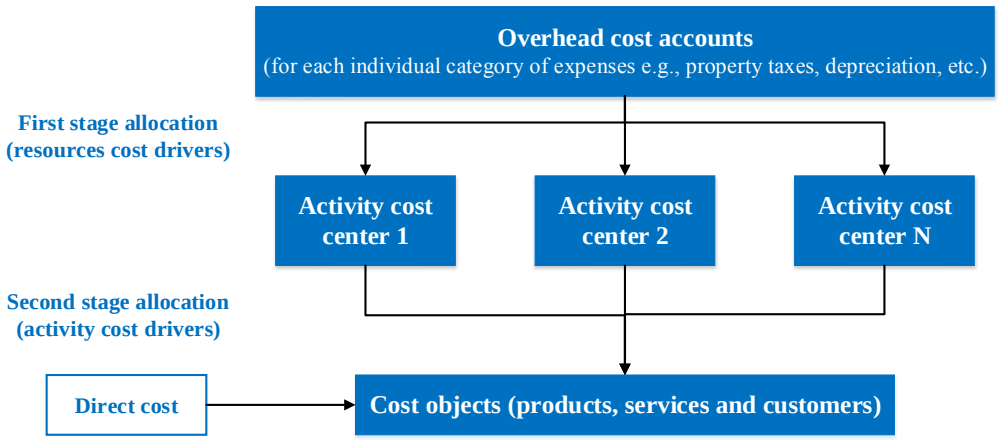

Figure 8 - Allocation stages in ABC system (source: Drury, 2008)

TD-ABC simplify the data gathering by estimating only two parameters which are cost per unit time of capacity and the unit cost consumed to produce product or to provide service. (Kaplan and Anderson, 2003) explain that in TD-ABC, the estimation process is simplified to be as follows:

1. Estimate the cost per time unit capacity

   It is allowed for manager to directly estimate the practical capacity of the resources as a percentage of the theoretical capacity. It is used to obtain the cost per time unit capacity owned by company

2. Estimate the unit time of each activity to produce product or provide service

   It is required to calculate the time needed to do a particular activity. How long it takes to accomplish one activity. One activity could be deploy into very detailed sub activities or unit works

3. Obtain cost-driver rates

   Finally in order to obtain the cost of particular activity, it is only needed to multiply the cost unit time of capacity with the unit time to complete that activity.

Since TD-ABC is proposed to overcome all the technical drawbacks of traditional ABC system, there are some benefits which does not exist in traditional ABC system. By using TD-ABC, manager will be able to report their costs on an

ongoing basis both for cost of their business activities as well as the time spent for those activities. Moreover, this report will emphasize the differences between available capacities with the real usage of that capacities (both quantity and cost). By simplifying process of data gathering of traditional ABC, TD-ABC has more flexibility to be updated. In this approach, updating the model could be done based on events rather than period of time (quarter or annually). It will provide more accurate insight of actual condition of company (Kaplan and Anderson, 2003).

TD-ABC is believed could offer transparent and scalable costing methodology yet easy to be implemented and maintained which make this system to be a strong negotiation tool to deal with customers. TD-ABC is believed has succeeded to cope the ABC's limitations but could give the result as good as ABC (Kaplan and Anderson, 2003).

In line with another costing methodologies, TD-ABC has some limitation as well. It will work properly in high repetitive job where profit margin is small, for instance in retailer business. This could happen because in TD-ABC standardization in time is an important issue. But if company wants to know why this cost could be occurred and how the behavior of particular cost object, implementation TD-ABC would not be worth it (Adkins, 2008).

2.3.3 Process-Based Costing (PBC)

Another most known product cost estimation is process-based costing (PBC). This approach was firstly applied in manufacturing company with multiple production processes. In order to implement this system, initially company should model its production using a specific method so-called process-based cost model (PBCM). PBCM is mathematical transformation which present the process description and its operating condition to measure the incurred cost (Kirchain and Field, 2001).

The basic idea of PBC lays in perception that cost is the result of design product, properties of its material and condition of its operating which modelled by particular processes and technologies. In line with this perception, it is explained that product cost is basically a context dependent. There is a direct correlation and dependency between product design and production cost. By nature, cost of product

is function of processes used to produce it. Meanwhile, cost of operation process is function of the design of the product itself.

There are three main stages to assess cost of product using PBC as follows:

1. Identify relevant cost elements

   Initially this technique is built as product cost estimation hence the common cost elements mentioned are really related to production process in manufacturing company, for instance material (including scrap), energy, labor, primary equipment, auxiliary equipment, installation expense, related tools in production process (molds or dies), building space, overhead and transportation (Kirchain and Field, 2001)

2. Establish the set of contributing factors

   Contributor factor is defined as the related operational activities or conditions which could influence the production process. For instance, at forming process it is necessary to know what type of force of the processes will be used. This certain information is important to be understand in modelling the processes and finally to identify its cost (Kirchain and Field, 2001)

3. Correlate process operations to cost of factor use

   After defining the list of relevant cost elements, the last step should be accomplished is defining its actual cost. For each cost element, it will be identified the relevant actual cost. In performing the third step, it should be considered some particular issues which are intensity of production (capacity and volume); operating time that related to process cycle time and material flows that could be varied within multiple process.

At a glance, PBC seems the same with traditional costing system but if it is looked deeper PBC tries to give a new understanding that cost is dependent result of production process and product design. Cost is created since the very first a product being design. By understanding this behavior, it becomes clearer for company which wants to reduce its product's cost, it is necessary to design as

efficient as possible its product which includes its design, material and production processes.

PBC is believed could give fair estimation even with limited design and operational data. This result could be achieved because combination of statistical information and engineering models could be linked with certain factors such as cycle time, material used, and capital requirements to obtain cost information (Kirchain and Field, 2001). Moreover PBC is built based on process flow which could be modelled as a flowchart. Flowchart is considered as one tool in quality improvement. Consequently, PBC could be a performance measurement tool to measure how good company performance after implementing improvement in terms of cost outcome (Lee, Bott et al., 2003).

2.4 Literature Findings

From the literature review has been done, it could be deducted that in area of PSS/ IPS^2 there is very limited studies explore what particular costs occur and appropriate costing system (cost estimation technique, costing model or cost assessment framework) for IPS^2 environment.

The latest and the most relevant research in cost assessment for IPS^2 companies is conducted by (Datta and Roy, 2010). They propose a cost estimation technique for IPS^2 availability-oriented use model. In the proposed model, joint cost approach is used. The combination of product cost estimations and service cost estimations, which are available in literature, are used to assess the cost of IPS^2 total offering in availability types of contract. Life-cycle stages and availability of data are two main input to determine which combination of cost estimation techniques should be adopted.

The most well-known cost estimation techniques have been explained in the previous section which include ABC, TD-ABC and PBC. All those methodologies initially was developed in particular purpose for product cost estimation. But as emerging service industries those methods have been adjusted to be applied in service organization as well. By considering some important issues needed to be addressed in estimating cost of IPS^2 environment, particularly for

function-oriented business model, Table 4 presents the strengths and limitations of each existing cost estimation techniques.

Table 4 – Strengths and limitations of existing cost estimation techniques compared with the need of cost estimation in IPS^2 environment (based on: Adkins, 2008, Kirchain and Field, 2001, Lee, Bott et al., 2003, Kaplan and Anderson, 2003, Huntzinger, 2007, Drury, 2008)

Important issues to be addressed in IPS^2 cost assessment	**Activity-based costing (ABC)**	**Time-Driven Activity-Based Costing (TD-ABC)**	**Process-Based Costing (PBC)**
Company's offering • *Product and service integration* • *Long-term relationship with supplier and customer*	(+) Indicate clear potential profit for company	(-) Could not give information why this cost could be occurred and how the behavior of particular cost object	(-) Doesn't really fit to calculate services since this method could not accommodate indirect cost
Internal organization • Servitization *(internal transformation)* • *Company's strategic objectives* • *Flexibility to adapt rapid competition (continuous improvement)*	(+) ABC helps manager to see that not all revenues are good revenues and not all customers are potential customers	(+) Manager will be able to report their costs on an ongoing basis both for cost of their business activities as well as the time spent for those activities	(+) Built based on process flow which could be modelled as a flowchart. Flowchart is considered as one tool in quality improvement
Operation cost estimation • *Resources requirement* • *Degree of accuracy*	(-) Requires a lot of time (-) Expensive to be executed (-) Difficult to implement as single costing estimation (-) Very complicated in overhead allocation	(+) Give degree of accuracy as good as ABC with simpler and less data required (+) TD-ABC report is flexible to be updated based on events rather than period of time	(+) Could give fair estimation even with limited design and operational data

Estimating the cost of product or service is obviously not an easy task and sometimes could lead to misleading focus. It could be done by using very complex method that gives high degree of accuracy or by using simple method but gives low detailed cost information. Defining the balance between those trade-off becomes more crucial in today's market where competition becomes harder. Occasionally company are trying too hard to allocate their cost by using very complex techniques which basically is not really worthy. Costing system is no doubt important issue in company but if a company wants to be competitive, it has to manage and improve its activities not only wasting its resources to allocate its costs.

Then, the ability of those cost estimation techniques to encourage company to do continuous improvement is questionable. Could those systems motivate and support company to do continuous transformation and improvement towards the long journey to be a successful IPS^2 provider? Do those systems give high value to company?

There is no doubt that market has become wider and more open in basis of international competition. If company wants to keeps competitive, doing continuous improvement is the only option. Unfortunately, traditional costing system or even ABC could not provide the sufficient information to mediate and encourage the improvement and transformation (Gunasekaran, Williams et al., 2005). The flexibility to adapt in new and unpredictable environment is a crucial key to outperform the local and global competitors. To successfully implement IPS^2 concept is not an easy job. The transformation process is obviously very long and gives internal as well as external challenges. The capability to flexible enough to adapt and change is fundamental requirement for IPS^2 companies, particularly for a manufacturing company who just entering the *servitization* journey by implementing function-oriented business model.

An IPS^2 company needs a costing system which could address some crucial requirements. It should be easy to build, implement and maintain in terms of time, cost and effort without ignoring the complexity of company's business process. A costing system which able to assess cost of service as good as cost of product. Furthermore, it should be easily update and adjust to encourage and

support company's transformation and improvement towards a long *servitization* journey (Azevedo and Sholihah, 2015b).

Considering those criteria, lean accounting is a proposed candidate to be adjusted to meet IPS^2 company's needs, particularly for function-oriented use model. This system considers and includes all the costs within value stream in how company provides its products and services. The adoption of lean thinking in cost management could lead company to increase their effectiveness and efficiency of their IPS^2 design, development, management and delivery toward the full *servitized* company (Resta, Powell et al., 2015). The detailed analysis about the strengths and possibility implementation of lean accounting in IPS^2 environment will be presented in the next chapter.

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CHAPTER 3
RESEARCH METHODOLOGY

The approach methodology will be applied in this research is a combination of intensive literature review and case study analysis. Intensive literature review has been used by many researchers to identify or develop a research agenda or framework on the various topics in accounting field of study (Ruiz-de-Arbulo-Lopez, Fortuny-Santos et al., 2013). The research design was structured as shown in Figure 9.

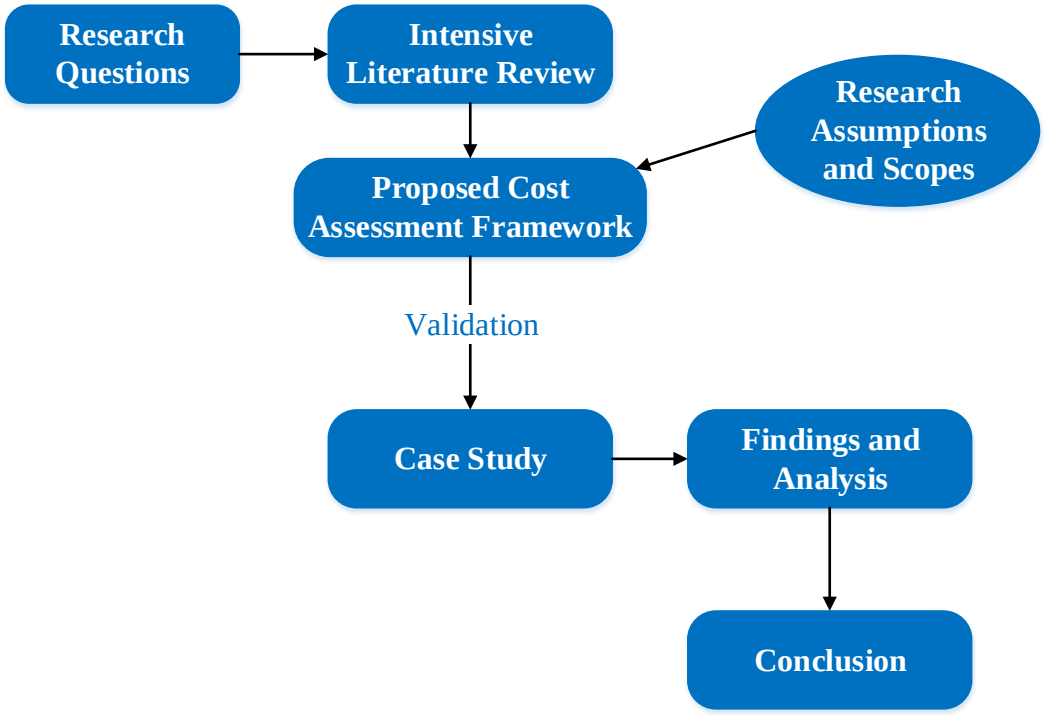

Figure 1 - Structure of research design

3.1 Intensive Literature Review

At the first stage, research goals, questions and scopes are defined. Based on this information, literature review will be conducted in related area including product-service evolution to existing cost modelling techniques. The result of literature review will lead to some research gaps and findings which will strengthen the completion of this research.

Related research works have been obtained from various sources for instance research journals, previous dissertation, thesis and other trusted and reliable research works using the key words such as “industrial product-service system”, “product-service system”, “*servitization*”, “cost estimation”, “Activity-Based Costing”, “Time-Driven Activity-Based Costing”, “Process-Based Costing” or “Lean Accounting”. The main purpose from this stage is to point out what the current situation and the problems of cost assessment in IPS^2 environment and what the cost estimations which are available and used in literature as well as in practice.

Based on the findings of literature review, the proposed cost estimation for IPS^2 environment will be introduced. This customized cost assessment framework would be proposed to address the IPS^2 environment and to fulfil the gaps of current studies in IPS^2 environment area. All the studies would focus on the IPS^2 function-oriented as initial step in *servitization* journey.

3.2 Case Study Analysis

Case study analysis is selected since the research questions which have posed are of an exploratory nature and aim at dealing with operational links. A case study are a recommended research methodology (Yin, 2013).

A theoretical framework could be referred as a good research finding if it can be implemented and successfully addressed the real industry’s problems. After developing the cost assessment framework for IPS^2 function-oriented business model, practical study of the real IPS^2 function-oriented companies will be carried out to verify the proposed framework. All the information obtained from the case study including the incompatibility of framework will be collected and afterwards will be corrected based on practical understanding form this stage.

Case study analysis is conducted by doing the semi-structure interview with companies’ representatives who has comprehensive understanding about company’s offerings and its costing system. Attachment A provides the detailed case study protocol used in this research.

The semi-structure interview is suitable approach to study the real situation and to validate some information collected from multiple resources for instance the company website, reports or other documents. Through this approach, it is possible

to gain the perception and opinion of the interviewee which give benefit to get unidentified and unrecognized problems (Laforest, Bouchard et al., 2012). The semi-structure interview as an open and two-way conversation, will help to further explored qualitative information about the companies.

Since all the data collected from this approach is qualitative information, the data analysis method is the descriptive content analysis. The full transcript of interviews conducted could be found in Attachment B.

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CHAPTER 4
REFERENCE MODEL AND FRAMEWORK

In this section, supporting model and framework will be presented which are cost assessment framework for IPS^2 availability type contract by (Datta and Roy, 2010) and lean accounting.

The exploration of cost assessment framework for availability type contract will give basic understanding what the existing cost estimation techniques proposed to be applied in IPS^2 environment. Although this framework is developed for different type of IPS^2 business model, but some important findings from general IPS^2 companies' characteristics could be adopted to propose more appropriate cost estimation for function-oriented business model.

The second model will be discussed is lean accounting. Based on the literature findings it seems clear that lean accounting with its value stream costing is a good candidate as basic framework for cost assessment for IPS^2 function-oriented business model.

4.1 Cost Assessment Framework for IPS^2 Availability Type Contract

The concept of PSS and IPS^2 have been developed since early 1990s. Nevertheless there are some parts of this field of study have not been explored yet, because this new strategy is quite complex and includes transformation in both strategic and operational aspects of company. One of those unexplored parts is cost management system, including its cost structure as well as its cost assessment. The change of company's business process, the change of company's relationship with its customer and supplier as well as the combination of product and service in company's offering have brought new challenges to company's costing system where traditional costing system is no longer appropriate method to be applied.

The latest and most comprehensive research in this area was done by (Datta and Roy, 2010). They introduced cost assessment framework for availability type service contract which is one practical example of availability-oriented IPS^2 business model, the second stage of IPS^2 continuum. In this business model, IPS^2

provider will be responsible to provide both products and services to customer whenever it is needed during the period of contract time. The main performance indicator for this contract is the availability for use in customer side.

The most common practice of availability type of contract is defense's equipment industry, manufacturing companies which provides equipment for defense purposes, for instance aircraft, weapon, and tank. Hence in the conducted research, they used a case study analysis from suppliers of Ministry of Defense, United Kingdom (MoD-UK). By analyzing three suppliers (IPS^2 providers) of MoD-UK, they concluded that in practice IPS^2 providers estimate the cost of their offering by using similar steps with service costing methodology shown in Figure 7. In order to give the best price in bidding stage, IPS^2 providers take into consideration very seriously two key parameters which are availability target and customer budget. They try to deliver all the availability targets required by MoD-UK without ignoring their budget ability. In detail, Figure 10 presents the sequence process of cost modelling of availability type contract studied from MoD-UK's suppliers.

The cost assessment model used by availability-oriented IPS^2 companies is a sequence process start with gathering information inputs to proceed the cost estimation process. The information inputs such as user requirement, user budget, industrial standards, supplier data, expert opinions and historical data will be used to deploy the details of activities should be performed during the contract (known as service break down system [SBS]) and its related activities including procurement and supporting activities to deliver the total offering.

Based on the insight from case study and literature review, Datta and Roy then proposed a cost assessment framework for availability type service contract (Figure 11). This framework consists of combination of product cost estimations and service cost estimations which vary based on two decision parameters, which are life-cycle stages of the offering and information availability. The decision parameters are used to decide which combination of cost estimations should be used. This proposed framework is using joint cost modelling approach.

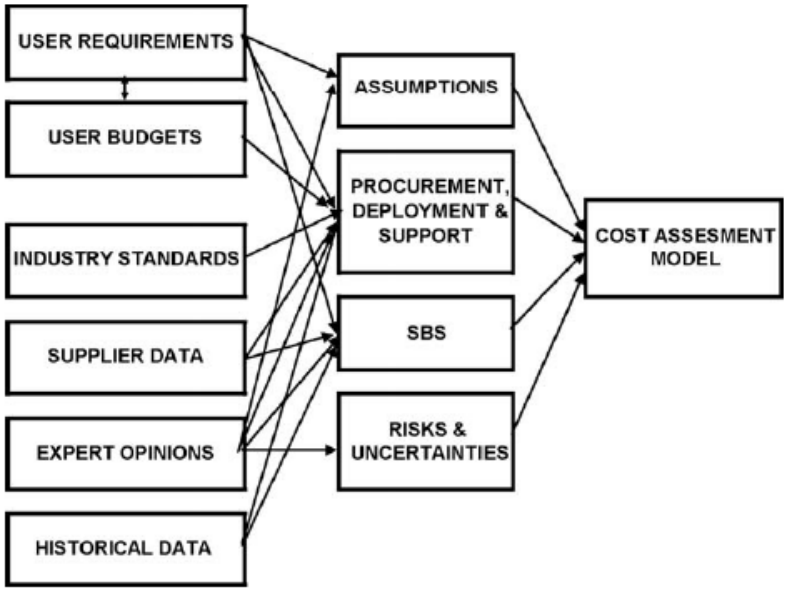

Figure 1 - Generic process of cost modelling of availability type contract (source: Datta and Roy, 2010)

Information availability is divided into three categories, which are low, medium and high. Low information availability means, there are only rough estimate of resources available and expert opinion to assess the cost of service during the contract. Medium information availability means, there are available information regarding similar services, historical data, performance target and system maintenance cost. And for high information availability, more advanced and comprehensive information throughout product-service supply chain are available such as the data base of cost of spare parts and resource information for each activity.

Meanwhile, as mentioned in life-cycle of IPS^2 section, Datta and Roy defined life-cycle of integrated offering as three stages i.e. design, delivery and adaptation. By using the life-cycle stage as one of the decision parameters, it will be possible for company to bid only in particular stages of life-cycle. Hence, they will have more relevant cost information to bid in different stage of total offering life.

By connecting cost assessment framework for availability type service contract with different PSS categories, Datta and Roy also developed the mapping

cost model for PSS categories (Figure 12). In line with cost assessment framework for availability type of contract, the mapping cost model for PSS is using joint cost modelling as well. Different combination of product cost estimation techniques and service cost estimation techniques are proposed for different PSS categories. The mixed approach of cost assessments aims to avoid some disadvantages either from product cost estimation techniques or service cost estimation techniques. The model was developed by considering the key cost elements including recurring cost, non-recurring cost, overheads as well as the hidden cost (risk or uncertainty) in PSS environment. PSS business model thrives from pure product-oriented to result-oriented, the amount of hidden cost or risk in cost estimation will increase alongside the increasing number of service in PSS package. The basic idea of this model is to provide general guidance for PSS implementation which divided based on three main PSS categories.

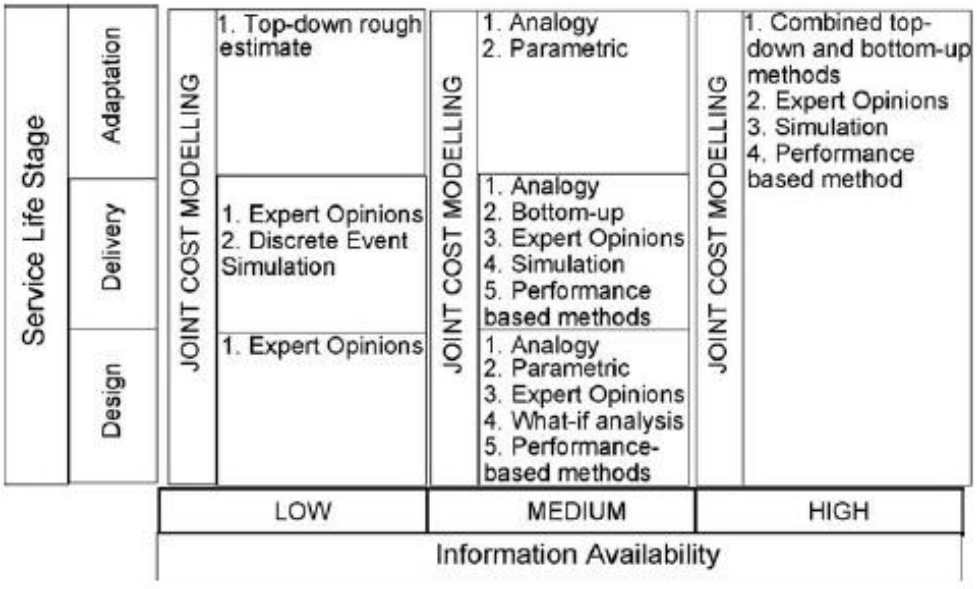

Figure 2 - Cost assessment framework for availability type service (source: Datta & Roy, 2010)

In general, both frameworks (cost assessment for availability-oriented IPS^2 and PSS) seem very clear, comprehensive and relevant with both IPS^2 and PSS business characteristics. The main issues of risks and uncertainties and whole life cycle of integrated offering, are considered within the frameworks. But in some points, particularly when it is recommended to use joint cost modelling, both framework will require a lot of efforts, in terms of time, cost and data available. To design and maintain this system it is needed high endeavor that could lead to company's suffering when it is faced with very rapid changes in market especially in today's global environment.

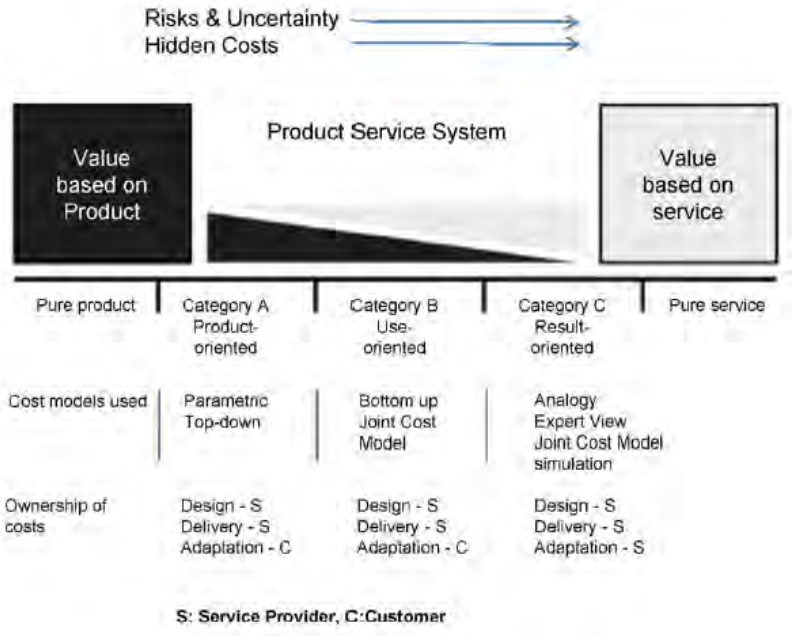

Figure 3 - The mapping cost models to PSS models (source: Datta & Roy, 2010)

4.2 Lean accounting

Lean principle or lean thinking was firstly introduced by Japanese scholars in 1977. This principle is extended version of just-in-time and Toyota Production System (TPS). Lean thinking in manufacturing company aims to make a "lean" production system by eliminating waste or anything which does not give value to the product throughout its production system. It gives emphasis in smooth material flow from raw materials until the product is completed. Since it was firstly

implemented in manufacturing company, lean thinking is really linked and associated to the lean manufacturing.

Nowadays, lean thinking could be seen as a mature field of study. There are abundant researches of this concept and its applications both in literature and practice. Lean thinking has been developed intensely and has been adopted widely. Some examples from lean extension application are lean in service industry, lean construction and lean value chain.

Lean thinking could not be considered only as a lean manufacturing. It has deeper meaning as a comprehensive way of thinking. Lean should be fully understood and adopted in overall company's activities including how it manages its business to deliver the real values for customer; how its products and services will be designed and produced (called value stream); and how it improves the flow of products and services through the value stream by eliminating non-value added activities (Maskell and Kennedy, 2007). Moreover, lean thinking has to be seen as business philosophy rather than a tool or technique for production system. Every element in a company is expected to think and act simultaneously to reach company's long-term objectives by implementing lean principle in every single aspect of company's business (Krijnen, 2007).

After widely recognized and gained attention in operational aspect, lean thinking is adopted in costing system, which is called lean accounting. (Maskell and Baggaley, 2006) define lean accounting as a new method to manage company's business which is built upon lean principles. It consists of a set of techniques for instance virtual performance measure, value stream mapping, target costing, box score as well as value stream costing. Furthermore, lean accounting is defined as a business management system, created based on lean thinking principles, and consists of several related tools in financial and operational measure that support company's continuous program as well as control at level of cell, value stream and company (Ruiz-de-Arbulo-Lopez, Fortuny-Santos et al., 2013).

In line with lean thinking in production system, lean accounting is designed to provide a real, timely and clear information to meet internal and external cost report requirement by eliminating waste from accounting process or unnecessary transactions or actions. Lean accounting will help to motivate internal

organization to continuously doing continuous improvement (Maskell and Kennedy, 2007). In detail, the aims of lean accounting are provide information to motivate internal organization towards lean transformation; reduce any activity or thing which does not give added value to accounting process and company and obviously support company's continuous programs. Lean accounting is used not only to know "how much does the product/service cost?" but "how could company improve the process to cut those costs?" (Ruiz-de-Arbulo-Lopez, Fortuny-Santos et al., 2013). Under lean principle, an accounting system is expected to give emphasis on the cost reduction. As mentioned earlier, lean accounting consists of a set of tools or methods. Figure 13 shows the primary method should be used to be successfully implemented lean accounting.

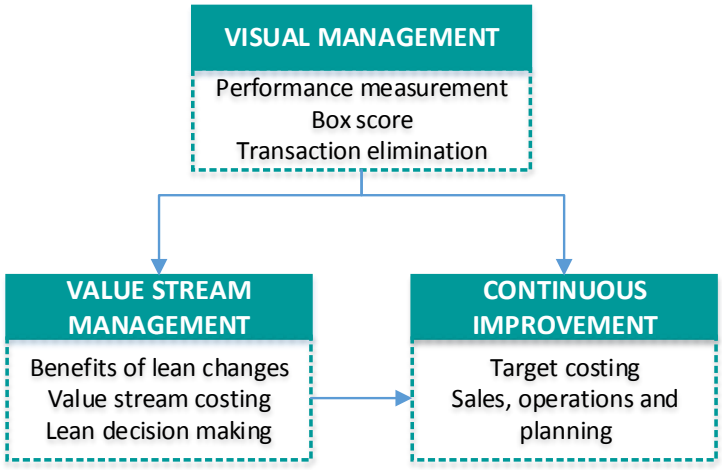

Figure 4 - Primary methods of lean accounting (source: Maskell and Kennedy, 2007)

Under lean accounting, the company's performance will be measured and displayed in a tool called the box score. The box score will present the company's performance into three-dimensional views, which are operational performance, capacity information and financial performance. This three comprehensive views will give broad understanding about the current and overall performance of value stream. The productivity of resources in value stream as well as the availability of capacity will be presented in capacity information view. By considering the box score, a company could deploy necessary actions should be carried out to improve

its internal performance both in value stream level and company level including what unnecessary transactions should be eliminated. Hence, this performance measurement, box score and transaction elimination is grouped as virtual management.

Value stream is a set of activities to design, produce and deliver the products or services. It gives detail information what resources will be absorbed to complete the production process and includes the information and material flows. Since, one of the main focus of lean thinking is to create the smooth flow of material, value stream is clearly important to be managed. Under value stream management, a cross-functional team will monitor the flow of product from material purchasing until the finished product is received by customer.

The implementation of new concept or improvement nearly infrequent gives direct significant impact to company, neither does lean principle. In short term, lean thinking could not reduce the cost of production or service provision very much. But by eliminating waste, a lean company will create a "new" capacity, which means another possibility to gain more revenues and profits. Traditional or current costing system will not be able to understand this condition. Instead of giving the relevant information about company's performance, it will provide misleading information which possibly lead to wrong conclusion that the transformation is giving the bad impacts rather than long-term benefits. Lean accounting is the only costing method which is able to give comprehensive view about the true benefit of new principle being adopted by company by its box score. The new availability capacity could be utilized by company to expand its business by designing new product, service or an integrated product-service offering as well as expanding the business in wider market (Maskell and Kennedy, 2007).

At the end, lean accounting will comprehensively motivate company to be in consistent tract to improve its organization. It gives information how organization's change and transformations affect the operational and financial performance (Ruiz-de-Arbulo-Lopez, Fortuny-Santos et al., 2013). (Maskell and Baggaley, 2006)

make comprehensive summary about principles, practices and tools of lean accounting as presented in Figure 14.

PRINCIPLES	PRACTICES	TOOLS OF LEAN ACCOUNTING
A. Lean & simple business accounting	1. Continuously eliminate waste from the transactions processes, reports, and other accounting methods	a. Value stream mapping; current & future state b. Kaizen (lean continuous improvement) c. PDCA problem solving
B. Accounting processes that support lean transformation	1. Management control & continuous improvement	a. Performance Measurement Linkage Chart; linking metrics for cell/process, value streams, plant & corporate reporting to the business strategy, target costs, and lean improvement b. Value stream performance boards containing break-through and continuous improvement projects c. Box scores showing value stream performance
	2. Cost management	a. Value stream costing b. Value stream income statements
	3. Customer & supplier value and cost management	a. Target costing
C. Clear & timely communication of information	1. Financial reporting	a. "Plain English" financial statements b. Simple, largely cash-based accounting
	2. Visual reporting of financial & non-financial performance measurements	a. Primary reporting using visual performance boards; division, plant, value stream, cell/process in production, product design, sales/marketing, administration, etc.
	3. Decision-making	a. Incremental cost & profitability analysis using value stream costing and box scores
D. Planning from a lean perspective	1. Planning & budgeting	a. Hoshin policy deployment b. Sales, operations, & financial planning (SOFP)
	2. Impact of lean improvement	a. Value stream cost and capacity analysis b. Current state & future state value stream maps c. Box scores showing operational, financial, and capacity changes from lean improvement. Plan for financial benefit from the lean changes
	3. Capital planning	a. Incremental impact of capital expenditure on value stream box-score. Often used with 3P approaches
	4. Invest in people	a. Performance measurements tracking continuous improvement participation, employee satisfaction, & cross-training b. Profit sharing
E. Strengthen internal accounting control	1. Internal control based on lean operational controls	a. Transaction elimination matrix b. Process maps showing controls and SOX risks
	2. Inventory valuation	a. Simple methods to value inventory without the requirement for perpetual inventory records and product costs can be used when the inventory is low and under visual control.

Figure 5 - Principles, practices and tools of lean accounting (source: Maskell and Baggaley, 2006)

4.2.1 Value Stream Costing

Value stream costing (VSC) is created based on value stream concept. It aims to capture all costs involving material, labor and any resources directly within value stream with little or no allocation. Distinct with traditional costing system, VSC uses an intermediate level of detail by focusing on a product family costing

which is produced in a value stream instead of an individual product. It encourages continuous improvement through combination of financial and non-financial performance measures (Maskell and Kennedy, 2007).

The costing is started with mapping the value stream of company's product or service. All necessary information on material flow and resources allocated to create, deliver and provide a product or service are mapped into a value stream map. This mapping process is called value stream mapping (VSM). During the mapping process, it will identify all resources (people, equipment, space) which will be used by the value stream. Since the costing process of lean accounting will be based on the value stream map, VSM is very important stage. The more relevant and reliable a value stream map, the more accurate the result of VSC will be.

In VSC, all the costs will be considered as direct cost and directly assigned to the cost object which is the value stream. This direct allocation is based on the fact that resources allocation are directly absorbed within the value stream to create and deliver values to customer.

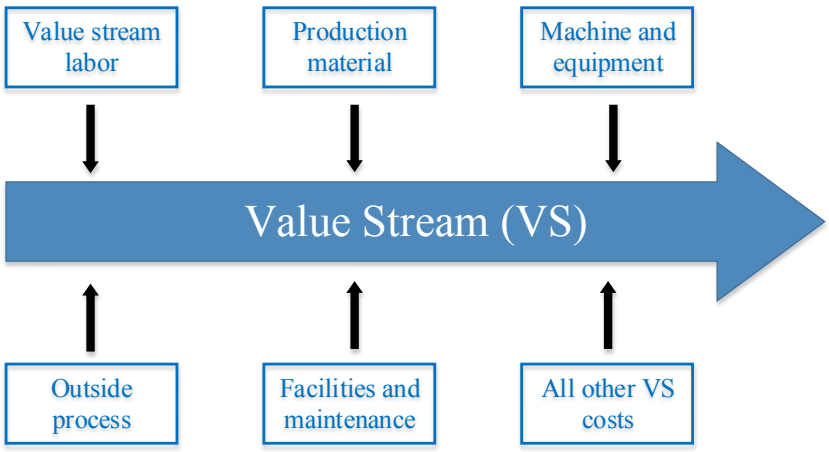

Figure 6 - Costs included in VSC (source: Maskell, Katko et al., 2007)

Ideally each resource will be assigned to a single value stream, but if this resource is used in several value streams, a simple allocation will be needed (Ward, Crute et al., 2003). Conversion costs are considered as fixed costs and material cost will be the main cost element for decision making. In very short-term, costs in VSC are generally fixed but in long-term it will be variable costs. Hence, classification of a cost whether it is fix or variable depend on the time frame being used (Ruiz-

de-Arbulo-Lopez, Fortuny-Santos et al., 2013). There are six cost elements which are mainly considered in VSC (Figure 15). The detailed description of each cost element will be presented in Table 5.

Table 1 – Description of cost structure in VSC (source: Maskell, Katko et al., 2007)

Cost structures in VSC	Description
Value stream labor	• This cost is based on the actual company's payroll for actual people who work in the value stream and has been defined in VSM • All labor of a VS are direct labor because their work contribute to overall VS performance
Production material	It is based on actual material used in VS or could be based on actual purchased/ issued materials to VS
Machine and equipment	• Depreciation expense of the machine with additional costs such as spare parts, repairs and suppliers. • If there are some machine used for more than one VS, this machine will be called as monuments. It will be necessary to allocate the cost among the affected value streams.
Outside process	If company uses outsourcing or vendor to support the VS performance, the relevant cost occurred on this strategy should be taken into consideration to VSC
Facilities and maintenance	• Consist of actual costs for instance rent/ lease, repair, maintenance for facilities • Since company's facilities or general maintenance in common do not belong to one VS only, simple allocation based on square space used could be implemented. For unused space, it will go to sales and marketing
All other VS costs/ support cost	It consists of the common indirect costs in traditional costing system such as supervisory, material scheduling and management, purchasing etc. This group of cost could be directly allocated to VS or using monument allocation

VSC is able to be a timely decision support tool because it is typically reported weekly. By using simple summary presented in simple "plain English" (shown in Figure 16), VSC offers good control and management of costs of up-to-date value stream condition. Furthermore, due to its simplicity the report of VSC is

understandable by everyone not only for financial people (Maskell and Kennedy, 2007).

VSC has strength over ABC by providing simpler report but still able to capture the cause-effect relationship as good as ABC system. Moreover, ABC obviously could not identify unutilized capacity while VSC successfully does. Thus, the combination of VSM and VSC mediates company in continuous improvement by presenting the operational and financial improvement (Ruiz-de-Arbulo-Lopez, Fortuny-Santos et al., 2013).

Lean Income Statement

	Period 1		*Period 2*	
Customer Sales	$998,977		$1,039,440	
Systems Sales	$1,002,466		$1,009,246	
TOTAL REVENUE	$2,001,443		$2,048,686	
Materials	$829,936	41%	$609,526	30%
Direct Labor	$305,767	15%	$312,984	15%
Support Labor	$340,245	17%	$342,421	17%
Machines	$113,862	6%	$116,550	6%
Outside process	$60,043	3%	$53,731	3%
Facilities	$40,250	2%	$41,200	2%
Other Costs	$12,009	0.6%	$9,664	0.5%
TOTAL COST	$1,702,112		$1,486,076	
GROSS PROFIT	$299,331	15%	$562,610	27%
Inventory Adjustment	($41,593)		($401,426)	
Corporate Allocations	$60,043		$61,461	
NET PROFIT	$197,695	10%	$99,723	5%

Figure 7 - Example of plain English report of VSC (source: Maskell and Kennedy, 2007)

In VSC, data or information needed to assess the cost are obtained at a higher level in the organization (value stream), unlike other costing systems that focus on individual product. Therefore, this costing system will eliminate unnecessary of complexity in costing process. This concept will fit to IPS[2]

organization since company is offering an integrated offering, not a single product or service. Moreover, it could lead to cost reduction in terms of human resource allocation. Because company implement simpler yet still reliable costing system, company will not need a lot of human resources to maintain a complicated costing system (data collection, allocation, reporting).

4.2.2 Value Stream Mapping

A value stream map shows the flow of materials and information in the whole manufacturing operations. It gives information of cycle time, downtime, inventories, and etc. (Hines and Rich, 1997) identifies seven tools to use in mapping a value stream (shown in Figure 17). Generally this seven mapping tools are generated from engineering field of study since the initial lean principle was developed and implemented in manufacturing industry.

The distinguishing characteristics among mapping tools are not only because of the different steps to map the value stream, but also because each tool is developed to address different types of wastes. Thus, every tool has different degree of correlation and usefulness to address different waste in production system.

Mapping tool	Origin of mapping tool
(1) Process activity mapping	Industrial engineering
(2) Supply chain response matrix	Time compression/logistics
(3) Production variety funnel	Operations management
(4) Quality filter mapping	New tool
(5) Demand amplification mapping	Systems dynamics
(6) Decision point analysis	Efficient consumer response/logistics
(7) Physical structure mapping	New tool

Figure 8 - Seven tools of value steam mapping and its origin (source: Hines and Rich, 1997)

It is clearly mentioned that there are seven wastes or *muda*, the Japanese term for wastes, in production system as defined 1) overproduction, 2) waiting, 3) transport, 4) inappropriate processing, 5) unnecessary inventory, 6) unnecessary motion and 7) defects. The detail degree of correlation matrix between mapping

tools and wastes is presented in Figure 18. In order to give the understanding of the seven mapping tools proposed by (Hines and Rich, 1997), Table 6 presents the brief description for each tool.

	Mapping tool						
Wastes/structure	Process activity mapping	Supply chain response matrix	Production variety funnel	Quality filter mapping	Demand amplification mapping	Decision point analysis	Physical structure (a) volume (b) value
Overproduction	L	M		L	M	M	
Waiting	H	H	L		M	M	
Transport	H						L
Inappropriate processing	H		M	L		L	
Unnecessary inventory	M	H	M		H	M	L
Unnecessary motion	H	L					
Defects	L			H			
Overall structure	L	L	M	L	H	M	H

Notes: H =High correlation and usefulness
M = Medium correlation and usefulness
L = Low correlation and usefulness

Figure 9 - Mapping tools & its degree of correlation (source: Hines and Rich, 1997)

Since those seven tools are designed to address the requirement to map the production process, it seems those approaches are not really appropriate to be applied in service by considering the difference characteristic between product and service. Hence, (Bonaccorsi, Carmignani et al., 2011) propose the simple method to map the value stream of service industry.

Table 2 - The seven mapping tools for product value stream and its description (based on: Hines and Rich, 1997)

Mapping Tools	Brief Description
Process activity mapping	The general steps to undertake process activity mapping are 1) study the flow of processes, 2) identify waste of the process by referring to the seven wastes of lean production, 3) rearrange the flow of processes to be more efficient by involving the possibility usage of different flow layout and transport routing 4) analysis each current process whether it is really needed and the consequence if a particular task or process being removed
Supply chain response matrix	This approach is aim to picture the critical constraint of lead-time for each process. The required lead time is the cumulative lead time from supplier and distributor.
Production variety funnel	This tool is similar with IVAT analysis method which divided company's internal operation based on I, V, A, or T shapes. "I" plant refers to a plant with the same production line to produce various similar product such as chemical manufacturing plant "V" plant is a production plant which uses very limited number of raw material but able to product high variety of products such as textile industry "A" plant is the opposite of "V" plant, when there are various raw material being processed in different value streams to produce very limited product, such as aerospace industry "T" plant refers to the assembly-to-order system where company has a lot of product combinations from similar components (part module).
Quality filter mapping	This mapping approach is used to identify what and where the problem of quality occurred in company's supply chain. There are three types of quality problems i.e. product defect, service defect and internal scrap. Those defects will be mapped latitudinal throughout the supply chain
Demand amplification mapping	Demand amplification mapping will present how demand is changing throughout the supply chain in different time buckets
Decision point analysis	This tool will picture where the decision point of company's supply chain is. The decision point means a point where company stops to produce its products by considering the actual demand not only based on the forecasts
Physical structure	Using this tool, company is able to show its structure based on the tiers in upper stream (supplier) area and downstream (distributor) area with assemble at the middle point

Fundamentally this method is used Pareto chart principle to portray the sequence task undertaken to provide service but using the specific icon which relevant. The standard icon for service value stream is shown in Figure 19. Furthermore, the identified wastes in service provision is obviously different with the production waste. This fact is happened due to the difference nature of service compared with product. Instead of seven, there are ten types of waste in service provision which is detailed explained in Table 7.

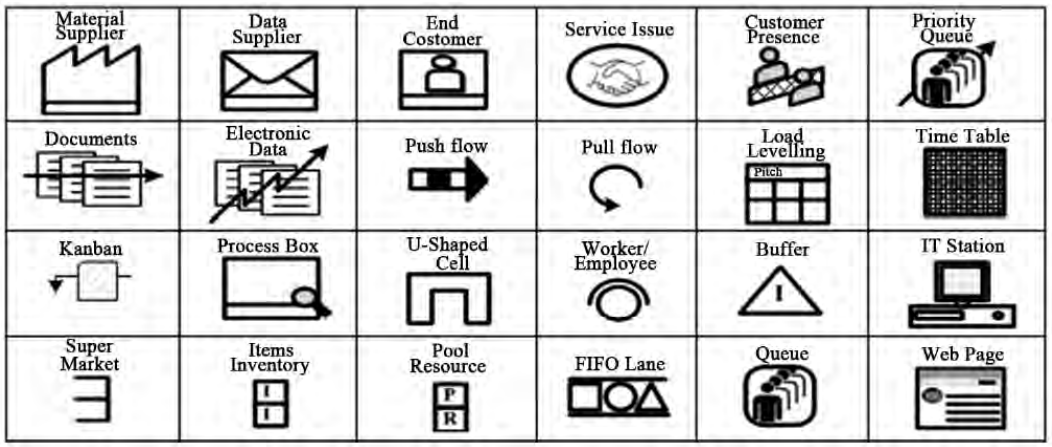

Figure 10 - The standard icon for service value stream (based on: Bonaccorsi, Carmignani et al., 2011)

4.2.3 Continuous Improvement in Lean Thinking and PSS/ IPS^2 Concept

Why continuous improvement does matter in today's business is surely related to the more competitive market. As increasing knowledge, technology awareness as well as the accessibility of information, customers become more demanding of company offers. Competition is no longer only based on the quality and price but has been extended to customization, flexibility, and responsiveness. A standalone physical product is no longer sufficient solution for customer's problem. Customers give more value to the overall solution which provide the good experience of product and/or service provided by company. Moreover, competition becomes much more difficult when rapid changing is taken into account. Doing business as usual is clearly an action of self-destruction. There is only one way to keep survive which is to be flexible, adaptable and innovative organization by doing continuous improvement.

Some new concepts or strategies are identified and proposed to address the recent competition. PSS/ IPS^2 and lean transformation are two of them. Even though the two concepts take different angle of improvement, both concepts have the same ultimate goal which brings company to be more competitive and finally obtain the higher and sustain profits. When PSS is trying to include more services in company's offer, lean transformation is trying to eliminate anything which does not give any value to customer. Both concept is not contradictory and has possibility to be combined.

As a more mature concept, lean has been explored, developed and implemented in wide range of application. Lean as the way of thinking has been adopted in various field of study outside its origin, manufacturing, including lean accounting. But in contract, there are still some parts of PSS/ IPS^2 have not been given enough attention yet, including accounting or cost dimension.

Table 3 - Types of wastes in service (source: Bonaccorsi, Carmignani et al., 2011)

Types of Waste in Service	Example
Defects	Data entry errors; Lost files; Lost or damages goods;
Duplication	Data re-entering; Multiple signatures; Unnecessary reporting; Multiple queries;
Incorrect Inventory	Stock out; Wasting time finding what was needed; Unnecessary copies;
Lack of customer's focus	Unfriendliness; Rudeness; Poor attention to the customer;
Overproduction	Reports no one will ever read; Processing paperwork before time;
Unclear communication	Incorrect information; Lack of standard data format; Unclear work flow;
Motion/Transportation	Poor layout; Ineffective filing; Poor ergonomic;
Underutilized Employees	Inadequate tools; Excessive bureaucracy; Limited authority;
Variation	Lack of procedures; Lack of standard formats; Standard time not defined;
Waiting/Delay	Waiting for approvals; Downtime; Waiting for supplies;

In principle, lean accounting is itself lean with low number of wastes. Companies who is using lean accounting would have better information to support the decision making processes. Its report is simple, timely and more important is understandable by everyone thus financial impact of company's improvement will be understood by every level in company. At the end, it would motivate internal organization to improve more. Furthermore, lean accounting drive the transformation company's business to more focus on creating and providing more values to customer (Maskell and Kennedy, 2007).

4.3 Summary

The first framework presented in this chapter is cost assessment framework for IPS^2 availability type contract proposed by (Datta and Roy, 2010). The frameworks is the most recent, important and relevant research of cost assessment in IPS^2 environment. This research finding gives basic understanding about the cost structures occurred in IPS^2 environment and its behavior. Not only that, their comprehensive research also successfully identifies the important issues which influence both company offerings and its costs. By considering their research scope which is one tier above of function-oriented business model and the complexity to implement their proposed framework, it seems obvious that their framework could not be directly adopted to function-oriented business model. But the relevant findings related to general characters of IPS^2 environment will be used in this research, such as cost structures in IPS^2 companies and external drivers which affect company's total offering.

The conclusion why lean accounting as the existing costing system is suitable to be adopted and adjusted for function-oriented business model is based on some following facts. Lean accounting with all its benefits could mediate and motivate people toward lean transformation by continuously doing improvement. In line with that, to be an IPS^2 provider is also a long and tough journey that required consistent improvement. Furthermore, to be successfully implemented pull system throughout its supply chain, a company should has an open and strong relationship with its suppliers and customers in order to maintain good flow of materials and products. This principle also exists in IPS^2 business model, an IPS^2 provider is

required to have strong relationship with its supplier and customer to facilitate not only flow of materials and products but also services and information that strengthen its mutual relationship and deliver more values to customer. Those similarities between lean transformation and *servitization* could be basis to decide that lean accounting is acceptable method to be adjusted into cost assessment framework for IPS^2 environment, particularly function-oriented business model.

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CHAPTER 5
NEW COST ASSESSMENT FRAMEWORK

This chapter will present the new cost assessment framework built based on the research findings from the intensive literature review in area of cost dimension in IPS^2 function-oriented business model.

5.1 New Costing System Requirements

A function-oriented model is the first continuum in *servitization* of industrial company. Product is the main center but IPS^2 provider includes product related services, for instance advisory services, planning services and technical services to guarantee product's functionality and durability during the product life cycle. In this type of business, contract agreement is really important issue. All information about what product related services should be performed, in what condition they will be performed, service level desired to be achieved by IPS^2 provider, price and any related term and condition to manage the relation between IPS^2 provider and customer will be described in the customer and company's agreement.

The common practice of function-oriented business model in contract form is maintenance contract both annually or during the whole time of product's usage. Generally, maintenance contract uses condition based maintenance (CBM) principle. Maintenance services will be provided if there are indicators show the functionality of products is decreasing.

In another case, an IPS^2 function-oriented company could offer an integrated products and services not as a long-term contract but as simple PSS package. Rather than offering the supporting services during the whole product life-cycle, an IPS^2 provider could be able to offer a simple total offering which consists of physical product and a certain services. For instance the combination of the physical product with single supporting service such as installation service, configuration service or upgrade service. The service package could vary from the simpler and single service to more complex and finally a long-term contract

relationship. In common, IPS^2 provider will provide the list of all offerings with respective prices in its catalogue.

The simple PSS package is obviously easier to be managed than long-term contract because risks and uncertainties could be reduced when the company only needs to provide particular service which is known for sure when it should be provided. This package is also suitable for the new customer who starts to build the trust with IPS^2 provider. In terms of cost, this package is easier to be assessed.

In any kinds of integrated offering, a good flow of information and knowledge exchanges among the IPS^2 parties surely plays really important role. If CBM is applied in maintenance contract, customer should give comprehensive and open information how its product condition is, how the product is used so far and so forth. A good cooperation from customer will help IPS^2 provider to provide the appropriate maintenance actions in terms of procedure and time. At the end customer could experience high degree of product utilization (Azevedo and Sholihah, 2015a).

The same condition will be valid in simpler PSS offering. The willingness of customer to share product condition and their cooperation throughout the service provision will affect the quality of services. In IPS^2 offering, participation and cooperation of customer will directly influence the successful of value delivery and at the end their own satisfaction.

(Wilkinson, Dainty et al., 2009a) explain the detailed operational characters of PSS product-oriented business model (Table 8). Since the major difference between PSS and IPS^2 laid only their customer, those operational characters could be adopted to be the operational characters of IPS^2 function-oriented.

Taking into consideration all those characters, generally IPS^2 function-oriented is relatively doing similar business with pure manufacturing company, since product is the main focus. But the inclusion of services into company's offerings brings the new challenge internally and externally for company. Service itself has different nature with product and the combination of product and service will bring the whole new experience for company internal business.

Table 1 - Operational character of product-oriented PSS (Source: Wilkinson, Dainty et al., 2009a)

Unit of analysis	Product-oriented PSS operations
Characteristics of operations: structural	
Process and technology	Tend to use various technologies through their operations to obtain high degree of efficiency in the production and effectiveness in service provision
Capacity	Operate different levels of capacity utilization due to various demand from customers
Facilities	Implement the combination of centralized manufacture and multiple field facilities
Supply chain positioning	Keep the vertical integration strategy in production but work closely with integrated partners to provide services
Planning and control	Focus in optimizing the product availability
Characteristics of operations: infrastructural	
Human resources	Has the employees who has good product knowledge and capable to develop relationship both with suppliers and customers
Quality control	Use product quality assurance methods and customer satisfaction evaluation
Product/service range	Has limited combination of supporting services. Supporting service is around maintenance service since product remain the focus
New product/service introduction	Use centralized capabilities to design product and consider certain amount of maintenance and relevant services which give co-creation value for customer
Performance measurement	The performance indicators which used are product availability, degree of responsiveness and customer satisfaction level
Supplier relations	In order to obtain cost effective flexibility in the whole supply, company integrate internal and external supply chains.
Customer relations	Tend to have strong relationship with customer due to high degree of interactions to provide product availability and functionality

At the end, it could be summarized that the specific characters of IPS^2 function-oriented should be addressed in designing the more appropriate cost assessment are:

- Have good information flow and knowledge exchange among supply chain actors

- Have strong partnership among supplier, IPS^2 provider and customer
- There are uncertainties and risk sharing between IPS^2 provider and customer due to services provision to maintain the product functionality during product life-cycle
- Company is dealing with long-term transformation to be more *servitized* company which required a lot of changes in overall internal organization
- To be flexible and adaptable to competitive market is one of company's main goals
- In terms of costing system, IPS^2 companies need simple but comprehensive and acceptable method. The costing system should support company's transformation rather than too complex and incriminating company

In contract, in general there are a lot new IPS^2 companies remain using traditional costing that not only give more emphasize in cost of physical product but also contradiction with servitization principle. (Maskell and Kennedy, 2007) identify comprehensive contradictions between the traditional costing system with IPS^2 concept (Table 9). The implementation of traditional costing is considered as disoriented action because it will not support company to be a successful IPS^2 provider.

Table 2 – Contradiction between traditional costing systems with IPS^2 concept (based on: Maskell and Kennedy, 2007)

Main Issue	Explanation
The wrong measurement	• The measurement of actual labour hours compared to standard hours, machine utilization and adsorption of overhead only drive company to produce more inventories, whereas the focus of IPS^2 companies is no longer the high number of physical products but more in good quality of product combined with service to provide more values to customer • Traditional costing still emphasize the maximization usage of individual resources while in IPS^2 concept, company is not only optimizing its resource utilization but also maximizing the flow of material, information and cast to obtain higher profitability

The wrong cost	Only focus on calculation of individual product cost which then be used as information base to take decision such as inventory evaluation or pricing. In IPS2 environment, individual cost is not comprehensive enough to be used as basis for decision making. It is required cost of product families and service families to identify the best combination for integrated offering
Understandable information	Financial information presented is not easy to understand by all people in company, which could compound fast decision making
Complex system	The need to collect, report and compare actual cost with standard costs bring high difficulties

Considering those facts, new costing system framework is clearly needed for IPS^2 function-oriented companies. The current costing system used, commonly is traditional costing system, is not comprehensive and relevant any more to estimate IPS^2 offering. It does not support and mediate company to successfully undertake IPS^2 concept. Hence, the following work will present the proposed framework of IPS^2 cost estimation as part of cost management methodology for IPS^2 environment.

5.2 New Cost Assessment Framework for IPS^2 Function-Oriented Business Model

The proposed cost assessment framework for IPS^2 function-oriented is based on cost estimation technique for availability type contract proposed by (Datta and Roy, 2010) and lean accounting explored by (Ruiz-de-Arbulo-Lopez, Fortuny-Santos et al., 2013) and considering the IPS^2 delivery and use framework by (Meier, Roy et al., 2010). The proposed framework is shown in Figure 20 and the following section will present the detailed description about the proposed framework.

5.2.1 Company's Value Creation Architecture

Cost as dependent factor is the result of all company's efforts to deliver values to customer either by producing and delivering products or preparing and providing services. Since the company is doing transformation from product-oriented producer becomes a product and service-oriented producer, company has to identify and design what offerings which will give the highest possible values

for its customer and how to do it, what processes is needed and what resources will be assigned to execute it. Company's value creation architecture is the first consideration in assessing the cost of an IPS^2 company because it is the basis of company's business process.

The general goals of being IPS^2 provider is to be more competitive in tight market and finally obtain the sustainable profits. To achieve those goals, IPS^2 provider tries to always offer and fulfil customer needs and requirements. The organization challenges lay within the fact that the company's resources are limited while external environments are very dynamic. This facts lead to conclusion that external drivers and internal capacities are important considerations in IPS^2 value creation architecture and indirectly will affect the cost structure of company.

The various external drivers which influence IPS^2 provider to define what the best offerings for customer are identified as global competition, technology development, environmental sustainability issues and customer affordability. External drivers will give an overview for company what opportunities and challenges exist in external environment. IPS^2 value creation architecture shows the ability and flexibility of IPS^2 provider to compete in dynamic market (Meier, Völker et al., 2008).

In another hand, internal capabilities precisely could be the obstacles. In some points, company's internal capabilities are limited and unable to benefit all external opportunities. Hence, an IPS^2 provider should have the robust and reliable internal capabilities which include informatics, socio-technical system, organizational structure, service network, co-creation value and innovation (Datta and Roy, 2010).

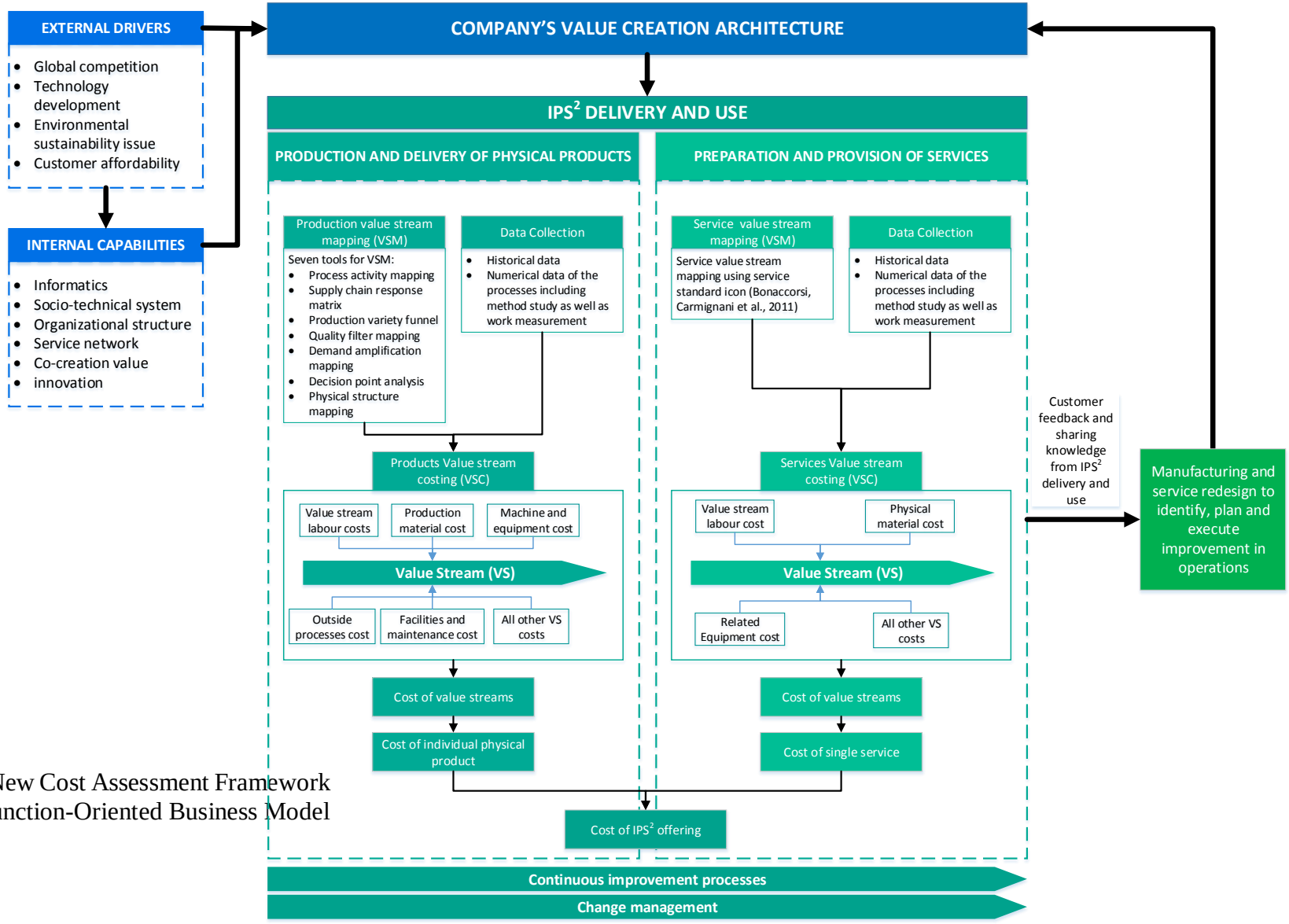

Figure 1 - New Cost Assessment Framework for IPS2 Function-Oriented Business Model

5.2.2 IPS^2 Delivery and Use

IPS^2 delivery and use is a stage where company implements its value creation architecture, the operational activities which cover all company's business processes. Since this research is focus on the cost dimension of an IPS^2 company particularly for function-oriented business model, the explanation will focus on the costing aspect and does not intend to explore what the production and service procedures of company.

In the proposed cost assessment framework (Figure 20), it is identified the main processes which generate or influence costs of an IPS^2 company are production and delivery of physical product, preparation and provision of services, continuous improvement processes, and change management.

Continuous improvement processes should be an important issue in an IPS^2 company. By doing continuous improvement company is expected to be more efficient and effective in its overall activities which can lead to cost reduction. Improvement could be done in wide aspect in company's business, for instance: company's production process, service provision process, human resource management and even in accounting itself. This continuous improvement could be done by various management tools from lean principle which have been mentioned in previous chapter such as quality management, box score and so forth.

In meanwhile, the most challenging to be an IPS^2 provider is organization transformation. How company changes, how company adjusts its internal organization to be more suitable with IPS^2 strategy and how this transformation should be managed. Change management has been one vital issue in IPS^2 transformation. Different with continues improvement process which has potential impact as a driver for cost reduction, change management will require a lot of efforts and in general very costly. Change management is a potential cost generator since preparing internal organization, for instance company's mind set and human resources ability, is no doubt a challenging job. Thus, continuous improvement processes and change management are important aspects to be included in cost assessment framework for an IPS^2 company.

In this framework, the calculation of production process and service provision are calculated as separated processes. It is considering the fact that in function-oriented business model, company could offer only pure product, only additional service, or the integrated product and service. By separating the assessment process, the framework could be applied in any condition of company's offering. In principle, either cost of product or cost of service will be calculated in similar sequence processes based on the lean accounting principle. But there are some differences in those processes that will be further explored in next section.

5.2.2.1 Production and Delivery of Physical Product

Cost of production and delivery of physical product will be assessed using the value stream costing. Value stream costing uses value stream map as the basis model to identify costs which occur throughout the value stream. In line with this fact, value stream mapping is surely important process because the more accurate value stream map, the more accurate value stream costing will be. There are seven tools to map the company's value stream with different degree of accuracy and relevancy as mentioned in section 3.3.2. Different company could use different mapping tool since each company has different characteristic to be considered.

(Hines and Rich, 1997) identify a specific method to determine the most appropriate mapping tool in certain circumstance, which is called value stream analysis tool (VALSAT). This method is summarized in diagram as shown in Table 10. The following steps will describe VALSAT in detail.

1. Identify company's production processes
2. Identify the possible various wastes of production processes which are believe could be reduced or removed (Colom A). This identification could be based on the identified seven wastes of production process in lean principle by adding one structure which is overall wastes
3. Colom B is the seven available mapping tools. Referring to Figure 18, the degree of correlation of each mapping tools against each wastes should be converted to point. Low correlation will be given one point, medium correlation will be given three points and nine points for high correlation.

4. Colom D should be filled with the information about the wastes which the competitor could be handle the best. This requirement could lead to formal benchmarking.
5. Weighting process is done by allocating the 40 points for the eight wastes/ structures. Company's manager could give the weigh based on the degree of importance. The more importance a waste, it will be given the higher point but the maximum point for each structure is 10 points
6. Colom C is obtained by multiplying weight of each structure with its respective correlation point
7. Tool with the highest total weight will be selected to map the value steam of company's production processes.

(Ruiz-de-Arbulo-Lopez, Fortuny-Santos et al., 2013) give a good example of how a VSM (Figure 22) is made based on its description of tasks and times for the assembly process of one manufacturing company (Figure 21). Beside value stream map, data collection will be another input to assess the cost of value stream. Data collection for historical data and any related numerical data of the processes including method study as well as work measurement should be done prior VSC process.

Table 3 – Supporting tool of VALSAT

		Tools	
Wastes/ Structure	Weight	[B]	Competitor Analysis
[A]	[E]	[C]	[D]
	Total Weight	[F]	

There are six cost structures which are considered in VSC. Those costs are labour cost, material cost, machine and equipment cost, outside process cost, facilities and maintenance cost and all other value stream costs. The detailed description of each cost have been presented in Table 5. All the costs are considered as direct cost and directly allocated to the cost of value stream. Cost of a single product then can be determined as accumulative cost of all value streams used to produce that product.

Process name	POS terminal model A No.	Description of task	Type U/L	Type P/N	Time per unit (s)	People in workstation	Cycle time (s)
ALP	10	Deliver screens to the work table	L	N	5	1	181
	11	Print stickers + clean the LCD screen	U	P	116		
	12	Deliver screens to the ALC process	L	N	0		
ALC	20	Carry glasses from the warehouse	L	N	10		
	21	Clean the protective glass	U	P	40		
	22	Take the glasses to EM	L	N	10		
Total LPC (ALP + ALC)					181		
EM	30	Mounting the base	U	P	–	1	375
	31	Mounting tablet	U	P	375		
	32	Putting tablet on base	U	P	–		
	33	Putting SATO logo on the base	U	P	–		
	34	Tablet final test	U	P	570	1	570
	35	Mounting the bezel frame	U	P	220	1	580
	36	Mounting the shaft of the bezel frame	U	P	180		
	37	Placing SATO logo on the wedge	U	P	180		
	38	Mounting the completed unit (tablet-bezel-wedge)	U	P	840	1	857
	39	Putting the pack logo on the assembled POS	U	P	5		
	40	Placing the assembled POS onto trolleys	U	P	12		
	41	Trolleys with POS to TM mounting	L	N	0		
Total EM					2,382		
TM	50	Screening test	U	P	360	1	762
	51	Running test	U	P	30		
	52	Final machine testing	U	P	360		
	53	Place POS in trolley	U	P	12		
	54	Trolleys with POS to the quality control department	L	N	0		
Total TM					762		
CCM	60	Quality control of machine functioning	U	P	30	1	162
	61	Quality inspection of the machine	U	P	60		
	62	Final check	U	P	60		
	63	Place machine in trolley	U	P	12		
	64	Trolleys to the packing area	L	N	0		
Total CCM					162		
PA	70	Packing and sealing the machine	U	P	120	1	200
	71	Place packaged machine onto pallet	U	P	30		
	72	Take pallet to finished product storage area	L	N	50		
Total PA					200		
Total processing time					3,687		

Notes: U – one-piece flow; L – in batches; P – productive; N – non-productive (transport or wait)

Figure 2 - Description of tasks and times for the assembly process of one manufacturing company (source: Ruiz-de-Arbulo-Lopez, Fortuny-Santos et al., 2013)

5.2.2.2 Preparation and Provision of Services

Cost of service will be calculated through the similar sequence of processes. The main differences with product cost lay in the value stream mapping process and the cost structures of service value stream. Service value stream is mapped by using standard icon for service which has been shown in Figure 19. Whilst relevant cost structures of service value stream are labour cost, physical material cost, cost of related equipment being used during service provision and other value stream costs for instance transportation cost for on-side technician.

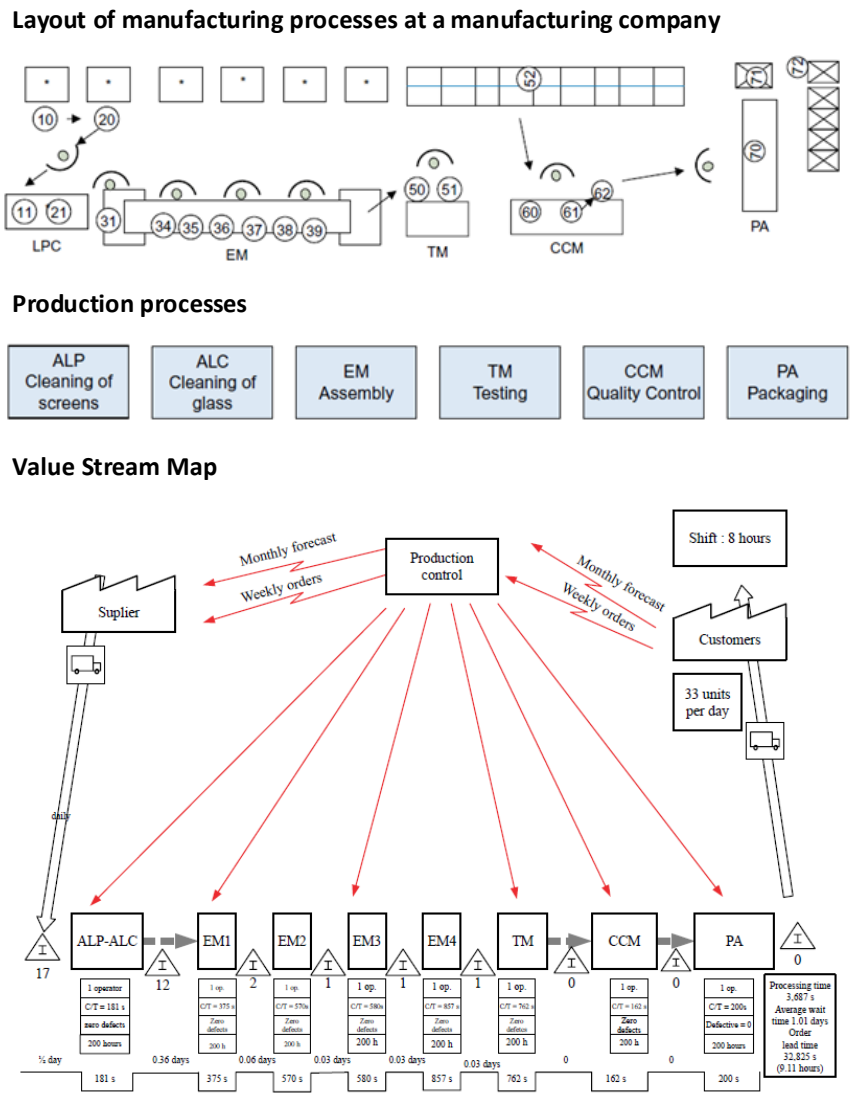

Figure 3 – Value stream map for assembly process of one manufacturing company (source: Ruiz-de-Arbulo-Lopez, Fortuny-Santos et al., 2013)

Finally cost of IPS^2 offering is accumulation of cost of physical product and cost of services.

The execution of company's value creation architecture with IPS^2 delivery and use will bring another benefit due to customer feedback and sharing knowledge. This sharing knowledge could be an input to undertake manufacturing and service redesign to identify, plan and execute improvement in operations as well as the structure of new offering. At the end, cost assessment for an IPS^2 company is not seen as separate issue in company but as coherent proses including company value creation and organization transformation.

5.3 Summary

The new cost assessment framework presented in this chapter was created based on the lean accounting with its value stream costing (VSC) which has been adjusted to meet IPS^2 characteristics. Through this framework it is shown that costing system within IPS^2 organization is a coherent aspect with company's value creation architecture and company's transformation which could not be separated. Cost is obviously one important information for company's decision making but complicated costing system which does not support company's transformation to be a successful IPS^2 provider is not a good option. By adopting lean accounting with its direct allocation, IPS^2 provider could trace the real costs to offer the integrated offerings and support the organizational transformation.

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CHAPTER 6
CASE STUDY ANALYSIS

In this chapter, a case study analysis would be presented. The main purpose of doing a case study analysis is to gain information and knowledge from the real practices how IPS^2 companies provide the integrated product and service offerings as well as their cost assessment process. All the insights gained from this research stage will be synthesized into practical findings and will be used to revise the proposed cost assessment framework to be more suitable not only in term of theoretical study but also in real industry practice.

6.1 Company and Business Context

Case study analysis is conducted in two IPS^2 function-oriented companies from machine-builder manufacturing industry in Portugal. The two companies is selected because they are the real practices of IPS^2 function-oriented business model as the research scope of this work.

6.1.1 Company A

Company A is categorized as machine builder manufacturing company which has specialization to design, product, install, maintenance and repair industrial plant and equipment. Founded in 1994, this company is specialized in fields of industrial automation and mechanical engineering in Portugal, which continuously involves services in its offering to provide more values to customer.

The Company A's vision is to grow in a sustained way and in the long-term, acting as a lead partner for multinational companies. And its mission is to offer engineered solutions, automated equipment and maintenance services for distribution lines, using the latest technologies available, to industrial customers on a global scale, aiming to optimize its production and/ or logistics processes. It is a multinational company which already reached the global market in 30 countries. Their main products are including industrial conveyors, robot arms, industrial automation, until supervisor and control system.

6.1.2 Company B

Company B is a machine builder manufacturing company in Portugal with niche market. This company produces the production machines or equipment specialize for cork industry. Founded in 1964 makes this company as a leader in proving overall solution in cork processing in its whole supply chain start from cork preparation process until it become the finished good product. Company A has mission to conceive, develop and deliver technological solutions for the cork production or transformation industry. Its vision is to be recognized as a technology excellence center by its target market. Even its target market is very specific, this company has been recognized as a world-wide company with 50% of its sales is international market. Company A always tries to develop its business in a wider perspective both in its market and product perspective in order to be a leader in several segment as following:

- Cork stoppers manufacture (natural, technical and agglomerated stoppers)
- Surface printing
- Surface treatment
- Counting and packaging
- Visual inspection of surface quality
- Specific solutions for laboratories

6.2 Integrated Product-Service Offering

From information gained in interview from both companies, companies are mainly selling three types of offering which are pure product offering, separate service offering and integrated product-service offering. The integrated product-service offering could be defined into two condition:

- The first one, company provide an overall solution for customer to build a new facilities in customer's plant. In this offering, company's job description is including engineering design of new layout until the required product already installed in customer's plant. Figure 23 gives brief overview how company provide this kind of offering

- The second type of integrated offering is when customer buy a new product with additional services for instance installation service, upgrading service or so forth

In theoretical study, IPS^2 is always refer to service contract which help customer to maintain their product functionality during period of contract time. Not all IPS^2 company provides this type of contract offering. In this case study, Company A provides the annual maintenance contract but Company B does not offer it.

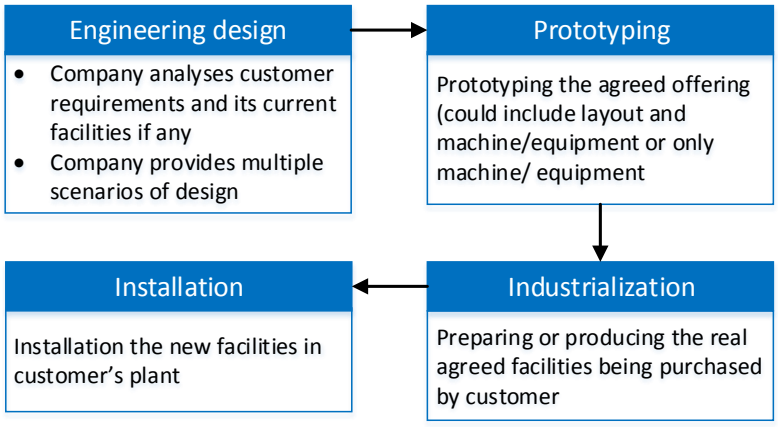

Figure 1 - General steps of company's integrated offering

Considering its customer behavior, Company B does not want to offer maintenance contract during period of time since its customer prefer to do corrective maintenance and pay based on that action instead of buying maintenance contract. Before assessing the cost of corrective maintenance of particular machine or equipment, Company B will ask customer to fill the maintenance form which consists of machine information for instance machine type, the usage age and machine detailed condition.

During this case study, the types of services that possible to be performed is validated. Form the real practice, services could be offered as separate offering, add-ons for product purchasing or as a bundle of overall solution. Figure 24 present the types of services involved in IPS^2 function-oriented business model from real practice.

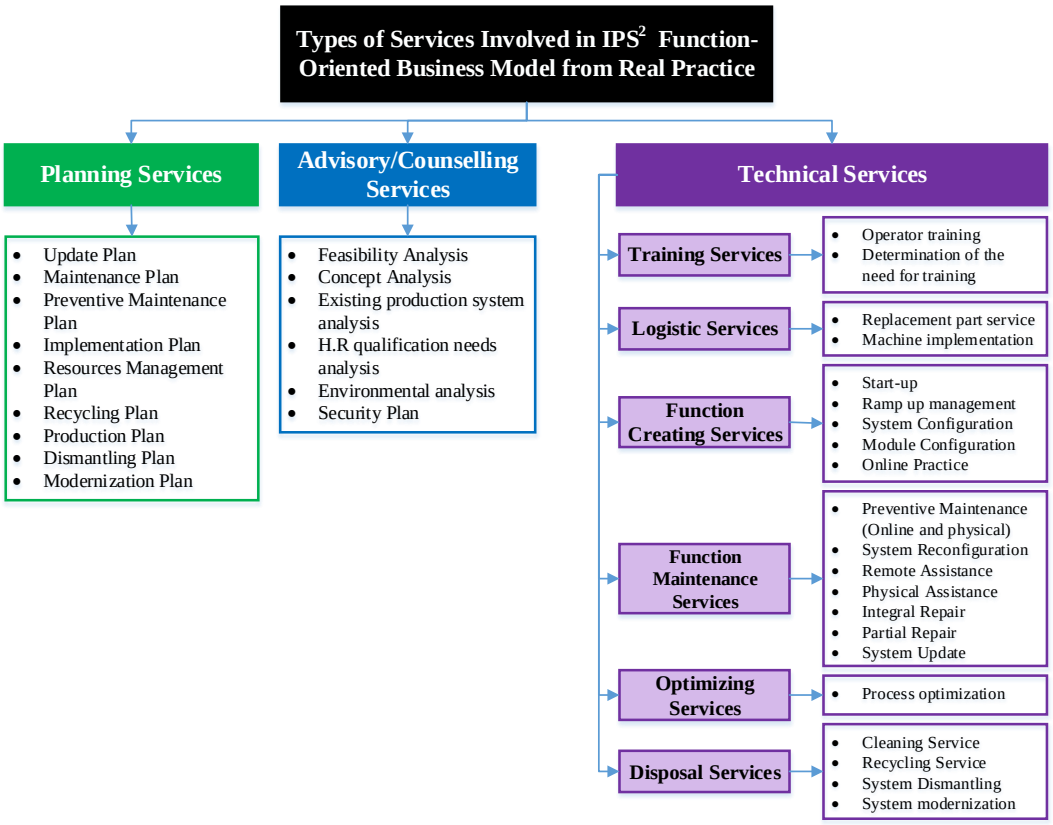

Figure 2 - Types of services involved in IPS^2 function-oriented business model from the real practice

From three main service categories, technical services has important role to generate more revenues and profits for company, particularly logistic services, function creating services and function maintenance services. Thus, company tends to focus in developing and offering this type of services.

6.3 Cost Management System

Both companies are using standard cost to calculate the cost of its offering. Data base of standard cost for every material, component and labor cost are stored

and managed in a financial data base based on spreadsheet. This data base would be updated in relative short period of time such as twice a year.

Based on the case study analysis, herewith the cost structure identified in product, service and integrated offering which is shown in Figure 25. Based on this finding the relevant cost structure in IPS^2 function-oriented company is revised and presented in Figure 26.

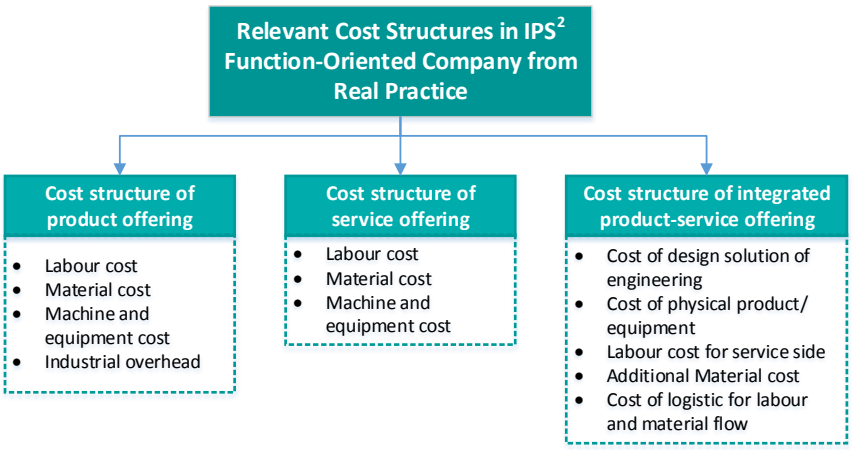

Figure 4 - The cost structure identified in product, service and integrated offering from real practice

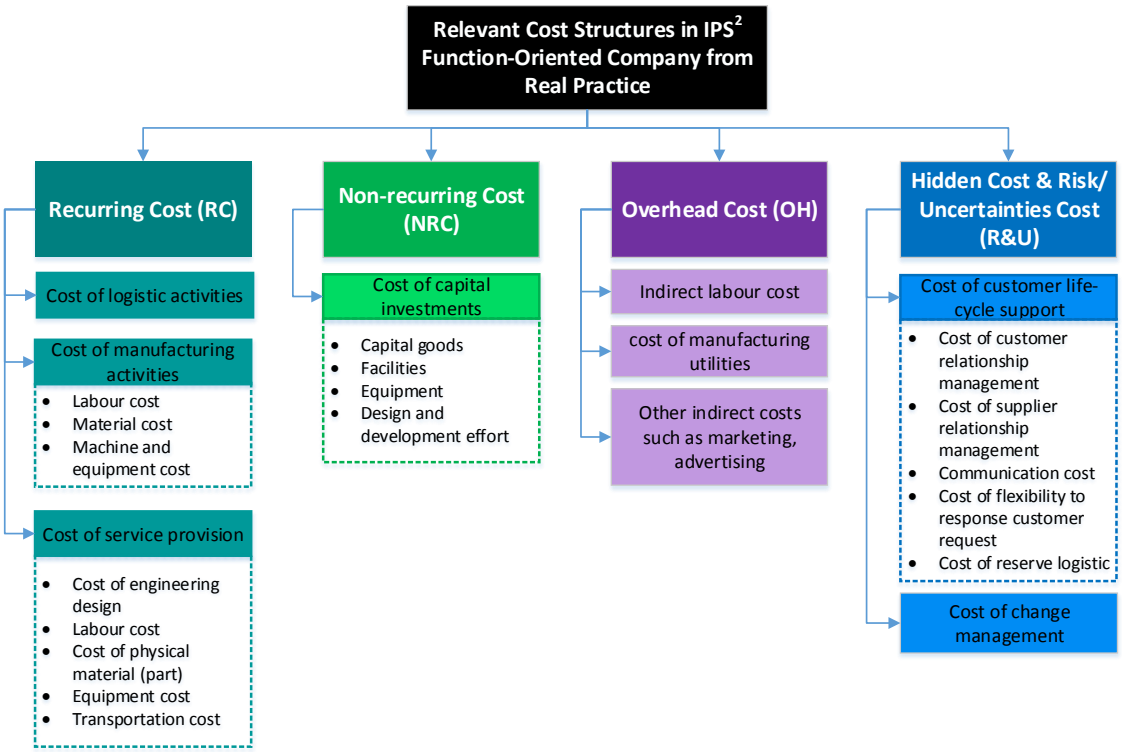

Figure 3 - The relevant cost structure in IPS2 function-oriented company from real practice

6.4 The Real Challenges to be an IPS^2 Provider

Being an IPS^2 provider is for sure will bring a lot of benefits and both companies have experienced those benefits. For instance the increasing of revenue and profits due to the service provision. But, this new strategy implementation has brought some challenges in their internal organization as well. By adding more services, company is able to increase its customer loyalty and obtain more suitable profits. But this transformation requires adaptation in internal organization which include human resource ability, supporting software, the change of organization mind set as well as quality management system. Human resource's capability is considered as the most challenging part. Both companies find it is really difficult to change the way their people think about what company is doing that service becomes more important.

In terms of costing system, it is still difficult for both companies to identify and calculate costs occurred because of the risks and uncertainties. They use the estimation only based on empirical data and expertise. Moreover, overhead allocation is remain a problem for both companies. There is only one type overhead and does not divide properly and it will be assigned in production and service provision equally. One big industrial overhead is assigned both for product and service using the same approach which is based on the labor hours. This approach is basically ignoring the fact that one big overhead cost is not used equally to produce a product and provide a service. Company A realizes that this overhead allocation is not accurate because product and service being treated at the same way but in fact their cost behaviors are different. This condition is match with the literature findings which explain the traditional coting has some technical drawback in overhead allocation.

6.5 The Revised Cost Assessment Framework for IPS^2 Function-Oriented Business Model

The application of case study analysis has brought some practical understanding about IPS^2 business context which did not obtain from theoretical studies. All the information particularly related to types of companies' offerings, cost structures for each offering and their costing system are very valuable findings

to revise the proposed cost assessment framework for IPS^2 function-oriented environment. Figure 27 show the updated framework which can be used to assess cost of offerings in IPS^2 function-oriented companies.

The main revision is given in relevant cost structures both in production and delivery products as well as in preparation and provision of services. Cost of engineering design which is not included in previous framework now being included. Cost of engineering design can be defined as all related costs which occur during the engineering design phase. It based on the working hours used by company's human resources to design particular products and services to be offered to customer.

Risks and uncertainties cost in service provision is also added. This risks and uncertainties cost is relevant for companies who provide maintenance contract like Company A. There are some risks and uncertainties which possible to be the cost generator, for instance failure rate, spare part price, labor cost, and technological speed. This risks and uncertainties could increase and decrease the total cost of maintenance provision during the period of contract but since customer pays a fix service cost so all those risks and uncertainties is owned by IPS2 provider.

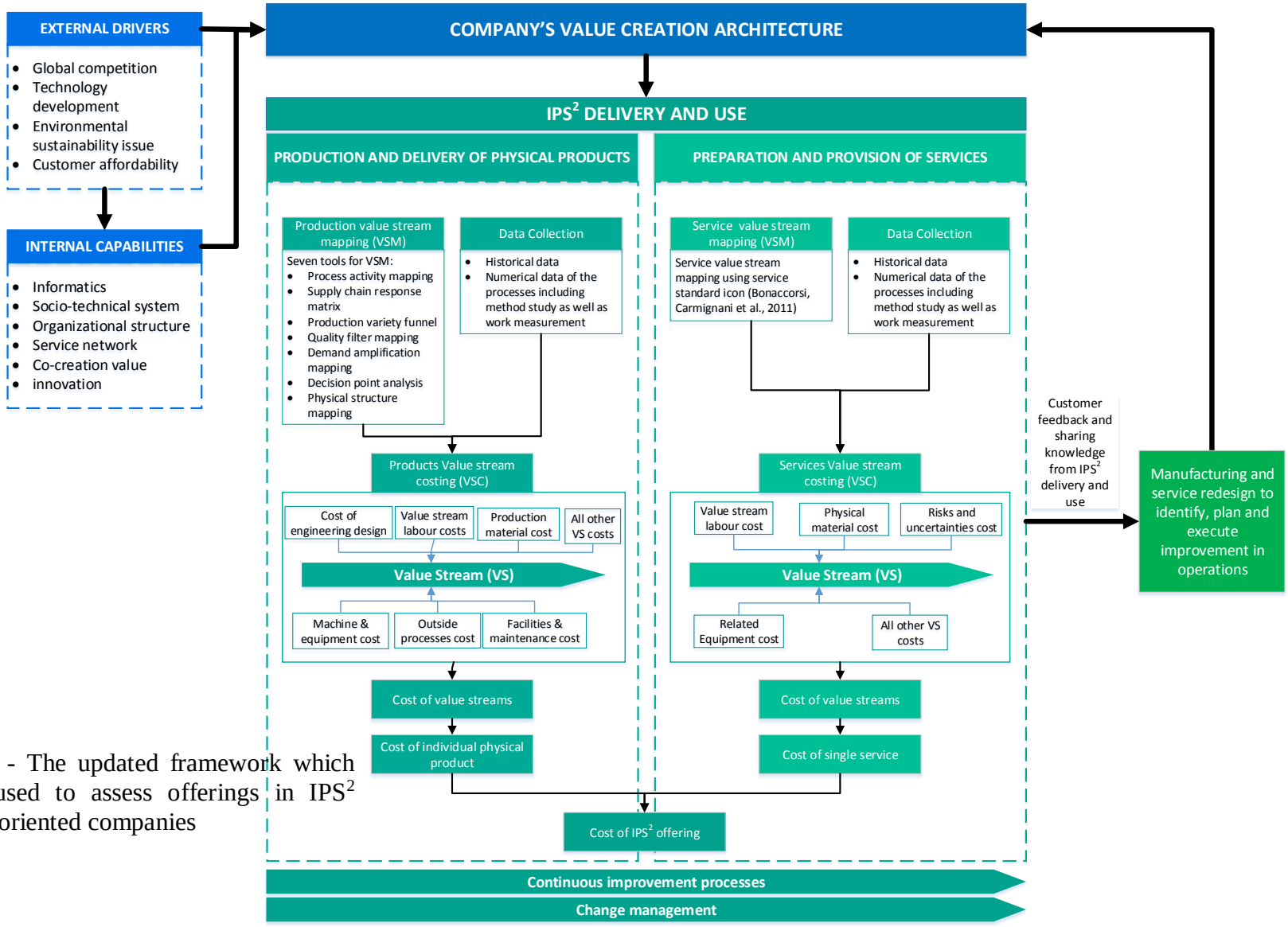

Figure 5 - The updated framework which can be used to assess offerings in IPS² function-oriented companies

CHAPTER 7
CONCLUSION AND FUTURE WORK

7.1 Conclusion

Dynamic and competitive market have changed the way of manufacturing company doing business. Physical product is no longer able to satisfy customer needs. Company's focus has been shifted to seek and provide more values to customer by adding services in its offerings. To be an IPS^2 provider who delivers the integrated or bundle of products and services is believe as a strategic solution to survive in more dynamic and unpredictable market. Service aspect of company's offering will give some benefits which do not exist in traditional type of business model. IPS^2 then becomes a new strategy which continuously growing both in theoretical study and practical application.

IPS^2 concept has been proposed since early 90s but there are remain various parts of this concept have not been received sufficient attention. IPS^2 concept is a complex area of study because it requires an overall transformation of company. One of the unexplored areas of IPS^2 is its cost dimension which include the cost structure and the cost assessment. Whereas, cost obviously continues to be one of the most critical competitiveness factors in global market. But otherwise, there is still limited study discuss this topic in IPS^2 environment.

Triggered by the posed research questions, this research project has achieved this particular conclusions:

1. The inclusion of services in IPS^2 offerings will change company's cost structures. In some points, service provision brings the risks and uncertainties which do not exist in traditional offering. This new issues are obviously could not be addressed by traditional costing system. Company's offering and company's business process have been changed, so does costing system. But unfortunately, many IPS^2 companies are continuing to use the traditional costing system which by nature is not suitable to IPS^2 companies' characteristics and needs. The case study analysis conducted as part of this research project proves both IPS^2 function-oriented companies

being studied remain using the traditional costing system, even though they understand the inappropriateness of this traditional costing with their new emerging strategy. In respect to this condition, Table 9 in Section 4.2 presents the detail contradiction between traditional costing system with IPS^2 concept, including the main issue that traditional costing gives wrong measurement, estimates and calculates the wrong cost, the understandable information and the complexity of company system.

2. Taking into account all IPS^2 characteristics particularly for function-oriented business model and the analysis of existing costing system, lean accounting is the best candidate to be adjusted becomes a new costing system framework for IPS^2 companies. By considering the IPS^2 characteristics and cost structures occur in IPS^2 companies, Figure 27 presents the proposed cost assessment framework for IPS^2 function-oriented business model. This framework is build based on literature finding which is verified in real practice. All the cost structures of integrated offering are relevant with the real IPS^2 application. The set of processes should be followed in assessing the costs is clear enough. Since, the framework is developed based on lean accounting, the costing system will be easy to build, implement and maintain.

7.2 Future Work

The result of this research is only limited on the framework. The needs of IPS^2 environment towards the more appropriate costing system which is tried to be addressed is solved by proposing the new cost assessment framework. Even successfully giving the clear and relevant cost structures as well as the cost assessment process to be followed, this research has not gone further into detailed in the operational calculation. There is no calculation example presented in this work. Moreover, calculation of risks and uncertainties are not defined clearly whereas risks and uncertainties become a major challenge in IPS^2 environment. Hence, future research to cope the research limitations should be carried out. The proposed cost assessment framework from this research is just the first step stone of cost management system from IPS^2 function-oriented business model. The

detailed calculation or supporting tools such as financial software could be the next research agenda in this area.

Another aspect which could be developed from this research is the expanding of the research scope. This research is focus on IPS^2 function-oriented business model with machine builder manufacturing company as the real practice being analysed. Since there are two other business models in IPS^2, all the findings from this research could be a basis to develop cost assessment framework or model for overall IPS^2 environment.

During the completion of this research project, two papers have been produced and submitted to international conferences. One paper was accepted in the XXI International Conference on Industrial Engineering and Operations Management, Portugal and the second one was accepted in The 3rd International Conference on Industrial Engineering and Service Science, Indonesia. Those papers discussed some particular parts of the achieved work.

The acceptance of this work in both international conferences means that the conducted research, including the research area and its result, are an interesting study. PSS/ IPS^2 concept or particularly the cost assessment for both concepts should be further and continuously addressed. The global trend has shown that PSS and IPS^2 strategies are gaining more and more attention not only in literature study but also in real practice. Hence, it will surely interesting if this research topic is further developed.

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ATTACHMENT A THE CASE STUDY PROTOCOL

Introduction

This protocol is a guidance to help researcher to conduct semi-structured interview at the company. It presents the sequential procedures and supporting tools to be followed in this case study implementation. The case study protocol could be used or adjusted to conduct the similar case study work in another related filed which contribute to research sustainability. Some relevant references are used to develop the protocol including (Voss, Tsikriktsis et al., 2002), (Yin, 2013), (Amaral and Sousa, 2009) and (Azevedo and Ribeiro, 2013).

Interview Preparation

At the first time, the potential interviewees would be contacted by email to give brief description about the study and invitation to participate in an interview as part of the study. Within 3 working days, they will be contacted again by email and/or phone to receive their confirmation in participating the interview. After receiving participation confirmation, the interview would be scheduled on each interviewee's convenient time.

In meantime, the researcher will prepare an interview script in advance which contain the particular areas to be deep explored, the list of questions would be asked and related data intend to be acquired. This interview script could be sent to the relevant interviewee prior the scheduled interview.

During the interview session, all conversation will be noted in interview script and/or notepad and recorded with recorder if the interviewees give the permission to do so. All those interview data would be compile as a structured interview report as soon as possible with adding the researcher relevant thoughts and/or comments with respect to interview session. If possible, this report would be checked by interviewees to validate whether all the information gathered are relevant and represent the current condition.

Field Data Collection

To conduct field data collection, it is necessary to identify, in advance, the relevant data and information intend to be obtained from this stage. This expected outcomes are deployed into set of questions and categories into areas. The field procedures or sources of information for each particular area would be determined afterwards. The main areas which would be explored includes:

- Company and business context
- Integrated product-service offering
- Cost management system

The following section would present the detailed information to collect the data from those main areas.

Company and business context

The following table presents the context areas of the company and business context should be addressed. During the case study implementation, the researcher should focus on this particular questions of each unit of analysis and try to answer all those questions by field procedures and sources of information.

Context Area	Unit of Analysis	Questions	Field Procedures/ Sources of Information
Business model	Company	What are the company's business objectives (vision, mission…)? What is the company's business model? *the researcher would refer to the 9 building block of business model canvas What are the main characteristics of company's business process?	Archival sources (background information of the company) Company's documentation (reports) Interview with the representative of company's management
Business environment	Company	What are the main characteristics of the company's business environment (industry, market growth, market share, etc.)? What are the main external business challenges in terms of customer demands and business conditions in recent years?	Archival sources (background information on the industry) Company's documentation (reports) Interview with the representative of company's management
Organizational structure	Company	How many production workers (direct labor) and other workers (indirect labor) owned by the company? What is the proportion number of employees based on categories (e.g. management, production, engineering, maintenance, etc.)? How is the company's organizational chart?	Company's documentation of organizational chart and quality manual
Company's performance	Company	How is the company's performance in terms of competition (productivity, quality)?	Performance reports and interview with the representative of company's management

Integrated product-service offering

The following table presents the context areas of the integrated product-service offering should be addressed. During the case study implementation, the researcher should focus on this particular questions of each unit of analysis and try to answer all those questions by field procedures and sources of information.

Context Area	Unit of Analysis	Questions	Field Procedures/ Sources of Information
Company's offering	Sales and marketing	The researcher intend to explore about the company's offering which include the types of product/service, its prize, sales policy, or special agreement with customers • What are the company's pure product offerings? • What are the company's additional (separate) service offerings? • What are the company's integrated product-service offering? Ask the detailed information about each PSS offering e.g. what service package include in the offering, what is the service level, how long is the time duration of the agreement, how is the price policy, what are the risk and uncertainty which possible to occur	• Archival sources (background information of the company) • Company's documentation (reports) • Interview with the sales and marketing team
Customer and Sales	Sales and marketing	• Who are the target market (local/ regional/ global) of the company? • Number of sales of pure product vs sales of separate service offerings vs sales of PSS offering in one year • Number of customer under PSS agreements	• Archival sources (background information of the company) • Company's documentation (reports) • Interview with the sales and marketing team
Development of product-service offering	Research and development	• Is there any specific methodological approach to develop the product, service and PSS offering? • What are the phases of developing PSS offering? • Does the company develop its products and services in integrated way and time?	• Company's documentation (reports) • Interview with the research and development team

Cost management system

The following table presents the context areas of the cost management system should be addressed. During the case study implementation, the researcher should focus on this particular questions of each unit of analysis and try to answer all those questions by field procedures and sources of information.

Context Area	Unit of Analysis	Questions	Field Procedures/ Sources of Information
Type of cost structure	Production of product and service provision	• What are the cost structures incurred and considered by company for each product cost, service cost as well as PSS offering cost? • How does the company determine its cost structure for each product and service?	• Company's documentation (reports) • Interview with production and team of product/service pricing
Cost calculation process/ steps	Production of product and service provision	• What are the methodologies used by the company to calculate the cost of its PSS offering? • Does the company consider risk and uncertainty in calculating the PSS offering cost?	• Company's documentation (reports) • Interview with production and team of product/service
Cost evaluation and control	Production of product and service provision	• Does the company has cost evaluation and control? If yes, how does the company do it? • How often does the company evaluate their cost?	• Company's documentation (reports) • Interview with production and team of product/service

ATTACHMENT B: THE CASE STUDY INTERVIEW

THE INTERVIEW OF COMPANY A

Company and Business Context

a. Business model

Company A is categorized as machine builder manufacturing company which has specialization to design, product, install, maintain and repair industrial plant and equipment

The Company A's vision is to grow in a sustained way and in the long-term, acting as a lead partner for multinational companies. And its mission is to offer engineered solutions, automated equipment and maintenance services for distribution lines, using the latest technologies available, to industrial customers on a global scale, aiming to optimize their production and/ or logistics processes.

b. Business environment

In today's market, customers of Company A are required more services but company is not ready to be a full service company due to some considerations:

- The readiness of human resources. Technical people should be more skillful and able to speak foreign language since its target market is world-wide
- Investment on machine and equipment. If Company A only focuses in service, the sale of product can be decreased and it can affect the company's return of investment

With respect to this condition, company A has some strategic solutions to cope those challenges in order to meet more customer demands

- Requirement of new human resource becomes more competitive. Beside requiring a skillful and experienced new employee, Company A also adding the foreign language proficiency as requirement
- Company A tries to offer services as a bundle offering with its products. If customers wants to get a particular service, it is possible for Company A to state "If you need our services, you should buy our product first"

c. Company's performance

Company A is in a good performance by continuously expanding their world-wide market and doing continuous improvement of the Management System

Integrated Product-Service Offering

a. Company's offering

Company's product offerings includes industrial conveyor, robot arms, industrial automation, electronic cabinet, palletizers, industrial information system, industrial processes and supervision and control

Company's service offerings includes studies and project, programming, maintenance and training. This service offerings could be offered as separate service offering without relation with customer's product purchasing but it could be combine and integrate with product offering

Company's PSS offerings. There are two type of company's offerings which could be considered as IPS2 offering, which are:

1. Project. Project is defined as two conditions. The first one, Company A receives an order from a customer to build new facilities in customer's plant. In this condition, the project will start by engineering design until the required product already installed in customer's plant. The second condition of project is customer buy a product with additional services for instance installation service
2. Maintenance contract. Company A offers a maintenance contract for customer annually. Customer pay a fixed cost in early year of the contract for maintenance for the whole year

b. Customer and sales

Company A is a multinational company which already reached the global market in 30 countries. Its sales percentage for project, pure product sales and maintenance contract sales are 57%, 20% and 23% respectively.

c. Development of product-service offering

Company does not have research and development department. Developing new product or service are done by engineering department. In general 3-4 new products are introduced in market.

There is no special methodology to develop new product-service offering because mainly product-service offering is designed and implemented vary on customer's demand and order (project).

Cost Management System

a. Types of cost structures

Cost of product

- Cost structures of company's product are material cost, labour cost, and industrial overhead
- Company is using standard costing to calculate the product cost
- Company has standard cost for each product component so if in project it is needed to make a new product, cost of the new product is obtained by referring those standard costing

Cost of project: cost structure is including cost of product installed in the customer's plant, additional material cost, cost of design solution of engineering which is based on worker hour, logistic cost of people and material flow and cost of service side which is also based on worker hour

Cost of maintenance contract

- Maintenance price for each customer could be different. The cost of maintenance contract is based on the product type, complexity of product, the product condition and the age of product
- Cost of maintenance contract is determined using estimation based on historical data and expert adjustment
- Company adds risk cost in maintenance contract but does not have specific method to assess it. The risk cost based on the empirical data and expertise

b. Cost calculation process/ steps

- Company is using standard costing to calculate cost of products, services or integrated PSS offerings
- Standard costing is based on historical data and the actual cost which are managed in company's financial data base. The standard costing is updated twice a year
- Company includes risk or uncertainties costs in its costing system but the value of its cost is estimating based historical data. Company still does not have a clear method to define this types of costs

c. Challenges in costing system

- Company assigns its industrial overhead based on the labor time both for product and service. There is only one type overhead and does not divide properly and it will be assigned in production and service provision equally. Company A realizes that this overhead allocation is not accurate because product and service being treated at the same way but in fact their cost behaviors are different.
- Company still does not have cost per time unit capacity used in service provision

THE INTERVIEW OF COMPANY B

Company and Business Context

a. Business model

- Company B is machine and equipment builder for cork production process. This company provides all machine and equipment to prepare and produce product based on cork start from cork preparation until machine to cork finishing or packaging
- Company B has been committed to add more services in its offerings to gain customer loyalty

b. Business environment

Company B is leading company in Portugal in this business area. Its experiences since 1964 give Company B a good market position in national and international market

c. Company's performance

Company B could be seen as a mature and experienced company. Being a company in this are for more than 50 years give company expertise in cork processing.

Integrated Product-Service Offering

a. Company's offering

Company's product offerings includes production machines and equipment for the cork production for instance surface printing, surface treatment or counting and packaging. Company A is able to provide all types of machines or equipment to process the cork from its whole supply chain

Company's service offerings includes machine upgrades, industrial repairs and after sales services. Service could be provided as a separate offering or as an integrated offering with products.

Company's PSS offerings is called process re-engineering, when Company B provide an overall solution for new layout plant with equipment and machines. Process re-engineering is mainly provided for Company B's current customer which has good relationship with company for years. Figure 23 shows the process flow of Company B's process re-engineering with its related costs.

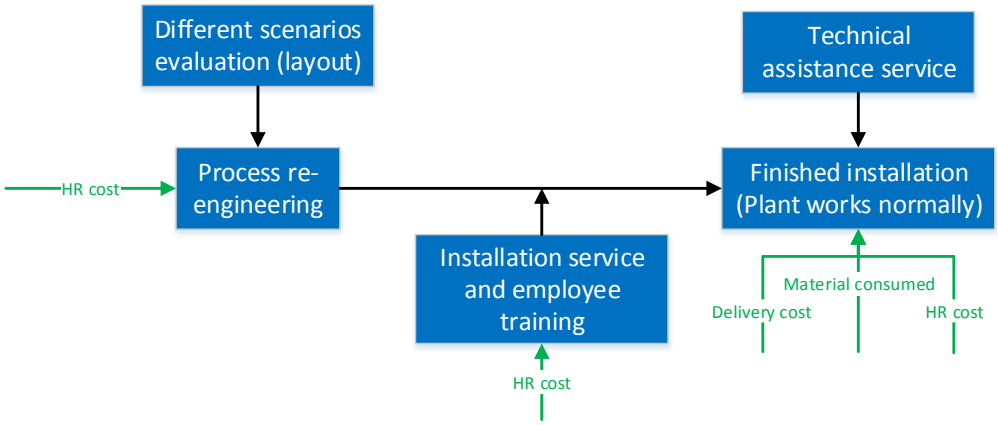

Figure 1 - Process flow of process re-engineering offering from Company B

Process re-engineering offering could be divided into three phases and customer could order it as the whole offering or only particular phase.

- Phase A: design concept which result is 3D or 2D design drawing of new layout with its related machines or equipment. Cost is calculated based on labor cost
- Phase B: prototyping. Cost is defined as labor cost and material consumed to prototype the design concept
- Phase C: industrialization. The real implementation of design concept. Cost is calculated based on working hours, material consumed, and know-how

Considering customer behavior, Company B does not offer maintenance contract during period of time. Since its customer prefer to do corrective maintenance or repair and pay based on that action instead of buying maintenance contract. Before assessing the cost of corrective maintenance of particular machine or equipment, Company B will ask customer to fill the maintenance form which consists of machine information for instance machine type, the usage age, machine detailed condition

IPS^2 offering is mainly provided based on the customer requirement and need. Hence, the cost of its offering will vary based on customer order.

b. Customer and sales

Company A is a multinational company which already reached the global market. 50% of its customers are international companies. Integrated offering is 15% of company's income.

c. Development of product-service offering

Since a couple years ago, Company B is started to involve in PSS transformation. The company has changed its business model to be more suitable for PSS characteristic and environment. For now, this company is function-oriented business model which provide product related service but in the future, Company B is planning to rent its machines or equipment to customer instead of sell it.

Innovative product and service is continuously developed by company for instance set up kid to help company to gain more efficient set-up time. This service is add-ons for particular machine and equipment

Cost Management System

a. Types of cost structures

The main cost structures are labor cost, material consumed cost, know-how cost. Know-how cost is respective cost for company's engineering design, knowledge, advertising or other technical cost which could be traced individually. This cost structure is estimated and adjusted based on the historical data.

b. Cost calculation process/ steps

- Company is using standard costing to calculate cost of products, services or integrated PSS offerings
- Company B has standard costing for each type of materials used in particular machine or equipment and labor hours. It uses costing system in excel.

c. Challenges in costing system

Challenges in terms of company transformation: by adding more services, company is able to increase its customer loyalty and obtain more suitable profits. But this transformation requires adaptation in internal organization which include human resource ability, supporting software, the change of organization mind set as well as quality management system

Challenges in terms of cost calculation: Company B still uses a lot of assumption to assess its cost particularly for technical services

BIOGRAPHY

The writer of this master thesis is Mar'atus Sholihah who was born in Gresik, 10th of June 1991. She is the first daughter from two siblings. Education has become very important issue for the writer hence the writer wanted to continue her study until master degree. The writer went to MIN 1 Kedamean for elementary school, SMPN 1 Kedamean for junior high school, SMAN 1 Krian for high school, Industrial Engineering ITS class of 2009 for bachelor degree and finally Industrial Engineering ITS class of 2013 for master degree under the BPPDN Scholarship from the Ministry of Education. During the completion of her master degree, she was very grateful and thankful for being accepted in master mobility program under the Interweave Erasmus Mundus 2. The writer got a change to take courses and conduct her master thesis at Master in Services Engineering and Management, Faculty of Engineering, University of Porto, Portugal for period of 2 semesters.

During the college time, the writer was actively involved in many university activities. She was work as a part-time staff at ITS International Office and toke a part in ITS internationalization journey. She has also joint in some research projects involving ITS and external organization for instance the Ministry of Education and the city government of Surabaya. She was very keen to contribute to education and research. The writer is very open-minded person and eager to look for some interesting challenges. For all those opportunities, the writer can be contacted through email address maratussholihah09@gmail.com.