Influential Factors in Long-term Product Service System Contracts

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Abstract

This dissertation presents different aspects of long-term contract for product service system (PSS); also different issues that companies are dealt for implementation of PSS. The study consists of literature review for understanding factors which can affect long-term PSS contracts. Different generic categories of green business models which are used in PSS contracts have been addressed and in addition, various models of contracts for PSS in industries have been identified too. The important factors which can influence these types of contracts are categorized in six major aspects organizational, social, economic, technological, legal and environmental.

Each of these factors separately has been analyzed by reviewing related literature. Moreover a general evaluation about effect of each factor in other influential factors has been presented. In respect of long duration of contract, the rate of uncertainty is higher than traditional method of buying a product. Here, problems which are related to each of these factors have been addressed. Moreover, different approaches of companies for these problems have been discussed which these solutions can be useful for other providers in similar situation.

Keywords: PSS, Contract, Long-term, Factors, Aspects, Relation.
Acknowledgement

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Abbreviations

**B2B**................................................ Business to Business

**B2C**................................................ Business to Customer

**BPR**............................................... Business Process for Reengineering

**C2C**................................................ Cradle to Cradle

**CMS**............................................... Chemical Management System

**CIP**............................................... Continuous Improvement Process

**DBFO**............................................. Design Build Finance Operate

**ESCO**........................................... Energy Saving Companies

**ERP**............................................... Enterprise Resource Planning

**FAR**............................................... Federal Acquisition Regulation

**IS**.................................................. Industrial Symbiosis

**NAWCTSD**................................. Naval Air Warfare Center Training Systems Division

**PPP**............................................... Public-Private Partnership

**PSS**............................................... Product Service System

**RAP**............................................... Rapid Assessment Program

**SAP**............................................... System Application Programming

**SSCM**............................................ Sustainable Supply Chain Management
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1 Introduction

Growing environmental issues in the world emphasize need of alternative solutions with concern about sustainability. Increasing population of the world as well as issues related to impact of human activities on environment are two important areas which need more consideration. Myung-Joo and Wimmer (2007) stated most of production and consumption troubles goes to three types of attitude, possessing of products, throwaway culture and too much consumption. Finding solutions for these issues require collaboration among different sectors in market; here provider as parts of this chain has a critical role.

The main goal of each company is producing more profit from its activities, which in traditional methods depends on volume and size of products. This means more usage in resources, production of wastes and negative impact on environment. Solution for this paradox requires more consideration for sustaining two aspects of economic and environment. Here presenting green business models for combining these aspects together can be seen as a solution. One of ideas which are developed by academic and industries research is Product Service System (PSS) which has a potential to increase sustainability in both parts of production and consumption.

Roy and Cheruvu (2009) stated three phases for a product service system: design, delivery and adaptation. Success in each phase requires precise planning, suitable infrastructure and knowledge. Many factors can influence each of these stages which this thesis tries to increase the knowledge about them. Moreover changing from traditional business models to product service system requires a profound knowledge of customers’ actual demand and usage pattern. Here longer time of connection between customer and PSS provider can increase information of provider about whole life cycle of product; furthermore this knowledge can facilitate delivery of services too (Simon, et al., 2000). Based on this, the scope of this thesis is to concern about long time product service system contracts and its influential factors.

According to novelty of PSS area, in market and even academic level (Mont, 2002b) more development in different dimensions of it is needed. Concept of contract with long time duration is a field that knowledge about risks and opportunities of it can help PSS providers for choosing proper business model. The solutions that different companies are used for these issues can be a good source of information for other PSS providers to handle similar problems.

1.1 Objectives of Project

The main objective of this thesis is:

To identify and map what different factors can influence in long time PSS contracts and to explore how companies could handle those today.

This objective has been broken down into three following research questions. They have described current situation of PSS in market and also have tried to identify factors which can influence this type of business model.

RQ1. What types of PSS contracts are used?

This research question aims to identify business models based on green technologies and investigates common factors that can influence them. According to this, terminology of PSS will be more clarified and some general problems related to implementation of PSS contracts
can be identified. This gathered key points can be used for finding influential factors in long-term PSS contracts for second research question.

**RQ2. What factors can influence long-term PSS contracts?**

There are many factors which can influence a PSS contract; recognizing these different factors helps a PSS provider to have a better understanding about possible areas of risks or opportunities. This research question aims to explore these factors which can affect long-term PSS contracts.

**RQ3. How can companies deal with factors that influence long-term PSS contracts?**

Companies which use different long-term PSS contracts should deal with many influential factors. Here approaches of a company for dealing with a factor can be used by another PSS provider in similar situation. This research question aims to identify different solutions for handling these factors.

### 1.2 Delimitations and Scopes

This thesis describes different factors which can influence long time product service system, but the main focus is on PSS business models with positive impact on environment. These business models use green technologies for delivering requested functions; concept of PSS refers to these types of green business models. Furthermore, center of attention is on contractual part of PSS and different factors related to it. Moreover the main focus of this thesis will be literature review in Sweden and UK; the reason for this is the accessibility to knowledge at two universities of Linköping (Sweden) and Cranfield (England). However literature review and case studies which are explained by articles in various regions can be used for detail analysis too. Moreover most of the time for conducting this thesis is in summer which limited accessing to related persons for interview. Here the literature review is carried out by using search engine of Science Direct database; this is due to time limits of research project and extent of literature in this database. Moreover search engine of this database can be accessed by students of Linköping University.

### 1.3 Outline

The first chapter gives an introduction to the report for the reader. Here the delimitations, research questions and the objectives of this dissertation are presented. It concludes an introduction and a section for defining research questions. The next chapter explains methodologies which are used to address these research questions. A description about PSS and different drivers and stages for implementation of it are stated in Chapter 3. Chapter 4 includes the result of first research question. Different types of PSS contracts which will be gathered by document studies will be listed here. Factors which can influence in PSS contracts will be recorded in Chapter 5. Moreover some approaches which can be used by companies for dealing with them have been explained in Chapter 6. Chapter 7 includes discussions about the results. The conclusions can be found in Chapter 8 and these are made from the results and discussions. Further research which is needed to be conducted in this area is presented in chapter 9. Following conclusion chapter, different references which are used in this thesis will be listed in chapter 10. In addition, appendix part contains extra useful information related to different parts of research.
Methodology Chapter

2 Methodology

This chapter describes the methodology which is used in this thesis. Methods, critical words for internet browsing and types of literature are represented; moreover the relation between the research questions and the research methods are described.

2.1 Research Design

This dissertation uses three research questions which are described. The first two questions try to identify different classification of PSS contracts and factors which can influence in it; moreover the third question describes how companies can deal with these factors which need exploring different opinions and approaches. Answering to these questions require collecting ranges of ideas and understanding current state of market; according to this, the nature of this thesis is more explorative. As Mora (2010) stated qualitative methods can be used for explorative research which identifying the problem or developing an approach to that problem is important. Based on this, using qualitative methods can be a suitable approach for collecting and checking different resources in this thesis.

Frechtling, et al. (1998) classified different common qualitative methods as observations, interviews, focus groups, document studies, key informants, performance assessment, and case studies. Here answering to these research questions require searching different areas of market and industries which require lots of time and persons. Based on limitation of time, this thesis will use document studies method; here document can be defined as “any written or recorded material” (Lincoln and Guba, 1985). Moreover document studies is not expensive and suitable for determining value, interest, positions, political climate, public attitudes, historical trends or sequences (Frechtling, et al., 1998). Literature review can summarize and synthesize the arguments and ideas of others; besides it can present new interpretation of old material as well as combining new with old interpretations. Moreover document studies method can trace intellectual progression of the field and advise readers on most relevant topics; based on this, various related areas to long-term PSS contracts, which have been described by different authors can be considered.

2.2 Methods for the First Research Question

RQ1. What types of PSS contracts are used?

Investigating market and business models for finding types of PSS contract requires time and broad study in many literature. In the first step familiarity with concept of PSS is important and information about different product service system contracts helps their functions to be clarified. Here knowledge about terminology of PSS can ease finding related literature; furthermore it can affect in quality of research. According to title of project which is Long-term PSS contracts, some keywords such as “PSS”, “product service system”, “contract” and “long-term” can be used for exploring in literature. Furthermore, information from study courses as well as relevant papers and articles can be used as complementary data. Based on this preliminary literature review, concept of PSS as a green business model will be described and also a general overview for different categories of PSS in market will be presented. These different business models besides their related drivers and barriers can be used as a list of keywords for deeper research about finding influential factors in PSS contracts.
2.3 Methods for the Second Research Question

RQ2. What factors can influence long-term PSS contracts?

This research question considers different factors that have potential to affect long-term PSS contracts. Primary information from earlier research question can be used as starting point. Many of the articles which are describing types of PSS contracts (RQ1) may also explore the factors that influence those contracts. Therefore, the articles which are reviewed for the first research question will be reviewed again, this time with the aim of getting information regarding the RQ2. This will allow introduction to the taxonomy of the concepts and choice of keywords for further search in scholarly literature. Because, this research is explorative in nature, and the author suspects that there may be knowledge gaps in the existing information about influential factors, it is important the survey consider all possible terminologies and aspects (even the ones which are not mentioned in literature related to RQ1). This will lead to extending the representativeness of the keywords, and assure that they will lead to a thorough and comprehensive literature survey. In other words “How can the author assure that all important aspects are included in the search?” What if some important aspects are not discussed in the existing literature related to RQ1?

In order to deal with this issue, two approaches can be considered. First approach can be performing an additional quick general survey over wider range of topics (wider than those explored in RQ1). Second is to perform a brainstorming with several people who are generally familiar with the concepts (such as graduate students in business, sustainability, or environmental fields). Brainstorming is a well-known technique for producing new ideas based on the existing keywords. The most suitable size for the brainstorming session is between five to ten people. After introducing the definition of PSS contracts and providing few examples, the aim of the session is presented and individuals are asked to provide feedback on the topic individually and later in group. These two stages of brainstorming are for increasing efficiency of it; here each member can generate a larger number of unique ideas in first stage (Barnett and Mendenhall, 2011).

Now that the concepts and keywords are identified and selected (re-exploring RQ1 main articles, additional initial survey, and brainstorming) the main literature review can be performed. In the next step, the result of literature review and the gathered information will be reviewed in detail, in order to identify important factors. This process of finding factors, literature review and analyzing can be iterative which means the result of it can be used for another loop. With an iterative approach, process of learning about a factor can guide thesis to new factors. This will help the project to consider all possible factors which have potential to affect long-term PSS contracts. This process has been described in Figure1.

![Figure 1. Steps of identifying various factors](image-url)
2.4 Methods for the Third Research Question

RQ3. How can companies deal with factors that influence long-term PSS contracts?

Here the factors which are identified in previous step can be used as keywords for searching and collecting information about different ways of companies to deal with these factors. Various problems which are addressed by literature will be gathered; and then different solutions of companies which are stated in literature will checked. Here these approaches of companies for dealing with influential factors in long-term PSS contracts can be used by other PSS providers.
3 PSS Description

This chapter describes concept of product service system and its related elements. In addition different stages and drivers for PSS will be explained.

According to Population Division of United Nation (2004), the population of world will be near nine billion in 2050. This increase in population can amplify the problems related to unsustainable production and consumption in the world. Depletion of resources and creation of higher pollution are two important problems which today the world are challenging with them. The earth have limited amount of resources which with this rate and methods of usage cannot meet the demand of future generation. Here changing in methods of offering products and services can consider as a treatment for this problem. In traditional methods of business, the company can gain more profit from selling higher number or volume of products.

One of approaches for changing these traditional models can be the usage of sustainable products and services. According to this the concept of PSS has been defined; and usages of different kinds of product service system are stated as an approach for dealing with unsustainable production and consumption (European Commission-DG Environment/COWI, 2008; Mont, 2000). Definitions of PSS are varied by different authors; but the general aim of these business models is reduction in resource usage and production of waste besides producing economic benefit (Berg, Bjerre and Henriksen, 2010; European Commission-DG Environment/COWI, 2008).

Goedkoop et al. (1999) has described PSS as “a system of products, services, networks of players and supporting infrastructure that continuously strives to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models”. This is one of the first definitions which are used for new types of product service system. According to this definition, the role of different factors such as network, infrastructure of customers and providers are significant. Here PSS describes as a business model that concludes different actors of market for being competitive; beside of that it consider environmental aspect of offering.

Moreover Tukker (2004) defined PSS as “tangible products and intangible services designed and combined so that they are jointly capable of fulfilling specific customer needs”. However, this definition has not mentioned environmental aspects of PSS, but idea of combing service with product can have a potential for reducing the impacts from just using physical products. Another definition for PSS have been proposed by Berg, Bjerre and Henriksen (2010), “Green business models are business models which support the development of products and services (systems) with environmental benefits, reduce resource use/ waste and which are economic viable. These business models have a lower environmental impact than traditional business models”.

Here core of all of these business models is lowering the environmental impact from the process of offering products and services to customers. For customers, product service system can be as a change from buying products to buying system solutions and services (Mont, 2004). Moreover in product service system, providers have a better controlling about whole life cycle of product (Mont, 2000). Here implementation of PSS can create some opportunities and risks for provider. These opportunities can come from long-term connection between parties of PSS contracts; here some factors such as higher feedbacks from customers can help providers in development of their offering. According to customers’ demand, provider can
customize its offering functions, which this may lead in higher satisfaction and retaining of clients (Kumar and Kumar, 2004). However long-term duration of PSS contract can increase the risk for contingencies, which may reduce the interest of companies for entering to these types of contracts.

3.1 PSS Benefits

Implementation of PSS can create some benefits for different areas such as governments, customers, manufacture and service companies, environment and society (Mont, 2000). Usage of PSS for higher sustainability has been discussed in different paper such as Manzini and Vezzoli (2003), Mont (2004; 2000), Tukker and Tischner (2006) and most of the papers addressed the ability of PSS for creation of sustainable production and consumption. According to this, governments can use this model for mitigating current problem related to unsustainable business. From customers’ perspective, PSS have the ability for offering greater range of products and services; moreover payment schemes and offering can be more adjusted based on affordability of customers (Mont, 2000). Here higher connection among providers and customers can lead to customization of an offering which can produce more satisfaction for clients (Mont 2004; Kumar and Kumar, 2004).

Through PSS, manufacture companies have more freedom to design and offer different business models (Tukker, 2004) which may increase innovation. This new ideas can lead companies to cost reduction for offering and consequently higher revenue. Moreover in both manufacture and service companies, higher connection among customers and providers can create higher and constant information flows which increase the performance of offering Mont (2000). Furthermore, copying of these offering models is hard which can help companies to keep their customers.

Higher responsibility of PSS provider through whole life cycle of an offering can lead to reduction in environmental impacts. According to take-back system producer knows that its product will be returned; here proper strategies for increasing its life time can produce more benefit for provider. Moreover, economic benefit of PSS can play as an incentive for providers to use these types of offering.

In PSS, customers pay for intangible services and not for buying a physical product (Mont, 2000). Based on this concept, some methods for reducing environmental impacts such as, dematerialization and life time extension can be economically through implementation of PSS. In traditional models of business, selling higher amount of products in number or volume means more revenue; here applying life time extension or dematerialization may be contradicted to this goal. In this situation, usage of different types of PSS models can consider as a solution for this issue; and here PSS has the ability to use for decoupling of environment and economic (Mont, 2004; 2000).

Moreover, product service system can offer a solution for producing new jobs and also protecting employment in developed countries (Meier, Roy and Seliger, 2010; Mont, 2004). Higher responsibility of providers during life cycle of PSS increases the need of labor works in its activities. As Mont (2000) stated, repair, refurbishment, disassembly and take back system are some parts that require higher labor works which can lead to creation of more jobs. Based on this, applying PSS can have positive effect in society and improve social aspect of sustainability.
3.2 PSS Drivers

According to Roy and Cheruvu (2009) major drivers of PSS are global competition, customer affordability, revenue generation opportunity, technology development and environmental sustainability. Table 1 shows these drivers; here global competition is an important factor for increasing interest of companies to PSS. The key factors in here can be classified as globalization, higher connection among industries and technologies, deregulation of a large number of industries, spread of connectivity in any places, joining India and China to world market (Prahalad, 2005). Here these factors can influence the interest of companies for entering to different PSS business models.

Table 1. PSS drivers (Adapted from Roy and Cheruvu, 2009)

Besides global competition, affordability of buying a service or product has an important role for producing higher revenue. Prahalad and Ramaswamy (2004) described customer affordability as difference between perceived costs and perceived benefits. Different types of PSS models by applying new ways of offering have the potential for increasing the affordability of customers. For example in sharing or leasing models customers do not need to spend much money for receiving a function. This can increase the level of affordability among customers and also numbers of them which can lead to producing more revenue generation for providers too. Moreover, offering different maintenance and operation services besides selling products can be another way for creating profit (Davies, 2004; Baines et al., 2007). Here satisfaction of customer can retain clients and create higher income for PSS providers (Kumar and Kumar, 2004).

In addition to these factors, development of technologies can be another driver for companies to apply PSS. Here design and delivery of innovative ideas which meet customers’ demand require usage of new technologies. Moreover the customization of products and service can reduce the options of customers for changing their providers. Here customers receive products or services which have been developed during long time connection with providers and they are tailored for their exact demands. According to this, it is hard to find another provider which can lead to retain of customers. Moreover, this can give provider enough time for improvement of its technologies which in current competitive world play as an important factor for absorbing newcomers and keeping customers.

In a successful implementation of PSS technological improvement in different areas such as, service network, manufacturing process, supply chain is necessary (Roy and Cheruvu, 2009). Moreover concept of PSS can be proposed as an approach for creation of sustainability Mont...
(2000); here PSS providers have higher knowledge about product compared to customers which put them in a better place for controlling usage phase of a product (McAloone, 2006). Furthermore, accepting PSS by people in society can influence governments’ decision; here increase in knowledge of customers about PSS can force governments for more support of environmentally friendly products and establishing proper regulations (Mont, 2001b).

3.3 Different Stages of PSS

Different stages in life cycle of industrial PSS are divided in design, delivery and adaptation (Roy and Cheruvu, 2009). These stages have been presented in Figure 2. The design part is one of important parts of PSS and it mostly uses more than 70 percent of total life cycle cost of product service system (Roy and Cheruvu, 2009). Other stage of PSS is delivery; here usage of suitable models for delivery of PSS can increase the interest and acceptability of customers for these new types offering. Education, customer expectation, value of time, competition, communication infrastructure, technology and affluence are some factors which can influence delivery of PSS (Malhotra et al., 1994). Here information which is gathered from usage and delivery phases can be used for development of different ways for increasing adaptation of these models among people (Roy and Cheruvu, 2009).

![Figure 2. Different life cycle stages of industrial PSS (Adapted from Roy and Cheruvu, 2009)](image)

Besides importance of these three phases in success of PSS; Mont (2004) describes four elements for PSS as product, service, network and infrastructure which is presented in Figure 3. These elements can be used to define of a framework for PSS and it shows different parts of PSS. According to definition of PSS, product is one of the main elements besides services for any offering to customers; here services can be any activity such as self-service, marketing, take-back, maintenance, upgrading, etc. which provider presents for availability of products to customers and moreover any services in usage phase and end of life stage (Mont, 2004).

![Figure 3. Different elements of PSS (Mont, 2004)](image)
Furthermore, different other dimensions such as, communication, education, technology can affect in service quality (Roy and Cheruvu, 2009) too. Based on this, for developing PSS the existing infrastructure of market is important; and it should be corrected by actors in case of inappropriate infrastructure or lack of it (Mont, 2004). Another element in PSS is network between different actors; here considering some players which traditionally should include out of product chain is a big difference between chain actors and PSS networks (Mont, 2004). In this step, understanding about different business models which are used by product service system can clear different activities of these offering models. Moreover knowledge about different economic and environmental drivers for implementation of them will be increased. Next chapter describes different classification for PSS business models.
4 Classification of PSS Contracts

The chapter describes different classification of PSS and various types of product service models which have positive impact on environment are listed. Moreover different existed contract models for PSS in industries have been represented for answering the first research question.

RQ1. What types of PSS contracts are used?

4.1 PSS Contracts Categorizations

As Meier, Roy and Seliger (2010) stated different types of PSS are not clarified by literature precisely; however some suggested classification by different authors can be found in literature. One categorization has been proposed by Tukker (2004) which product service system have been divided into three main classes, product-oriented service, use-oriented service and result-oriented service. In two first classes, role of traditional product is significant; however in product-oriented service, provider offers some extra services to customers. In case of use-oriented service, the ownership of product will remain for provider which can be useful for further maintenance and improvement. In the contrary of these classes, main consideration of result-oriented service is performing the result that customers seek. Here the concept of product is not critical and PSS provider is responsible to meet the customers’ requested result. These classes can be divided to several sub categories. Product related service, advice and consultancy, product lease, product renting, product sharing, product pooling, activity management and outsourcing, pay-per-service unit and functional result are eight types which are classified by Tukker (2004). This classification has been presented in Figure 4.

![Figure 4. Main and subcategories of PSS (adapted from Tukker, 2004)](image)

In respect of European Commission-DG Environment/COWI (2008) six different business models have been identified. These types of PSS contracts have been classified in Energy Service Companies (ESCOs), Design Build Finance Operate (DBFO), Chemical Management Services (CMS), Resource Management, Remanufacturing and Car-Sharing which is presented in Table 2. According to shifting focus in product to result, the first four models can be considered as result oriented service. However remanufacturing for its connection to
product, can be seen as product-oriented service; moreover in car-sharing the usage phase of products is in more concern which can put it in use-oriented service.

Table 2. European commission classification (European Commission-DG Environment/COWI, 2008)

<table>
<thead>
<tr>
<th>European Commission</th>
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<tr>
<td>Energy Service Companies (ESCOs)</td>
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<td>Design Build Finance Operate (DBFO)</td>
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<tr>
<td>Chemical Management Services (CMS)</td>
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<tr>
<td>Car-Sharing</td>
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<tr>
<td>Remanufacturing</td>
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<tr>
<td>Resource Management</td>
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</tbody>
</table>

In addition, Berg, Bjerre and Henriksen (2010) are categorized PSS models as Functional Sales, Energy Service Companies (ESCOs), Chemical Management System (CMS), Sharing Businesses, Design Build Finance Operate (DBFO), Other Green Business Models. These models have been stated in Table 3. In the following, descriptions about each of these business models have been described. All of the business models which are proposed by them have been described here.

Table 3. Classification of PSS models based on Berg, Bjerre and Henriksen (2010)

<table>
<thead>
<tr>
<th>Berg, Bjerre and Henriksen</th>
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<tr>
<td>Energy Service Companies (ESCOs)</td>
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<td>Design Build Finance Operate (DBFO)</td>
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<td>Chemical Management System (CMS)</td>
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<td>Sharing Businesses</td>
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<td>Functional Sales</td>
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<td>Other Green Business Models</td>
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</table>
4.1.1 Energy Saving Companies (ESCOs)

Optimization of energy in industries and for local usage requires appropriate level of information and technology. Here the role of a good business model for connecting ESCOs with clients is important. An ESCO contract can encompass designing, install, finance and also maintenance of whole project (Berg, Bjerre and Henriksen, 2010). In this model the provider of ESCO usually gets a share of profit from saving of energy. Here reduction in energy can produce a good economic incentive, for both customer and ESCO provider; moreover it creates a positive impact on environment too. Contractor is free for choosing appropriate technologies to reduce energy usage and optimization of processes. However, this may increase the risk of ESCO provider, but it also provides motivation for finding innovative solutions to reduce energy usage in whole process (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010).

4.1.2 Car-Sharing

In this model the provider rent a car for specific time to customers which usually can be for hours (European Commission-DG Environment/COWI, 2008). Here reduction in number of required cars for customers’ mobility can have a positive impact on environment; moreover the amounts of resource for production of these numbers of car are less compare to private cars. Here customers have the ability for choosing different brands of cars and also the quality of cars have been checked by providers. On the other hand, providers can have the control for whole life cycle of its cars; moreover companies can absorb people who want green products or they are not satisfied by traditional models such as rental or ownership (European Commission-DG Environment/COWI, 2008).

4.1.3 Resource Management

Resource management as a green business model proposes a contract between waste producer manufactures and waste managers to increase the amount of recycling and reuse (European Commission-DG Environment/COWI, 2008). Here different methods of waste management such as preventing, reducing, recycling and reusing can be applied by waste manager contractor. Decrease in amount of waste have a positive impact on environment and reduction of resource usage. Here by using different methods of waste management the product or some parts of it can be used in market which can reduce the need for new material and product. Reduction in cost for new feedstock can play as a good incentive for applying this business model by manufactures and waste contractors (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010).

4.1.4 Sharing Business

These models can be considered as more general models of Car-Sharing; one of good result from applying sharing models in business can be reduction in number of required products and services for a specific function. Usage of common resources and products for delivery of a function to customers reduce the environmental impacts of their activities. In this model concept of private ownership is changed and a shared product can be accessed by users when it is needed (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010). Decreases in amount of resources which are used for this number of products reduce the cost of production and also give the chance to provider for renewing and maintenance during usage time. This can prolong the life time of a product and increases
providers’ benefit by reducing investment for replacement products (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010).

4.1.5 Chemical Management Service or Chemical Management System

These two business models provide the same activity for customers and just they have been addressed by different names. The core for both of these models is based on reduction of material usage and optimization of industrial processes for better utilization of material resources (Mont, Singhal and Fadeeva, 2006; Berg, Bjerre and Henriksen, 2010). In traditional business models higher volume or size of selling chemical creates more revenue for companies. In these models of contract, provider of chemical is responsible for preparing a service or managing chemical for manufacturer. The method of this management can be different, such as using new technologies or consulting with a company that has precise information. This information can be related to optimizing a specific production process or increase the efficiency of devices by controlling whole system (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010). Reduction of chemical usage by these business models can directly decrease the amount of impacts on environment besides of that it can reduce expenditure of company for buying required resources and transportation cost.

4.1.6 Remanufacturing

In remanufacturing model a product that is used by a customer can bring back on market with some processes. Here a company applied these processes for refurbishing and upgrading of a used product, which may be attractive for other customers. As Sundin (2004) described various process of a generic remanufacturing model can be included inspection, cleaning, storage, disassembly, process, reassembly and testing. Remanufacturing has a mutual benefit from downstream and upstream (European Commission-DG Environment/COWI, 2008). Reduction of waste production in downstream besides decrease in needed material for new products can be called as positive effects of the remanufacturing.

4.1.7 Design Build Finance Operate (DBFO)

DBFO is one green business models with long-term duration which typically last for near 30 years (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010). The provider based on a public-private partnership (PPP), is responsible for design, building, financing, operation and maintenance in a project (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010). Here the risk for executing of a DBFO project will be divided between receiver and provider of service. The higher and extensive knowledge of provider about whole processes of project puts him in a better place for any optimization of system and maintenance. Moreover, there are many incentives for contractor to reduce amount of energy and material usage which both can reduce the cost of investment and operation also environmental impacts (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010).

4.1.8 Functional Sales

Recognizing and providing actual demands of customers is the goal of this type of PSS model. Because of its concept, many common characteristics can be found among functional sale and other product service system models (Berg, Bjerre and Henriksen, 2010). Functional sale can produce profit, according to delivery of customers’ requested function, with less
impact on environment (Mont, 2004). Maintenance, repair, seeing whole life cycle and higher responsibility of provider can consider as various offering which this model contains (Berg, Bjerre and Henriksen, 2010). In this model provider has more concern about usage phase of a product which usually is not considered by manufacturers. Reduction in material and energy are some of environmental benefit which can be reached by using this new business model (Berg, Bjerre and Henriksen, 2010). Besides environmental effects, reduction in cost of energy, spare parts and maintenance are some economic factors that play as incentives for customers to accept this model.

4.1.9 Other Green Business Models

There are some other business models which can be considered as new types of product service system. Sustainable supply chain management (SSCM), Cradle to Cradle, Industrial Symbiosis (IS) and other models have a good potential for reducing environmental impacts. According to this, a new category for these novel business models has been suggested by Berg, Bjerre and Heniksen (2010) which consists of these models. Each of sub categories related to this business model uses a specific concept for dealing with economic and environmental aspects; but in general a reduction of material resources, energy usage and waste production can be seen during implementation of them. All of these models produce an incentive for both customer and provider in usage time.

4.2 PSS Contracts in Industries

According to the USA Federal Acquisition Regulation (FAR)¹ and Meier, Roy and Seliger (2010) general categories of contract for product service system in industries can be presented as six categories Fixed price contracts, Incentive contracts, Indefinite delivery contracts, Cost reimbursement contracts, Spiral Contracts, Time and material contracts, Labor hours contracts and Letter contracts. A general scheme of PSS contract classification is shown in Figure 5. A brief description related to each category and different sub models of contract based on Federal Acquisition regulation and Naval Air Warfare Center Training Systems Division (NAWCTSD) is presented in below. According to Datta and Roy (2010), normally the time for these types of contracts is between 5-30 years and they can be influenced by various demands of customers during this time.

4.2.1 Fixed Price Contracts

From definition of Federal Acquisition Regulation amount of payment in this type of contract has been discussed and decided before start of contract. This amount can be adjustable price or fixed price. In situation which acquiring commercial items will be needed the concept of firm-fixed-price or fixed-price contract can be used by contracting officers. These types of contract will usually be used when uncertainty in business activities are minimal or can be predicted in specific level (Roy and Cheruvu, 2009).

Fixed Price with Economic Price Adjustment

This subcategory of fixed price contract will be used when stability of price in market is not predictable. Any changes through labor conditions or bull and bear of market can affect in settlement. This economic adjustment price usually applied to established price, actual costs

of labor or material, cost indexes of labor or material. This type is not usually the first choice of any contracting officer unless for protecting the contractor or government against high fluctuation of material and labor price in market (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

Figure 5. Different types of contract used in product service system (Roy and Cheruvu, 2009)

**Fixed Price Contracts with Prospective Price Redetermination**

In this type, the contract can be divided in two parts. In initial period of contract which is usually the longest period, the price is constant. In performance period the price can be based on a ceiling value because of adding uncertainty and other factors. Here contractor’s accounting system should be suitable for determining the price with these existed uncertainties. Twelve months is the minimum intervals of each subsequent pricing period (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

**Fixed Ceiling Price Contracts with Retroactive Price Redetermination**

This type of contract is suitable for research and development projects with maximum estimation price of 100,000 $. According to amount of money and short performance period, usage of other fixed price contract is impracticable. The contract payment will be made after
negotiation about billing price. Lack of incentives for cost controlling creates a disadvantage for applying this type of contract (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

**Firm Fixed Price, Level of Effort Term Contracts**

According to effort of contractor in specific time and area of work, the payment will be calculated. For research and development in particular area this type of contract can be used. The outcome of contract is a report which shows the result of an investigation. This investigation can be about a project or achievements related to it. Usually payment is based on expended efforts instead of outcomes of project, and contractor will be paid a determined fixed price. When required level of efforts for achieving a goal is unidentified but the minimum level for reaching it is specified, this type of contract can be applied (Federal Acquisition Regulation, 2011).

**4.2.2 Incentive Contracts**

This kind of contract is useful if firm fixed price contract cannot provide the receiver’s needed demand. The contract incentive items help provider of a service to improve its efficiency and waste management (Naval Air Warfare Center Training Systems Division, 2011; Federal Acquisition Regulation, 2011).

**Formula-type Incentives Contracts**

**Performance Incentives**

The performance of a service here plays an important role; for example, according to design and delivery of a service the price can be calculated such as the power of engine instead of physical engine (Mont, 2004). The contract requires to be checked for quality and standard level of service. Different specification of contract such as testing conditions, precision of instrument and analyzing data should be expressed in details. This type of contract is suitable for major system contract. Development and production sectors can use this type to improve their performance (Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

**Cost Incentive**

Usually incentive contracts use some adjustment formula for calculation of profit. This reevaluation of profit can be used to motivate contractor to manage cost better. According to this, contractor should watch out these cost incentive and constraints of expenditures during its activities (Roy and Cheruvu, 2009; Naval Air Warfare Center Training Systems Division, 2011).

**Delivery Incentives**

The primary objective in delivery incentives contract is delivery of a specific important item without any interruption to receiver. These items can be as quality of service, delivery time, etc. The method of reward and penalty can also be used in this type of contract (Federal Acquisition Regulation, 2011).
Structuring Multiple Incentive Contracts

Unlike other incentive contracts, here two or more items can be the source of motivation for increasing the performance of contract. Increasing the quality of service beside reduction of delivery time can be an example for this type of contract but there is a need for a ceiling level of cost from contractor side. A ceiling level of cost help receiver of service not to carry an unexpected and overburden cost during contract (Federal Acquisition Regulation, 2011).

Fixed Price Incentive

The payment of contract is fixed but it can be adjusted when it comes to actual price. The calculation of final cost can be made by using a specific formula and determining final negotiation and total target cost. (Naval Air Warfare Center Training Systems Division, 2011).

Fixed Price Incentive (Firm Target)

Firm target is suitable when parties can negotiate according to profit, cost and profit adjustment. Here in the start of contract a target profit, ceiling value, target cost and a profit adjustment formula are specified. After finishing contract, the difference of actual and negotiated cost will use for calculation of profit. If the contractor exceeds the negotiated price the final profit of contract will be reduced, based on using profit adjustment formula. On the other hand any reduction of cost by the provider will affect its profit. This stimulates any provider for innovation and reduction of related cost (Federal Acquisition Regulation, 2011; Roy and Cheruvu, 2009).

Fixed Price Incentive (Successive Target)

Successive target contract can be divided in two stages. In the first stage an initial cost and profit target besides initial profit adjustment formula will be specified. In addition before buying or installation, production point, firm target profit and cost price will be negotiated. Here the ceiling price plays as a maximum level of payment to contractor, which will be specified too. In the second stage when contract reach to its stable situation and production point two parties to the contract will be renegotiated with each other about cost and profit. Here the target profit of firm will be estimated by the formula which should be accepted by both sides. This type of contract can be useful when price and cost of a service is unknown and calculation of realistic price is difficult. The accounting system of contractor should be suitable for providing appropriate information related to negotiation and realistic profit adjustment formula (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

Fixed Price Contracts with Award Fees

When there is no appropriate incentive for motivation of a provider because performance cannot be measured objectively, governors can use award fee contract. The evaluation of performance will be done periodically and award fee is an extra payment besides the fixed fee of contract for satisfaction of provider (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011).
**Cost Reimbursement Incentive**

This type of contract can be used when uncertainty is inevitable in contract. According to any incurred cost which is mentioned in contract, the payment will be done. A ceiling value for cost will be stated, that contractor should not pass it (Roy and Cheruvu, 2009).

**Cost Plus Incentive Fee Contracts**

At start of contract an initial agreement between both sides of contract about price, sharing of cost and calculation of sharing cost and profit will be made. According to activities of contractor, the performance, cost and profit of contract reevaluated. If the actual cost is lower than expected cost it increases the benefit to contractor. On the other hand, any extra expenses which exceed the negotiated price can reduce the expected profit. The calculation of cost can be made by following formulation (Berends, 2000; Naval Air Warfare Center Training Systems Division, 2011).

\[
\text{Final Payment} = \text{Target Cost} + \text{Fixed Fee} + \text{Buyer Share Ratio} \times (\text{Actual Cost} - \text{Target Cost})
\]

This kind of contract can be applied to development project, service and test program (Berends, 2000; Federal Acquisition Regulation, 2011).

**Cost Plus Award Fee Contract**

The payment consists of a fixed fee and award amount fee which will be paid based on specific performance of service or product. This performance can be in reduction of delivery time, reaching to special quality, innovation in product or service, etc. The amount of payment usually depends on decision of receiver and its precise formula for calculation of it (Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

4.2.3 **Letter Contracts**

According to this type of contract contractor has an obligation to do manufacturing, or delivering of services. Here the demand of customer or government is an important incentive for applying this type of contract. If there is no other appropriate model of contract for applying to project, then this type of contract can be considered (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011).

4.2.4 **Indefinite Delivery Contracts**

In general this type of contract is used for acquiring supplies and services, but specific time and amount of this delivery will be defined in future time (Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

**Definite Quantity**

When the amount of service or supply can be identified, this type of contract is useful. The contract provides delivery of specific amount of supply or services for a time period. This can be planned for a particular location. Here usually the provider of service or suppliers can be reached easily (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011).
Requirements

When governments or receivers anticipate the need for a supply or service in future, but the precise amount of it is not determined, this type of contract can be used. First an overall estimation of activities and requirements should be performed by government. The estimation should be based on similar cases and current available data. This estimation is not for presentation to contractor companies. Moreover a maximum obligation of contractor to delivery and minimum government’s obligation for ordering should be specified in contract (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

Indefinite Quantity

Here the contractor obligates to provide an indefinite quantity of order for a fixed period of time, for example a government can put in an order for an individual requirement. Number of units or money values can see as the limitations of quantity which will be stated in contract. A minimum level of delivery and maximum obligation of delivery can be written in contract. The amount of maximum should be calculated according to information of current market, similar contract, etc. This type of contract should be used when government cannot specify the minimum demand of service or supply, but they anticipate these requirements during contract time (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011).

4.2.5 Cost Reimbursement Contracts

When rate of uncertainty in a contract will increase or the estimation related to effect of other items will be difficult, usage of cost reimbursement contract can be a solution. The payment is for occurrence of needed services but an overall estimation of cost and ceiling price will be made before contract. The contractor cannot pass this estimated ceiling level without permission of contractor officer (Roy and Cheruvu, 2009; Naval Air Warfare Center Training Systems Division, 2011).

Cost Contracts

In these types of contract there is no payment fee, and usually it can be seen in research and development projects. Nonprofit educational institution and organization use this model too (Federal Acquisition Regulation, 2011).

Cost Sharing

Similar to cost contracts, contractor does not receive any payment but for specific agreed items, contractor can charged receiver of service. Here contractor accepts the risk and cost of contract, in exchange of substantial compensation benefits. This benefit can be seen as an invention or development of a product or something that is not related to monetary stuffs (Federal Acquisition Regulation, 2011).

Cost-Plus-Incentive-Fee

An initial ceiling value will be determined. Parallel of this a specific formula for price calculation will be established and based on it recalculation of price will be made. In situations where the provider of service exceeds this value price, its profit will decrease. On
the other hand, any activities of seller which reduces the actual cost can increase the total profit of seller (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011).

**Cost-Plus-Award-Fee**

The price consists of two parts: a base payment and an award payment. The base payment is determined as a fixed amount in start of contract (It can be zero). Award as the other part will be calculated by performance of contractor from government and this increase motivation of provider to presenting higher quality of service (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

**Cost-Plus-Fixed-Fee**

Contractor receives a fixed negotiated payment which is determined in start of contract. The variation of actual cost does not affect this fixed fee, but it can be adjusted in respect of changing tasks of contract. Here there is no motivation for provider to reduce cost. If the cost exceeds the determined ceiling value, there is no reimbursement for it. Moreover if the actual cost is lower than specific initial value only the actual cost will be compensated. The payment can as a lump sum or on a prorated basis. A cost plus fixed fee contract is suitable when the level of required effort is unknown or the project is related to preparatory investigation and research. This type of contract is not appropriate for use in development of major systems (Loeb and Surysekar, 1997; Federal Acquisition Regulation, 2011; Roy and Cheruvu, 2009).

4.2.6 **Time and Material Contracts**

When there is not an exact estimation for duration and cost of contract or precise calculation of these costs will be difficult then time and material contract can be useful. This type of contract is usually used for providing services or supplying products. Total price can be calculated based on the fixed fee for labor, hourly wages, and profit, material cost, overhead, general and administrative expenses. It is recommended if there is no suitable other contract options (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

4.2.7 **Labor Hours Contracts**

This type is the same as time and material contract but here there is no material supply from contractor. This material is not included in contract for supplying by contractor, only labor hour will be paid by owner of contract (Federal Acquisition Regulation, 2011; Naval Air Warfare Center Training Systems Division, 2011; Roy and Cheruvu, 2009).

4.2.8 **Spiral Contracts**

One problem related to any business or contract is obsolescence of technologies. Regarding this, another type of contract with aim of removing this issues and avoiding technology obsolescent is developed. Spiral contract with its long-term duration and continues upgrading of technologies can be a good solution for this problem (Roy and Cheruvu, 2009).
4.2.9 Relation between Contracts and Industrial PSS Dimensions

Moreover, Meier, Roy and Seliger (2010) have offered a suggested relation between these contracts with three dimensions of industrial product service system. Revenue generation opportunity, customer affordability and sustainable customer value are these three dimensions. These dimensions can be used by industries when they are offering a PSS models or improving the current business model. The definition of these dimension have been presented in drivers for PSS. Here customer affordability is connected to long-term perspective of contract for absorbing and retaining of customers, revenue generation opportunity can be used for increasing market share and sustainable customer value is a driver which with high concern in sustainability (Meier, Roy and Seliger, 2010). Table 4 presents this relation.

Table 4. Relation between contracts and industrial PSS dimensions (Adapted from Meier, Roy and Seliger, 2010)

<table>
<thead>
<tr>
<th></th>
<th>Customer Affordability</th>
<th>Revenue Generation Opportunity</th>
<th>Sustainable Customer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed-Price Contracts</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost-Reimbursement Contracts</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Incentive Contracts</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Indefinite-Delivery Contracts</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Time-and-Materials, Labor-Hour and Labor Contracts</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Spiral Contracts</td>
<td>✔</td>
<td></td>
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</tr>
</tbody>
</table>
5 Influential Factors in PSS Contracts

This chapter describes various factors which can influence product service system. Moreover, some statistics and information related to each of these factors based on literature review are listed.

RQ2. What factors can influence long-term PSS contracts?

Implementation of PSS models in market required support from different stakeholders and also some changes in their structures. These stakeholders cover designers, providers, financial institutions, governments, customers and other interested parties which their support in whole process of design, delivery, and adaptation of PSS is important. However, this support is depended to several factors; for example, better quality in service or speed in delivery are two factors which can absorb interest of customers for these types of PSS contracts. Identifying these factors can increase the success of PSS; moreover, it can improve knowledge of companies for finding proper approaches to deal with them. In the following, based on gathered information, different factors which can influence long-term PSS contracts have been addressed.

5.1 Internal Structure of Service Provider

Implementation of PSS requires good design, suitable delivery and adaptation from users (Roy and Cheruvu, 2009). To have a successful PSS, each of these factors should work well; this needs a harmonious organizational structure. As (Mont, 2001a) stated, changing in internal and external organization of companies is important for implementation of PSS. Moreover, production, packaging, sales, maintenance, management sectors of a company should be trained and ready for implementation of PSS. Here, the effects of external factors such as competitors, suppliers, etc. should be considered in offering PSS contracts too.

The internal structure of a provider is a factor which can affect PSS contracts; here, potential for implementation of PSS models by company should be fully examined. There is not a unique way for product and service designing because of the various types of customer, provider’s functions and relation between them (Schuh, Friedli, and Gebauer, 2004). According to this structure and abilities of a provider, should be checked before implementation of specific types of PSS contracts. In some cases, this structure can be a barrier for implementation of PSS; for example, accounting system of many companies are based on traditional sales of product which means the volume and number of selling product is an important factor for calculation of benefit (Roy and Cheruvu, 2009; Mont, 2004). This can engender problems for companies to change this system for operating in different types of PSS contracts which provision of a function is the main aim of companies.

A survey by Neely (2007) stated that big companies with high number of employees have a higher possibility for offering product and service system to their clients. Figure 6 presents this relation between size of companies and type of their focus in market.

One of issues that can happen in small companies during implementation of PSS is the lack of human resources and involvement of them during this process. This involvement requires investment in training employees and information technology for managing them (Mont, 2001a, 2001b). Here, lack of budget, human resources and management technology according to small size of company can produce several problems for PSS provider. Moreover, implementation of PSS because of its characteristics and different methods requires suitable
software and hardware. As Roy and Cheruvu (2009) stated, changing in attitude of different stakeholders such as designers, suppliers, customers and solution providers from pure manufacturing is a critical aspect of PSS which consists changes in people, hardware and software (Roy and Cheruvu, 2009). For instance traditional internal accounting systems which works based on amount of selling should change (Mont, 2001a). Hardware and software of provider have a big effect in its abilities for presenting a better service. Nowadays, without communication devices such as telephone, fax, photocopier and computer, management of administrative work can be difficult by increasing size and activity of company.

Training and motivation of human resources are some necessary factors which help PSS providers, in designing and delivery of its goal. Here personnel of a company are an important part of a PSS provider during contract. How they will be trained and prepared for this process is critical. Tikkanen and Polonen (1996) stated that training of personnel and strong involvement of them is an important factor for succession of business process for reengineering (BPR). The BPR can be describes as creation of changes in working life of employees; here roles of each person in group is important and can be defined as a person’ expectation about how he or she wants to behave in relation with other members (Tikkanen and Pölönen, 1996).

Any changes in system required high effort and force which this can be described as commonsense law of inertia which is used in logical programming (Liao, 2002). Base on this, a change in managers or employees of companies which is used to work with traditional methods for selling and buying of products can be a difficult task and requires support from higher level of directors. In case of Institute of Strategic Defense Management (ISDM) which
is responsible for training Taiwanese military officers for financing, administration, logistics, etc. the inertia of personnel and managers for updating with new technologies and methods engendered many problems for system (Liao, 2002).

Lack of information about design and delivery part of a complex engineered service is a factor which can be considered by companies during offering PSS contracts. This comes from lack of knowledge about organizational abilities of a company besides changing traditional service culture in manufacturing companies (Neely, 2009). Another factor which can influence personnel is bonus systems which generally are based on amount of sales, size and volume of presented product or service. This system, forced agents and different parts of company to work for higher selling in size and volume instead of customers’ required function (Berg, Bjerre and Henriksen, 2010).

In addition to effect of managers in expanding PSS, existence of appropriate incentives for workers can increase their motivation. In any company, personnel of each section have a higher knowledge about related problems of their work. This profound knowledge about issues can put them in a better situation for handling problems. According to Gallup consulting, there are three types of employees engaged, not engaged and actively disengaged. Specification for each of these employees can be seen in Table 5. The different percentages of each group in a company can influence total activities of it. A firm with high numbers of actively disengaged employees can have many problems related to efficiency and quality of works.

<table>
<thead>
<tr>
<th>Engaged</th>
<th>Not Engaged</th>
<th>Actively Disengaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>They are Innovator and builder, also work with passion. They want to use all their abilities and show their potential.</td>
<td>The task is more important for them than the result of work. They prefer to take command instead of being creative. They do not have a productive connection with their managers.</td>
<td>They are not happy and satisfy in their work and usually see the negatively in any activity. The effect of these people in work area can cause a big damage to all other workers and company too.</td>
</tr>
</tbody>
</table>

Inappropriate integration among various parts of a company reduces PSS performance and also success of PSS contract. Companies usually consist of two different parts for providing

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product and service to customers, that a better knowledge about their network promote the quality and success of PSS (Schweitzer and Aurich, 2010). Here a better connection between different internal sectors of company is crucial. For example financial group of a company usually are responsible for calculation of required investment, but without knowledge about the technical and operational stuffs these calculation cannot be accurate.

Using information technologies methods, such as data mining can be a useful technique for understanding customer’s interest and habits. Here system can gather information related to delivery and usage phases of PSS, and then this data can be used for improving service and product (Roy and Cheruvu, 2009). This process requires suitable algorithms for processing collected data and also appropriate applications for analyzing them (Kusiak and Smith, 2007).

Usually controlling of product service system is more complicated than traditional system of selling and buying a product (Berg, Bjerre and Henriksen, 2010). Many factors such as infrastructure, long-term of contract, relationship among suppliers, provider and customers, can affect in PSS contracts. For example as Datta and Roy (2010) stated changing demand of customer during long-term relation in PSS contracts requires using different processes for handling them. The management of PSS will be harder when it comes to a worldwide company; however in some cases it can cause high cost saving. For example Kranenburg and van Houtum (2009) showed that letting transshipment of parts in semi-conductor market by some carefully selected distribution centers can lower the cost of process. Here selecting midpoint centers which are responsible for delivery and controlling equipment should be considered carefully.

There is always a competition between different sectors of a company for receiving higher rate of fund for their projects (Berg, Bjerre and Henriksen, 2010). The long duration of a contract means that there is a stream of benefit for company during project time. This besides limited investment potential by each company can create a problem. Berg, Bjerre and Henriksen (2010) stated that in ESCO contracts, limitation of funding can produce an internal competition among different sectors which are responsible for various projects. For example Alfa Laval Company realized that competition between sales and after sales sector maybe happens during functional sales contract in addition, another competition can happen in sales of efficiency vs. sales of products (Mont, 2002a).

5.2 External Structure of Service Provider (Network, Partners, Suppliers and Competitors)

In addition to internal structure of a company, interactions of outside actors are important for expansion and promotion of PSS contracts. Network, partners, suppliers and competitors can be considered as critical factors in external structure of any provider. Their activities performance can be a big help for a company to implement product service system contracts successfully in market.

Nowadays relationships between companies and suppliers are critical in world market. PSS has a potential for producing more profit based on suitable relationships between these two parts (Meier, Roy and Seliger, 2010). According to various suppliers in market, companies have different choices for selecting among them. This means suppliers should have a better offer in performance or price to be the winner of this selection. Marketing and supply chain integration can be presented by following matrix in Figure7 (Deloitte, 2002; Lee, 2001; Piercy, 2002 as cited in Jüttner, Christopher and Baker, 2007, p.380). According to this, the winners of market require good support of suppliers or have a good amount of supply.
Moreover they need a profound knowledge about market and customers. The winner should be able to link various suppliers with its clients by diversification of product and services besides using different methods of delivery (Jüttner, Christopher and Baker, 2007). As Ray (1982) stated in Lichtenthal, Yadav and Donthu (2006) using appropriate advertising have a good potential for helping providers to reach this goal. Moreover; PSS providers can use this connection with supplier for influencing activities of suppliers and higher control of material chain.

Figure 7. Levels of marketing and supply chain integration (Deloitte, 2002; Lee, 2001; Piercy, 2002 as cited in Jüttner, et al., 2007, p.380)

In any product and service system, networks between actors and partnership are an important factor (Meier, Kortmann and Volke, 2007; Becker, Beverungen and Knackstedt, 2008). Each company has a specific amount of knowledge about its services, products, markets and customers. Higher communication among different actors of market can help them to evaluate their current market and customers with lower cost and time. As Berger, et al. (2004) stated sharing resources, knowledge and capabilities are the goals of partnership. According to this, each firm can get a higher amount of information or capability for performing a function to customers. However there are some obstacles which can affect this process; White (2009) presented some of barriers for partnership such as people, roles, behavior, structure, resources, and the rest that can be seen in Figure 8.
Figure 8: Common barriers of partnership (White, 2009)
5.3 Cost and Price

Companies usually have different strategies for using PSS. Some see it as a solution for environmental problems; others consider its economic aspect and the way of satisfying customers (Maxwell, Sheate and van der Vors, 2006). According to this, economic aspect has an important influence in absorbing different companies for PSS contract. Here product service system has a great potential for increasing environmental and economic benefits of a company based on a new form of relations between provider and customer (Goedkoop, et al., 1999; Meijkamp, 2000; Stahel, 2001). In this area, some factors such as cost, price and other economic factors should be considered carefully.

As Merriam-Webster, cost\(^3\) is described as “the outlay or expenditure (as of effort or sacrifice) made to achieve an object”, and also price\(^4\) is “the amount of money given or set as consideration for the sale of a specified thing”. Based on these definitions it can be said the price is amount of money which a provider puts for its product or service according to customers and market situation; but cost is sum of all expenditures that for providing a product or service should be considered.

Estimation of the cost in any PSS contract can be important factor also a difficult task too. However cost for a product can be calculated directly but in service area there are many ambiguities which should consider in assessment. The number of studies for estimation of service cost is very low (Datta and Roy, 2010). This estimation of cost contains many assumptions and using rules of thumb besides information from experts and there is no specified framework for it (Datta and Roy, 2010). Many efforts related to evaluation of the price have been done. Meier, Roy and Seliger (2010) also Roy and Cheruvu (2009) work in founding a framework for PSS, which it will be helpful for calculating of service price. In assessment of PSS price a holistic view of activities, overall cost, initial investment and estimated price can be helpful. This price and cost are main topics in PSS contracts which should be discussed between provider and client. Some efforts have been performed in this area for estimation of this cost for PSS. Curran, Raghunathan and Price (2004) stated different cost estimation techniques, and divide them in \textit{classic} and \textit{advanced} techniques; each of them has its advantages and limitation for evaluation of cost estimation. Moreover Datta and Roy (2010) present a cost modeling for availability type service which can be used as a base for assessing of PSS contracts cost. \textbf{Figure9} shows five different cost estimation techniques which are presented by them:

\textit{Analogous}: Comparing a product with a base product with main similarities creates a foundation for calculating its price. Assessment of price is based on distinctions between object and base product; by identifying these differentiations correctly estimation of price can be done (Asiedu and Gu, 1998).

\textit{Parametric}: Regarding Parametric Cost Estimating Hand-book of the Department of Defence (1999), parametric technique uses one or more cost estimation relationship (CERs) for evaluation of cost in manufacturing, production and end of life. This calculation contains mathematical algorithms and formulation.

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Analytical: This method is more accurate than former methods and can be used when most of product and process characteristics are known. In respect of its dilatory calculation, the method is not suitable for first step of the project (Datta and Roy, 2010).

Activity-Based Costing: Bottom-up is another name for Activity-based costing method which works with detailed information and engineering calculation for estimating the cost (Toth, 2006). The price for tasks, physical components, consultancy and all of particular costs are considered in calculation. The analyst should know about details of design and configuration of components; also more information related to material and labor of system for executing it in system manufacturing level (Goodman, 1992; Rand Corporation, 2002).

Expert Judgment: In most cases there is no existing price estimation and it requires estimation by connoisseur who works in that field. The method can be quicker than other methods and used as a draft for cost assessment. Other methods can be used to improve accuracy but the error and bias of estimation from experts should be considered too (Datta and Roy, 2010).

In PSS contracts, the offered price from provider is one factor that can absorb and retain customers. This price can be calculated after estimation of overall cost; in here accuracy of cost estimation is important. Any underestimation can lead to financial loss; on the other hand by overestimation of cost, companies can lose their customers (Datta and Roy, 2010). Sometimes PSS contracts may require more investment in initial stages of implementation based on training of different actors and employees, establishing contacts, connection and informing stakeholders, etc. (Mont, 2001a). Based on a research near 70 percent of total life cycle cost is in early stages of PSS design (Datta and Roy, 2010). For calculation of this cost, some factors such as initial capital investment for equipment and installation of them should be considered. Here Coster (2008) identified four elements, manufacturing activities, capital investment, logistics activities and customer life cycle support for calculation of total cost of ownership. Information about these items can help a preliminary assessment, for required investment of PSS providers. Here by having a better knowledge about business and its activities, finding a suitable answer for handling initial investment will be easier.

Demand for a product or service in market is a factor which should be analyzed before making any decision for long-term PSS contract. Ryu, Tsukishima and Onari (2009) stated three types of demand information which are shown in Figure10. The characteristics of each type are different and choosing appropriate models for gathering information related to these requests help system to be more efficient (Ryu, Tsukishima and Onari, 2009). Here PSS provider can have a better evaluation about potential of market and future of it. Any bull or bear in market or rise and fall in inflation affect the cost of service and consequently in price of PSS contracts. Moreover, innovation in technologies which are related to specific service
and product system can affect in changing price of PSS too. Here presenting new technologies, which require lower feedstock or investment can reduce cost of current PSS models in market and consequently their price of offering.

![Figure 10. Three types of demand information (Ryu, Tsukishima and Onari, 2009)]

One main target for usage of PSS contracts is reduction in environmental impacts (Mont, 2004). Here durability and quality of a product can extend its life and as a result reduce usage of new resources for production of new products. Extension in product lifetime is one of offering methods in business models related to PSS (Khumboon, et al., 2009). Traditionally selling more products can produce higher income for product-oriented companies and this contradicts with life time extension of products. The provider will be more satisfied when the customers require for more new product, and life extension of product delays this process.

For selling introducing a PSS contracts advertising can play a critical role. There is various kind of advertising which can be applied to topic of business (George and Berry 1981; Twimble and Hemsel 1991). Usually all methods of advertising which are used in normal business models can be exercised here too. Offering a trial period of service or executing a pilot project in specific area can assist companies for raising knowledge of society about their activities. This can change their thoughts about service and make a mutual trust between both parties. Usage of a proper advertisement will help a provider for gaining its goal (Lichtenthal, Yadav and Donthu 2006) which for a PSS provider can be gaining higher share of market or producing more adding value. Advertising in TV, Radio, newspaper and Internet are some usual ways of increasing interest of customer to an activity or product (Edwards, 1968); here other new ways such as attending in conferences or workshops can be helpful too.

One important activity of sale sector in a company is gathering information related to customers (Darmon, 2002). Each representative of company provides important information related to needs and request of customers in different times and places. All these collections of information can be used to detect actual demand of clients; then regard of this, new services or products can be designed. Training personnel of different sectors in a company such as sales, research and development can be helpful in this process. As Meier, Roy and Seliger (2010) stated, Mori Seiki Company which works in field of machine tool
manufacturing, trains its customer besides other after sales offering. Here even training of customers and increasing knowledge of among them may affect in more acceptance of PSS; also this education and training may produce new ways for income too (Mont, 2004).

An important external driver for a company is supplier (Mont, 2002b) which provides required material of PSS providing. What will happen if a special substance of PSS becomes scarce or the price for it will increase? Many external factors can engender this problem, such as conflict between big suppliers, demand in market, war, political issues etc. For example the political tension in Libya and flowing war which started in February 2011 raise the price of crude oil in market. Data related to this regard of U.S. Energy Information Administration⁵ are presented in Table6. The commodities and change of their indicators in market places, depends on many factors which can influence final cost of a PSS contract. The provider of PSS should beware about bottlenecks of its work, and items that can have direct or indirect effect on its process cost. For instance some operational costs such as energy usage have a direct effect in cost estimation.

Table 6. Crude oil prices (Dollars per Barrel) regard of U.S. Energy Information Administration

<table>
<thead>
<tr>
<th>Year &amp; Month</th>
<th>Domestic</th>
<th>Imported</th>
<th>Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average for 2010</td>
<td>77.96</td>
<td>75.88</td>
<td>76.69</td>
</tr>
<tr>
<td>January 2011</td>
<td>88.73</td>
<td>87.99</td>
<td>88.28</td>
</tr>
<tr>
<td>February 2011</td>
<td>89.46</td>
<td>91.72</td>
<td>90.84</td>
</tr>
<tr>
<td>March 2011</td>
<td>99.35</td>
<td>104.91⁶</td>
<td>102.16⁶</td>
</tr>
</tbody>
</table>

⁶ Estimated Data

Price: Dollar / Barrel

Martorell, et al. (2010) stated managing human and material as two types of resources can affect in business models such as maintenance. Furthermore their scarcity and complexities makes the price evaluation to be hard. According to United States Department of Labor⁶, the cost of labor for some areas such as the USA, Canada and Western Europe are high, while in developing countries this cost is low, for example China and India. Figure11 presented a good comparison between differences of payment in various countries. This diversity of cost can be seen in value of varieties of resources in different countries too. For example, a PSS company which requires wood as one of its resources can provide a cheaper service in a country or place that has forest and high enough amount of wood resources. This means similar PSS design can have different price, based on offering regions.

The end of life for products is highlighted in business more than before; based on this, law of take backing for products have been accepted by many countries (Toffel, 2003). The strategy of treating obsolete or out of order product is important for society and companies. Here the cost of obsolescence can play as an important factor for PSS (Meier, Roy and Seliger, 2010). In traditional business models this cost is paid by customers, but in new models responsibility of managing it comes to duties of providers. However deep connection between customer and provider in long-term PSS contract makes finding and collecting of products be easier than traditional methods of selling products.

![Figure 11. Hourly compensation costs of manufacturing employees in selected economies and regions, 2008 (United States Department of Labor)](image)

5.4 Trust

Trust can be defined in many different ways such as viewpoint of social psychologists, economist, philosophers, etc. (Blomqvist, 1997). In any product service system trust have a big role and it can see specifically or in background of system. Garbarino and Johnson (1999) besides Morgan and Hunt (1994) stated that trust is a precondition for creating suitable relationship between customer and provider also any commitment. A strong partnership between both parties of long-term PSS contracts is essential (Meier, Roy and Seliger, 2010). The consequences of a contract can be remained for a long time; according to this, both parties of contract should know each other appropriately.

Reputation and history of a provider’s activities can be a good indicator for judging its abilities to manage different projects and moreover its advantages in competition with others (Capozzi, 2005; Dierickx and Cool, 1989). The reputation of provider plays as a hidden insurance for customers and can create trust among them. Acquiring this reputation requires high investment and it is a time consuming process for owning it (Keh and Xie, 2009). Regard of this holding reputation is a critical aim for all companies (Capozzi, 2005).

Moreover concept of trust can be expressed as a subjective phenomenon, which many items can affect it; the weight and size of these factors can be different related to each person and situation (Josang, Ismail and Boyd, 2007). Topic of trust requires a comprehensive survey for
understanding. How trust can be created between customer and provider? Which factors play important roles in creation of trust? Answers to questions similar these help PSS provider to have a better understanding about trust. Building of trust between customers and providers are important, for example in PSS contracts which both parties should have access to sensitive information exist of trust is a helpful factor (Mont, 2004).

However, trust is usually seen as a need of provider for absorbing and keeping customers, but mutual trust can be beneficial for both parties (European Commission-DG Environment/COWI, 2008). Clients require getting a suitable and reliable service; this can be prepared by a trustworthy provider (Fombrun, 1996). When there is no history of relationship between customers and provider, a good reputation of company can see as a positive point for selecting it (Campbell, 1999). Here this reputation can produce initial trust for customers which want to go through long-term PSS contracts.

Furthermore, long-term relation of customer and provider in PSS contracts helps provider to understand real demand of customers; and according to this knowledge, a suitable solution can be offered. Subsequently offering better solution to customers creates a stronger relationship and mutual trust between both parties. Here middle sectors such as branches, service providers, sellers and other parts of provider who communicate with customers have a critical role in creation and conservation of trust (Hope, Muhlemann, 1997).

5.5 Social Norms & Intangible Factors

People in society use some implicit or explicit rules which guide them in their evaluation, behaviors, interactions and beliefs; these regulations are different in various places and cultures. Social norms can be depicting as collection of these usual rules and behaviors (Peyton Young, 2008). The source of these rules can be different matters such as religion, historic events, culture, etc. Hong and Kacperczyk (2009) stated that many social scientists consider social norms as an important factor for economic and market outcome.

These norms can be classified as:

- **Injunctive Norms:** This type of norms contains activities and behaviors which are accepted by most of the people.
- **Explicit Norms:** Any rules which are spoken by all people or written.
- **Descriptive Norms:** Comprehension of how everybody in society acts whether or not these acts are accepted by others.
- **Implicit Norms:** Some rules will be found after violating them. They seem to be hidden and not stated openly.
- **Subjective Norms:** Beliefs and expectations of other people can be put in this type.
- **Personal Norms:** Some rules which we use in our actions.

Diversity in people’ behavior besides long time of a contract makes difficult prediction of what can be happened during implementation of it. Many ups and downs happen in relation

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between customer and provider during contract time. Each client or group of customers has their specific norms and behaviors which should be considered by PSS provider. In some countries or community of people, special regulation approved and respected; this regulation can come from different origins such as religious beliefs (Clouser, 2002) or historical heritage of people.

Another important problem is related to interest of people for ownership of a product (Prettenthaler and Steininger, 1999; Berg, Bjerre and Henriksen, 2010). Possession of a product and pleasure of this feeling is another barrier for expansion of PSS models. People like to have ownership of their stuffs and buying a physical product usually makes them happy (Mayo, 2005). In most walls in city, Billboards, radios, TV, and many other places, many glamorous advertising for offering a new product can be observed by people. This massive amount of advertising besides high innovation in technologies and diversity of products have been set traditionally for increasing rate of selling products. Changing people’s attitudes about ownership is important and some concepts such as reduction of resources and long lasting economies are emphasized in it (Prettenthaler and Steininger, 1999).

5.6 Support of Government & Politics

History shows that leaders and governors have a major influence on much decision-taking. The governments usually react based on interest of whole society about a topic. Higher sensitivity among people about environmental issues can force governments to select proper strategies for dealing with these issues. Here different PSS contract models can be used as solution for these issues (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010). Here an enthusiastic politician who has a good background about PSS can have a higher effect in spreading product and service system. On the contrary lack of support from governors and politicians can defer development of PSS models. As European Commission-DG Environment/COWI (2008) stated achievement in sustainability of economic and environmental can be the main goal of politicians for accepting different PSS contract models.

Tax and subsidy are two critical factors which have potential for correcting failure in market and also behavior of people (Biz/ed, 2005). Tax as one arm of government for controlling market, companies, prices, and habits of people have an important role in directing society. Tax can influence people’s habits, such as amount of usage or buying a product (Institute for Environmental Studies, 2008). Any increase in tax rate of a material or product has a direct effect on its price; this means a customer should spend more money for buying it. According to limited purchase power of each customer, this increase of price lowers the demand. For success of a PSS mechanism in economy besides performance of a company, the existed framework of economic in society such as tax system should be suitable (Mont, 2004). For example Berg, Bjerre and Henriksen (2010) stated in case of buying electric vehicle which is offered by Better Place company the problems related to circulation of tax was a reason for lack of interest among customers for purchasing these cars.

Subsidy usually uses for arousing customers to a special product or way of behavior. Governments use subsidy for changing behavior in society and increase the interest of people for specific items or activity (Bacchetta and World Trade Organization, 2006). Moreover subsidy can help PSS provider in pervading of markets. In case that, governments recognize a proper business model has a good potential for reducing issues of society or wants to protect a particular industry, subsidy can assist them in solving these issues (Bhagwati 1971; Bacchetta and World Trade Organization 2006; Johnson, 1965). Here companies can do the same thing.
in their relationship with customers; they can provide some incentives or some sort of subsidy for absorbing clients to their new offering functions, products or services.

Merriam Webster defined insurance as “coverage by contract whereby one party undertakes to indemnify or guarantee another against loss by a specified contingency or peril”.8 Mont (2004) described one problem related to insurance during implementation of PSS. Transportation cost as highest and important part has a big influence in public activities (Tseng, Yue, and Taylor, 2005). Moreover, calculation of tax and insurance is usually based on ownership of vehicle instead of traveled path, which lowers incentive of customers to reduce distance and number of trips Mont (2004). The calculation of insurance depends on many factors, which vary for each PSS contracts; here complication of PSS besides differentiation of activities and actors can make this estimation difficult.

Local, regional and global decision can increase or decrease speed of PSS development. Leaders of countries or cities, who are familiar with nowadays problems of society and also outcomes of using PSS, can be a good aid for developing this system. Kyoto Protocol9 is a good model for co-operation of countries in global level; which during its execution time, it assists to solve many issues related to environment. This means any level of decision, such as global level (Kyoto protocol) can be made in PSS sectors and this decision can influence in speed of its development.

The effect of governors in developing of PSS is mutual; a good design and delivery of PSS can create a lot of job opportunities in local and regional areas (Mont, 2002b). Customers request for quality, time, and location besides product availability and functionality should be seen by a competitive provider (Meier, Roy and Seliger, 2010). Here higher responsibilities of a PSS provider during contract time, not only for product but also for keeping high quality of its functions create a demand for recruiting new employees. For example, contingencies in long-term contract may increase the need for more maintenance, training or other activities by PSS providers. This means creation of more jobs during implementation of PSS contracts. However Mont (2002) stated expansion of activities and scale of operations can direct PSS to use automation which may reduce rate of employment.

In present competitive market, reduction of production cost is an important goal for many companies (Weustink, et al., 2000; Keuschnigg and Ribi, 2009). One of barrier for reaching to this aim is the higher price of workers in developed countries. In respect of this, many big companies interested to outsource their production and use outsourcing for lowering their cost; China and India are two significant countries which have a lower price of labor (Kedia and Lahiri, 2007). Direct connection between suppliers and customers in type of business to business (B2B) or business to customers (B2C) needs appropriate management of human and infrastructure system (Mont, 2002b). Here PSS has many potential in activating competitiveness, environmental and economic benefits, and it can define new concept of connection between client and provider (Goedkoop, et al., 1999; Meijkamp, 2000; Stahel, 2001).

The outsourcing of many factories and plants in other countries have been increased the rate of unemployed persons in developed countries (Keuschnigg and Ribi, 2009; Kedia and Lahiri, 2007). The price of workers and production in these countries cannot compete with some

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developing countries (Keuschnigg and Ribi, 2009). Here product service system contracts can offer a solution for producing new jobs and also protecting employment in developed countries (Meier, Roy and Seliger, 2010). For example, demand for technical services in local regions for implementation of PSS, helps to lower effects of job loss which will be created by outsourcing (Stahel, 1994 cited in Aurich, Fuchs and Wagenknecht, 2006). It is hard to outsource human resources for a service in local area; success of local and regional companies can produce more jobs for whole region (Mont, 2002b; Aurich, Fuchs and Wagenknecht, 2006) which can have a positive effect in reputation of a company and higher support of society too. Here this support and pleasure of people can be the best outcome of implementation of PSS. As Manzini and Vezzoli (2003) described one of important element in PSS contracts is selling satisfaction to customers instead of traditional offering of product. Creation of more jobs by this system besides increases in satisfaction of people can inspire governors for supporting these types of PSS contracts. Political parties usually use different slogan for winning power competition. What slogan can be better than increase of employment and job opportunity in society?

5.7 Delivery Time of Service

Speed of delivery in products or services is one of important demand which makes customers to be more pleased (So and Song, 1998; Blackburn, et al., 1992; So, 2000). Customers’ request should be considered more carefully by provider and one of critical items is answering demand of clients on time (Blackburn, et al., 1992). Many services will be worthless if the time of request would be passed. We can find some interesting samples in computer software and programming business. Nowadays, the most usual activities of computer users are connection to internet for daily tasks, search and entertainment. This can be performed by different browser software. The statistics about share of browser in market have been presented by Figure12. It can be seen that there is a drop of usage rate for Internet explorer (recommended browser of Microsoft). Mozilla Firefox, Opera, Chrome and many other browsers specifically works in improving speed and quality of their exploration, which it makes difficult for Microsoft to compete with them in market. Here ability of browsers for delivering a requested function, in shorter time was a factor for selection by customers.

One of big effect related to technology can be its role in constructing of interplays and connections between products and services (Auernhammer and Stabe, 2002). Here choosing an appropriate technology of production and delivery besides mid center can reduce time of delivery; moreover in some cases, such as transshipment parts in conductor market, it can reduce cost of process too (Kranenburg and van Houtum, 2009).

Customer usually makes a comparison between speed of a delivery by service and ownership of physical product which is bought for the same aim. A service provider who is responsible for plowing a land should deliver this service in special season of year for customers; otherwise client should choose another way for obviating its demand. Here any delay in performing this service affects in production of farms and consequently satisfaction of clients. In addition a good and fast delivery of service can produce more trust between providers and clients (Ritter, Ryssel and Gemünden, 2000) which can influence in retaining customers. Moreover, the creation of trust among both parties can reduce the cost of transaction (Ploetner and Ehret, 2006). Although a range of customers prefer to buy a product instead of using service, but they should beware of problems related to maintenance and failure of machines too.
Usages of new Information technologies fundamentally have changed domestic market. The importance of information related to customers such as their actual demand, requested price, extra service appeals and many other items can be a valuable source for designers, sale persons and managers in any companies (Bose and Mahapatra, 2001; Ngai, Xiu and Chau, 2009). Gathering, sorting and data mining of this huge amount of data are a long time process which requires expert persons for analyze and interpretation of them (Seng and Chen, 2010). However usage of powerful computers and software opens another stage for companies to analyze this vast amount of information. The results from analyzing this information help companies to identify real demand of customers, categorization of clients and suitable strategy design (Liang, 2010). Maybe understanding customer requests in past takes a lot of time for evaluation but with applying new algorithms and applications which can show statistical data by figures and tables designers and managers can have a higher control and realization on PSS.

5.8 Simplicity and Flexibility

Generally the users of any products or services are people who require instruction of how to use a service or product correctly. This can be learned by reading catalogs of products or training by some experts from company which requires time and in some cases spending money. Here simplicity and convenient in usage of a technology have a big influence in people decision for using it (Kulviwat, et al., 2007). Everybody like to use a service as simple as it can be, for example by pressing a button or even without using any action and just automatically. According to this, a good service should obviate the demands of customers with no extra effort.

Issues of old people with new technologies in different areas are a usual problem which can be seen in society (Eisma, et el., 2004). Simplicity can increase range of customers in PSS,
this will happen because more variety of people in different ages, and knowledge can use them. In case of old or disable people, they usually require additional help from a third person or party for adaptation and usage of new products or services. Another example can be the rate of internet users, which is higher in younger people than older persons, who have some problems for adapting to this technology.\footnote{Pew Research Center, http://pewresearch.org/pubs/1093/generations-online, [Accessed September 27, 2011].} Moreover, other problem is about lack of accessible design among industries; in business, usually most of product is for youth market (Keates, Lebbon, and Clarkson, 2000; Eisma, et al., 2004).

Various types of customers who are from different areas and cultures have different requests that a flexible product and service system contract can see these demands. Richter, Sadek and Steven (2010) stated that implementation of PSS requires high investment in first stages which can be payback through usage phase; according to this, only by considering flexibility of design provider can handle all future incidents and risk. This time of payback can be different based on connection time of PSS contracts for example in case of DBFO contracts this time can be for decades. (Berg, Bjerre and Henriksen, 2010).

Creation of profit from any product service system is based on an organizational network (Becker, Beverungen and Knackstedt, 2008). Here applying flexibility, in different parts of this chain can increase profit from implementation of PSS. As a proposed model by Shimomura, Hara and Arai (2009) method for designing of service can be divided in 3 sections. Different parts of these sections are identifying customer value, designing service contents and service activity which are presented in Figure 13. Identifying customer value explains actual demands of customer, then according to these facts product service system can be designed. Understanding real need of customers helps provider to customize its service for specific range of clients; here flexibility of PSS can create a wider area of choices for customers.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure13.png}
\caption{Designing method for service activities by (Shimomura, Hara and Arai, 2009)}
\end{figure}

PSS can create many opportunity for customers and providers, but one of interesting potential related to PSS is its potential to see whole life cycle of a product (Mont, 2000; Meier, Roy and Seliger, 2010). Here long-term PSS contracts provide a chance for both parties of contract to have a better understanding about whole system. Based on long-term contract, new requirements of customers can be delivered to provider for suitable solutions. On the other hand, higher connection between both parties of long-term PSS contract increases the knowledge of provider according to specific needs of customers which can create new methods of offering. This provides more satisfaction for clients and consequently retaining of
customers. Here flexibility of provider for adjusting its abilities for new and various demands of customers can be helpful.

Richter, Sadek and Steven (2010) stated that, higher cost for adaptation of a system means the flexibility of it is low; here flexibility can be defined as a power of providers for adapting themselves with external changes. According to Wiendahl, et al. (2007) one of factors which can influence flexibility during production is Modularization which can be applied to product service system too (Richter, Sadek and Steven, 2010). A product or service which is consisting of different modules has a greater potential for changeability. Here changeability can be described as the power of system for reacting to any relevant changes. These changes can be happened by internal and external factors (Ferguson, et al., 2007). Any changes of demand can be analyzed by provider and related to new demand some relevant modules can be altered. Richter, Sadek and Steven (2010) stated for development of PSS contracts, high investment cost is needed in first stages and then this investment can produce profit during usage stage. According to this and uncertainties which can happen during implementation, flexibility has a major role in long-term PSS contracts for solving possible problems (Richter, Sadek and Steven, 2010).

5.9 Stability and Good Quality of Service

Regard of Merriam Webster 11stability is defined as the quality, state, or degree of being stable, which is one of customers’ demands. Stability and function reliability of a service in some cases can be critical, such as providing electricity for a hospital. Another example is the heating services in Sweden which stability of heating during cold seasons is a crucial from customers; interruption of this service can create many troubles for clients and consequently loss of their trust to provider. As Sundin, Öhrwall Rönnbäckand and Sakao (2010) result showed the main disputed sales factor among suppliers were stability and function consistency of service besides longer life time of product and higher environmental offering.

Any interruption during time of PSS contract makes many troubles for customers, which can be economical, social, emotional, etc. and this can affect in decision of customers for continuing agreement. As Capozzi (2005) stated reputation of company is an important factor for provider, which can create trust between customers and providers. Customers interested on a good and stable service during contract; here well-known companies with proper history of activities can have a better option (Capozzi, 2005; Dierickx and Cool, 1989). Also in first stages of dealing this reputation can be a suitable indicator for absorbing customer and show stability and goodwill of provider (Campbell, 1999).

Product service system contracts should have the ability for delivering range of diversified services to customers (Mont, 2004). Here according to long and immediate relation between parts of PSS, different scenarios and customized offering can be offered to customers; however cost or benefit of this product diversification are related to various factors such as, connection among different business activities of a company to each other (Qian, 1997). This diversification can help to retain customers and moreover it can attract new customers (Mont, 2004). Moreover it has potential for buying time for PSS provider during contract time to adjust its technology and innovation for new type of products and services.

The recent product and service system necessitates an advanced training experts and devices for maintenance which usually can be provided by only PSS provider (Wang, 2010). This can

cause a reduction in choices of customers for example only few specific numbers of provider can perform this task. Kortmann (2007) as cited in Meier, Roy and Seliger (2010) classified maintenance as one of seven different services that can be seen in tool and machine industries. Here some solution such as outsourcing of maintenance can be helpful. In traditional market, companies have no other choice for choosing outsourcing for their different activities. Low price of production, not rigid regulations in developing countries besides other factors can increase interest of companies for outsourcing. However using outsourcing reduced their knowledge in the body of company (Wang, 2010; Mont, 2001a) which can affect in quality of service.

Continuous improvement process (CIP) goal is to increase quality of service and product in a sustainable ways (Imai, 1986). Different phases of CIP as Schweitzer and Aurich (2010) stated are presented in Figure 14. According to this continues process of improvement, besides an immediate connection between both parties in PSS contracts; providers can gather feedbacks from customers in a better way. Next step can be analyzing these feedbacks and presenting solutions; moreover in some points, it can conclude to new design for PSS. This helps provider to increase quality of service and satisfaction for customers. Meier, Roy and Seliger (2010) stated from research of Mahnel (2007) that near 65% of examined companies changed their suppliers for their low quality of service; here quality of service is an essential factor for retaining customers.

For a stable offering to customers, primary infrastructure which is needed for PSS contracts should be considered in designing stage by providers. Here according to Roy and Cheruvu (2009) type, urgency and complexity of requirements should be checked before any
implementation of PSS contracts. For example, a company such as Apple, for selling iPhone and its services in countries without high-speed internet connection can have a problem. Most of these programs and applications related to iPhone users can be downloaded and installed through connecting to internet; that without having appropriate structure for connecting to internet many abilities of these services cannot be used. Based on this, in designing PSS, service quality and stability of service should be checked according to the basic existed structure of that place. Here, the role of the production network besides service network is a necessary factor for the success of PSS (Schweitzer and Aurich, 2010). Difference between spreading combine heat and power (CHP) plants in Sweden and other countries is another example related to lack of infrastructure. CHP plant can provide electricity and heating of an area with a higher efficiency than usual power plants (Peng, et al., 2008) which absorbs interest of companies for using it. In Sweden, Tekniska Verken company is responsible for providing Power and heat of Linköping area (Holmgren and Amiri, 2007). The cold weather condition of the region and existed pipelines for transferring hot water to customers’ house make this offering possible with low effort and cost. There are many other regions that may have a good potential for implementation of similar systems but investments in pipeline networks and preparing other required infrastructures can be seen as a big barrier.

### 5.10 Knowledge Sharing in Design

A product-service system can be divided into three phases: design, delivery, and adaptation (Roy and Cheruvu, 2009). These phases have important roles for offering a sustainable and beneficial PSS contract that contains designing of services and products besides considering obsolescence, supply chain, uncertainties, and required infrastructural potentials (Roy and Cheruvu, 2009). In order to have a suitable design for a product-service system, information about these different parts can be valuable. According to Datta and Roy (2010) in designing PSS, near seventy percent of the total life cycle cost is in early stages. Here, sharing knowledge among different parts of the company during the design time can be an important factor which can influence success of product-service system contracts. Bertoni and Larsson (2010) stated seven different barriers which can happen in companies for sharing knowledge, which can be observed in Table 7.

**Table 7. Various barriers of knowledge sharing in design (adapted from Bertoni and Larsson, 2010)**

<table>
<thead>
<tr>
<th>Knowledge Sharing Barriers</th>
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<tbody>
<tr>
<td>Acceptability and self-censorship</td>
</tr>
<tr>
<td>Reward &amp; Commitment</td>
</tr>
<tr>
<td>Resignation</td>
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<tr>
<td>Loss of time in decision making</td>
</tr>
<tr>
<td>Awareness</td>
</tr>
<tr>
<td>Language and models</td>
</tr>
<tr>
<td>Trust</td>
</tr>
</tbody>
</table>
Acceptability and Self-censorship

Acceptability and self-censorship is one of barriers in sharing of knowledge between PSS providers. Bertoni and Larsson (2010) stated that people usually unwilling to exchange their knowledge with other parts of design chain and moreover to put themselves in trouble situation. This behavior of workers can affect in process of PSS design; here without interaction among different players such as, employees, managers and customers for sharing of information, design and implementation of PSS contracts cannot be successful.

Reward & Commitment

Another factor which can affect in information sharing is lack of commitment. Different involvement elements, which have dynamic nature, beside complicated connection among them, makes the design of product service contracts to be a hard task (Roy and Cheruvu, 2009). Typically every person wants to show more eminent image of his/her task in a project; however if PSS designers do not concern about other actors of chain and just focus on their specific areas which they have a profound knowledge, then sub-optimization can happen in PSS (Bertoni and Larsson, 2010).

Resignation

Diversity of designing for PSS and no clear methods for performing it, produce more ambiguity for engineers (Bertoni and Larsson, 2010). Design of product service system contracts, for companies with dissimilar organizational structure are different (Meier, Roy and Seliger, 2010). Bertoni and Larsson (2010) stated that an observation showed, most of information for design part can be found in other sectors of company or department; this information usually is not accessible by experts and designers of PSS who necessitate it (Bertoni and Larsson, 2010). Finding information and managing these gathered data is a time consuming task which can direct designers to resignation and give up from their goals.

Loss of Time in Decision Making

One of issues related to sharing of knowledge is loss of time for decision making. Holman, Kaas and Keeling (2003) stated that one third of developing time for traditional product system is used for gathering information and making decision. Reducing this time and finding suitable information in minimum time can have a big influence on development of PSS (Bertoni and Larsson, 2010). In current world for being competitive, the role of information and speed of access to statistics can be crucial for companies. By reducing time of accessibility to required data, company can save time of employees for searching information and manage it in more proper activities.

Awareness

An interesting barrier which PSS providers should deal for sharing information is awareness. Four dimensions for this concept have been identified by Bertoni and Larsson (2010):

Spatial Dimension: People of a company or place do not have any information related to other experts or information in different areas. This lack of information usually based on not knowing other persons in different other regions (Bertoni and Larsson, 2010).
**Time Dimension:** In here people do not have information about outside of their group for a specific time; however, up to dating data and information can solve this problem (Bertoni and Larsson, 2010).

**Complexity of System and Effect of Decisions:** According to complexity of system and variety of stakeholders, it is possible that some decisions produce sub-optimization in system; and then it may reduce the total performance of system (Bertoni and Larsson, 2010).

**Low Realization of Benefit for Possessed Knowledge:** Knowing that what sector interested on information is an important factor. Presentation of data for people who are not any ideas about the real value of information can increase the in risk of ignoring them (Bertoni and Larsson, 2010). The method for presentation of information can be another factor which should be considered too.

**Language and Models**

According to novelty of long-term PSS contracts, many dimensions of this concept have potential for development. The process of this development can be eased by analyzing information from different areas. Successful or failed implementation of PSS contracts from whole the world can provide good information for this survey. This means experts in PSS provider companies should put their efforts for gathering different resources and information (Mont, 2002b). Here role of language can be important; moreover communication between different parts during whole process of PSS is necessary and it can be obtained by language (Bertoni and Larsson, 2010).

**Trust**

Sharing of knowledge can be affected by trust too. Here an important target for PSS providers should be the creation of trust among workers and different levels of company (Parker, 2003). Another aspect of trust can be seen in usage of information from different sources in designing phase of PSS (Bertoni and Larsson, 2010). The reliability of information and data should be considered carefully and here the role of trust can be important.

**5.11 Contract Documentation and Legal Charges**

As a Trakman (2001) states, contract is a legally recognized agreement by parties which may be required to solve their issues by law. One of contract parameters which has changed and improved during centuries also it can be applied through different situation by interpretation and analogy is legal perspective (Julià-Barceló, 1999). Documentation complications, responsibilities of sides, type and amount of fines, incentives, etc. are some items which necessitate to be checked by two parts of a contract; these items based on law can be considered as legal aspect of long-term PSS contracts.

Mont, Singhal and Fadeeva (2006) stated that an important step for long-term PSS contracts is preparation of contract. For this preparation, creation of trust between involved actors and moreover knowledge about balancing and controlling it can be useful (Mont, 2004). The concept of contract and enforcement items can provide more satisfaction of both parties in long-term PSS contracts. Here contract can specify different responsibilities of provider and customer with clear content; but as Toffel (2002) stated even contracts with many details cannot predict all possibilities during contract time.
Contract provides a deal between two or more parties; and as Hviid (2000) stated contract can be seen as a combination between forces of legal items and self-enforceable commitments. Based on this, definition of these items are important and they should be legalized. Possibility of occurring various unforeseen events in product service system with long time duration is higher (Datta and Roy, 2010), which increase need of specific rules for solving them; here renegotiation can play as a good item which reduces cost of settlement by arbitrator (Hviid, 2000). Many items such as responsibilities of each party during accidental interruption, fines according to any types of malfunctions, etc. should be considered in written contract too.

In some cases security of technologies and assets which are used in PSS contract required to be protected. Lee (1999) stated six important branches of regulation for right or obligations about quote data and price as intellectual property rights, securities market, competition, a new sui generis property in databases, confidentiality, and the misappropriation. There are many laws that before signing and during contract time should be considered. For example in case of intellectual property rights, copyright can give the owner to protect its activities in certain conditions and specific amount of time (Lee, 1999).

Here differences of short and long term contracts can be useful for selecting them among companies. Eminent distinctions of long-term and short-term contracts are explained by Hviid (2000) in five topics. First the performance of long-term may be varied towards a series of short-term contracts. Moreover the transaction cost and policing for a series of short time contracts maybe higher than a long-term contract. If the credit market is not accessible then the earnings from long-term contract is easier. Even in absence of renegotiation, long-term contract proposes a higher commitment to both parties; also in case of information asymmetry a long-term contract is a better choice than a series of short-term contracts (Hviid, 2000). Topic of preferring long-term or short-term contract can be interesting for more research; here Hviid (2000) described that long-term contract can be more beneficial than a series of short-term contract.

Berg, Bjerre and Henriksen (2010) and Mont (2002a) stated that some confidential processes can reduce the intention of companies for accepting particular type of PSS models. For example, Alfa Laval Company stated that producer during offering a system solution, is needed to reach to some information for developing support services and monitoring production line (Källrot, 2001 cited in Mont, 2002a). As another example, in chemical management system (CMS) which a supplier is responsible for preparing feedstock of a company during a long time; the existence of risk for leaking out the information related to private process, plays as a barrier for implementation of PSS. Here the first important priority for the company can be protecting its confidential activities.

Other contract can affect in price of an agreement and based on situation offset it (Polinsky, 1987); here rise or fall in the market affects decisions related to presentation of a product or service. Demand from market affects in calculation of PSS price; if another contract with lower price will be presented to market, providers should prepare themselves for appropriate solution to face it. This effect can be seen in most of usual long and short term contracts. As Triantis (1999) stated companies may use some types of hedging in contract for preventing any risks like other activities and contract.

Both parties to a contract require insurance regarding performance of other party; this assurance can be included in different written paragraphs of agreement. Posner (1979) explained that a big unsolved factor in legal aspect of economic is penalty principle. Here penalty clauses play as insurance for both parties to a contract against any contingencies and
possible damages (Goetz and Scott, 1977). Provider is responsible for any types of problems related to malfunctioning of product or service. On the other hand, consequences related to misusage of service or product will come back to customers. Based on this, any probable faults in PSS should be discerned and described in contract. Here two types of penalty by De Geest (1999) have been defined as liquidated damages and expectation damages. The liquidated damages are calculated at time of contract but in contrast expectation damages are estimated after breaching (De Geest, 1999). However willingness of parties for entering to a contract will be lower by exist of expectation damages penalties which this weakness cannot be seen in liquidate compensation (De Geest, 1999). The next stage can be the allocation of different types of fines to these recognized items. These paragraphs and related fines can be considered as conditions of guarantee or warrantee in system.

In our society standards of each product require to be checked and possessed a specific level of requirements. Standard has been defined by United Nations Industrial Development Organization (2006) as “A standard is a document which provides, inter alia, requirements, rules, and guidelines, for a process, product or service. These requirements are sometimes complemented by a description of the process, products or services.” According to importance of functionality during PSS contracts, there can be a need for setting new types of standard. Here the topic of specific performance arise which should be mentioned in contract. De Geest (1999) stated that specific performance and penalty clauses have a significant difference which lies in temporal dimension. At this point specific performance may prevent and compensate possible damages but exist of penalty calluses insure companies for extra compensation sanctions (De Geest, 1999). Applying specific performance need time to be operational, and it can work only in future not in the past; however penalty clauses can only be applied in events and damages which are happened in past (De Geest, 1999).

5.12 Rebound Effect

The element of environment has an important role in design and delivery of PSS. Moreover, existed problems in our current world which are related to high amount of consumption and production require some solutions which consider sustainability. Here Kang and Wimmer (2008) stated that usage of product service system contracts can fix production and consumption activities in society and reduce its negative environmental effect. In traditional way of trade between customers and providers, profit will increase by augmenting size and amount of selling product (Mont, 2004; Kang and Wimmer, 2008). This types of trade, alongside increasing of population and more demand for products and services has been created many existed problems for environment during these decades. The greenhouse effect, CO₂ emission and depletion of resources are some of issues which can be observed today.

Based on statistics of World Bank, China and India has a big rate of economic development during this decade12, which means affordability of people in these countries for buying different products will increase in future. In addition, according to Population Reference Bureau (2009), these two countries have the highest number of population in future too. The statistics about estimation of population in countries has been presented in Appendix A. Here increase in population besides higher affordability of consumers for buying can raise the impacts on environment. Moreover, most of highest populous countries are in developing countries which means compare to developed countries they do not have the same level of

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environmental regulation and technology. This can boost the problems related to environment too. Here, new ways of providing demands for customers which are not based on amount of products can reduce usage of material for production phase. Here usage of information technologies or new methods and tools can help in success of this process. Based on these technologies, communication among customers and providers are faster and more flexible; but then again, this can raise some negative effects towards usage of these new technological devices (Crul and Diehl, 2009).

According to higher accessibility level of people to market, different types of rebound effect can take place, for example technological improvement in engines actually increased usage of coal in England (Alcott, 2005). Here higher knowledge of people about new types of products and services which are offered in market can increase amount of usage too (Bartolomeo, et al., 2003). For instance, a person who use bike for its commuting through city can be motivated to buy or rent a car with seeing a suitable offering in TV, magazine or internet. Mont (2004) describes that rebound effect can be considered as a problem which can happen in macro-level of PSS contracts and it categorized them in direct, indirect and transformational effects. Both direct and indirect effects are related to mechanism of price but in transformational, is about changing preferences of consumers or social intuitions (Greening, Greene and Di figlio, 2000; Mont, 2004). Here Bartolomeo, et al. (2003) offered six categories of rebound effects, Cost effects, Space effects, Responding effect, Time effects, Behavioral effects, Platform effect.

Cost Effect: Reduction in energy or material usage according to optimization of processes or increasing efficiency reduce the price of product also cost for using it during lifetime. The result of this reduction in price has potential to increase interest of people for buying products (Bartolomeo, et al., 2003). Based on this, reduction in environmental impact of a product will be decreased by increasing number of used products among people.

Space Effect: Existence of internet and other communication services removes boundaries of distance between customers and providers. New methods of buying materials by telephone or electronically can have positive impacts on environment according to no need for physical visiting of shops and transportation. On the other hand possibility for ordering higher amount of material and transportation can be increased (Bartolomeo, et al., 2003), which means higher negative impact on environment.

Responding Effect: Any financial saving according to cost reduction of material or energy produces an opportunity for customers to use this money in different areas (Bartolomeo, et al., 2003). Spending money in this new area means usage of a new product or service which consequently has its new environmental problems.

Time Effect: One of interesting rebound effect is the effect of time. Process of selection and buy of a product usually is a time consuming activity. The need for physical existence in dealing or being present in a training class and other activities reduces number of customers; developing different methods of searching and dealing which most of them used electronically devices can obviate this barrier (Bartolomeo, et al., 2003). For instance, electronically banks or buying from websites, produce a suitable environment for some types of customers which have lack of time for shopping. Based on this, using of these new facilities can increase usage of product and as result more environmental impacts.

Behavior Effect: Behavior effect is an interesting topic, here presenting new product or services in different types of business models can influence and change habits of people.
(Bartolomeo, et al., 2003). For example, leasing or sharing business model theoretically has a good potential for reduction in resource usage and environmental impacts; however it can reduce the intention of customers for responsibility about products (Mont, 2004). People usually have more care about their own equipment; this can reduce lifetime of leasing products and positive effect of this business model in environment.

Platform Effect: Using better infrastructures and technologies improves level of knowledge among people; this knowledge besides its abilities for developing different sectors has some side effects too. For instance, buying materials by using internet requires some primary information about operation system, websites, different methods of searching and payments. Users of these new infrastructures have a better chance for finding suitable offers of products and services compare to traditional customers. Furthermore, educated persons' demands are different from normal persons and their requirements from life regard of their knowledge are higher (Bartolomeo, et al., 2003).

Each of these rebound effect and consequences of them should be checked before designing of PSS contracts to clients. Arcadis is a German company which is developed Rapid Assessment Program (RAP) that Bomhof, Hoorik and Donkers (2009) stated it has a good ability for studying effect of interventions in large infrastructural projects as well as recognizing possible rebound effects in information and communication technology. This type of software with their ability to evaluate possible scenarios and rebound effects can be used for research and development of PSS contracts.
6 Companies’ Approaches for PSS Influential Factors

This chapter tries to explain different issues related to each of PSS influential factors and furthermore, suggested solutions by authors and companies are presented.

RQ3. How can companies deal with factors that influence long-term PSS contracts?

Preparation and implementation of long-term PSS contracts require a comprehensive analyzes of different factors which can affect it. In this thesis, some of related problems for each of these factors according to literature review have been presented; however for some of these factors this research could not identify specific problems. Here companies’ approaches for dealing with problems which are related to these factors can be used by other PSS providers. Based on this, different solutions of companies which have been stated in research besides have been listed.

6.1 Internal Structure of Service Provider

As Berg, Bjerre and Henriksen (2010) described inertia of managers for changing traditional structure of companies is a barrier for interest of companies to go through functional sales contracts. The answer to this question can be different based on selected PSS contract. For example changing policy of governments and illustration of successful beneficial cases can be used for ESCO contracts (European Commission-DG Environment/COWI, 2008). In case of CMS contracts, forces from public legislations can be as driver of managers for this change (European Commission-DG Environment/COWI, 2008). In sum, exist of policy or general need can see as solution for this problem.

Lack in budget, human resources and management technology of small sized company can produce some problems for different stages of PSS contracts. One solution here, as Berger, et al. (2004) stated can be partnership among companies which have potential for unification their knowledge, resources and capabilities. Moreover this problem can affect in training of workers too. Here training of personnel and strong involvement of them can be considered as an important factor for succession of business process during reengineering (Tikkanen and Polonen, 1996). Motivating and training of personnel can be helpful for implementation of PSS which require investment in time and money. In case Institute of Strategic Defense Management internal and external forces for renovation in whole military system, This institute tried to use innovative and modern methods for training officers who should work with new weapons and devices. Lack of knowledge about novel methods and technologies was a barrier for these changes. As a solution for this predicament, ISDM applied a three-stage method. First some potential persons were selected, and then they sent for training in abroad allies’ military classes. Finally these new methods was applied to whole system and courses were redesigned (Liao, 2002).

6.2 External Structure of Service Provider (Network, Partners, Suppliers and Competitors)

Lack of acquaintance with economic advantages of PSS contracts among consultant, contractor and financial firms are some other barriers which in ESCO project can be seen (Berg, Bjerre and Henriksen, 2010). Higher knowledge of these parts about what beneficial outcomes can be produced by implementation of PSS can influence in their support for these types of contracts. Here presenting successful implementation of these models for these
different actors can be useful (Berg, Bjerre and Henriksen, 2010). Moreover in process of decision making aggregating of information as well as presenting important factors in clear form can help decision makers for faster act (Bertoni and Larsson, 2010).

In process of selling products usually retailers have an important role. One of aims for using different types of PSS contracts can be reduction in need for physical products and materials which can affect in retailers’ activities. In traditional methods, these centers gains more benefit by selling higher numbers of product in size and volume which is contradict with aim of PSS providers (Mont, 2002a). As solution for this problem profit from implementation of PSS can be shared among different actors of service provision (Weitz and Jap, 1995) that increase the interest of these centers for higher cooperation with PSS providers.

Sharing as one type of PSS contracts has a good potential for reduction in resource usage and environmental impacts; but one of issues in sharing PSS model is lack of motivations for product manufacturers to produce sharing type of product (Berg, Bjerre and Henriksen, 2010). In this model, PSS provider is the connector between manufacturer and customer of PSS. For example, as viewpoint of a PSS provider, durability of product can create more income. Here durability has a direct effect in reducing cost of provider and consequently increasing benefit; but in contrast, optimizing a product for higher energy efficiency, is not in high priority compare to durability. This is according to this fact that usually operational cost of product such as, energy or fuel usage should be paid separately by customers. This reduces incentive for providers to force manufacturer to improve its products energy usage. Here higher involvement of a manufacture company in sharing business model can motivate it for designing better products (Berg, Bjerre and Henriksen, 2010).

6.3 Cost and Price

As Berg, Bjerre and Henriksen (2010) stated affordability of small companies for high investment of research and development can affect their interest for PSS. Here partnership among different companies can produce an opportunity for them to share knowledge, capabilities and resources for handling this problem (Berger, et al., 2004). Moreover it can show them some new methods of business which have not considered before.

Lifetime extension for products is an interesting topic which can be properly in PSS contracts. According to interest of companies for gaining higher income by offering more products and services, applying product lifetime extension can be seen as an unwanted problem during this process. Here renting, pooling, and leasing can be used as solutions for service provider to increase concurrently the quality and profit of company together (Berg, Bjerre and Henriksen, 2010; Khumboon, et al., 2009; European Commission-DG Environment/COWI, 2008; Tukker, 2004). Both provider and customer can use the positive effects of this business model. Provider can get its benefit without compromising the quality of its products and services; on the other hand an appropriate price can be offered to customers. It depends to selected model this price can be paid back in intervals of contract time.

Transportation as a highest share of cost among logistics system has an important role in public activities (Tseng, Yue, and Taylor, 2005). Managing the problems related to this part can motivate providers for implementation of PSS contracts in their business. In some cases, maintenance or transport of product for end of life and other improvement is not economically feasible. For example, process of returning products to a furniture manufacture which its market spread in widespread regions was a difficult task and can be not economical (Besch, 2004). One solution can be construction of decentralized service facilities near most important
customers and scaling down of central manufacturing plant. Another possibility is cooperation with local service companies. Here the manufacturer rent products to these local companies; then maintenance, remanufacturing and other facilities will be provided by these local service companies to customers (Besch, 2004). Moreover service providers get spare parts, training and knowledge related to different aspects of product.

One of big problem for PSS provider is financial threat from renting equipment and products to customers (Besch, 2004). The risk of returning product before repaying its cost put pressure on companies. Here these returning products lose some of its value and quality during usage time and it is hard for PSS provider to find a customer for this type of products. One suggestion by Besch (2004) is establishing a minimum period for renting in PSS contract, which buyer of product or service cannot return it. Here customers can stop the contract but this cancelation requires a fixed amount of payment to service provider for covering its investment.

Lack of interest for going through a long-term PSS contract is another obstacle for accepting PSS by public institutions (Berg, Bjerre and Henriksen, 2010). Uncertainty about real profit and risks are some of factors which are the reasons for this decision. For example in a CMS model, customer’s dependency to a long-term contract reduces their flexibility for changing supplier (Berg, Bjerre and Henriksen, 2010). Moreover, using a long-term contract requires a proper system of payback during agreement period which is not a suitable strategy for some of providers. One other solution that can be applied in here is more financial support from public (Berg, Bjerre and Henriksen, 2010).

In some type of PSS business models such as, design build finance operate (DBFO) cost of transactions is high; its reason can be for much complication in different required agreements for a contract (European Commission-DG Environment/COWI, 2008; Berg, Bjerre and Henriksen, 2010). In DBFO a company is responsible for whole process of design and building of plant. In addition financing and operation of project should be done by contractor too. According to complexity of procurement model also different types of agreements, the transaction cost will increase. Here creation of trust among partners can lower this transaction costs (Ploetner and Ehret, 2006).

In some remanufacturing contract cost of repair and maintenance are higher than raw material. As Mont (2002a) stated in Interface Inc., cost of recycling and repairing material is more expensive than virgin raw materials. Here setting a suitable price for raw material can consider as a solution for this issue (Mont, 2002a). Moreover accepting refurbished products can be another problem which remanufactures companies should be concern (Mont, 2002a). However reduction in price for this type of products can solve this problem, for example in case of Electrolux Company, this company reduced the cost of these refurbished products up to 35% (Brotto, 2001 cited in Mont, 2002a).

6.4 Trust

During contract time PSS provider may need to access some sensitive information from customers; this information can be needed for increasing performance of processes (Mont, 2002a). For example Alfa Laval Company stated that producer during offering a system solution requires this information for developing support services and monitoring production line (Källrot, 2001 cited in Mont, 2002a). Here increase of trust between customer and provider can help this situation (Mont, 2002a).
6.5 Social Norms

The approval of people for changing their behavior or accepting new ways of usage is a critical point in development of any PSS plan (Rexfelt and Ornäs, 2009). Hindering process of signing a long-term PSS contract according to traditional attitude and routines among public procurement and politicians are one problem which can be seen in ESCO model (Berg, Bjerre and Henriksen, 2010). Here routine can be expressed as ‘A capability for repeated performance that has been learned by an organization in a context of selective pressures’ (Feldman, 2000) which is stated as one of important factors in inertia and resistance to changes in companies (Collinson and Wilson, 2006). The lack of knowledge about the activities and outcomes besides exited structure and difficulties for changing in habits of personnel are some barriers for acceptance of this model (Berg, Bjerre and Henriksen, 2010). Using different ways of advertising and training such as demonstration of projects and increasing knowledge of different actors on its economic benefits can help companies for solving these issues (Berg, Bjerre and Henriksen, 2010).

As Mayo (2005) stated people like to buy physical products. Interest of people for possessing a product is another topic which can produce some difficulties for going through some type of PSS contracts. One solution can be demonstration of abilities, which a PSS contract can offer to customers. Here consumer by selecting a proper PSS contract such as sharing can reduce its cost also avoid the possible risks related to ownership of product (Berg, Bjerre and Henriksen, 2010). For example, this risk can be need of extra time and payment for maintenance.

Fashion has a big influence in our decision for buying products (Besch, 2004). Using PSS contracts can produce some risks and opportunities for persons who are used to have last technological or fashion products in market. Here customer preference for buying a fashion product is an important factor which should be considered carefully (Dewi and Van Voorthuysen, 2011). In some cases PSS can provide the requirements of customers better than old method of selling product; as an example for some customers renting of a BMW car and the pleasure of driving with it cannot compare with anything else (Tukker, 2004). In addition, a PSS provider which is well-known and have a successful history for its activities can absorb a higher rate of customers (Capozzi, 2005; Dierickx and Cool, 1989) and benefit from market. Here provider has an opportunity to maintain and optimize its products during contract time; moreover by life time extension provider have a better way for resource management too (Besch, 2004). Besides of that, customers get benefit from using good quality furniture and also receiving suitable maintenance during contract time.

As Rexfelt and Ornäs (2009) and Mont (2004) stated, owning product is usually more convenient based on higher support from whole society. Any changes in behavior of people require high effort from different actors (Rexfelt and Ornäs, 2009). One solution for this issue can be decoupling of ownership from product usage which is stated by Mont (2004). Using appropriate advertising besides role models can affect in this topic Mont (2004); moreover training during school, university, workshops, etc can be useful too. A suitable explanation for advantages of PSS through advertising increase knowledge of society about it; furthermore help providers in expansion of their market. However changes in norms will happen during time and it is a time consuming action (Peyton Young, 2008). People acquire their norms in interactions among others, training, beliefs and existed rules in society. Changing in one generation slowly affect in next generation levels and consequently whole society.

Lack of willingness among customers for extra payment to compensate additional costs of companies through improving environmental features is a problem among people of society.
Rese, Karger and Strotmann (2009) stated a question about willingness of customers for extra payment to PSS supplier, according to using new technologies in their processes. In design of different PSS contracts both aspects environment and economic are important; however customer usually compare different offers from using PSS contracts with traditional methods. Tuominen (2011) stated that, the key factor in here can be increase of knowledge among customers about this topic and finally making profit from it.

6.6 Support of Government & Politics

Lack of public procurement from government agencies can play as a barrier in development and spread of PSS (Fishbein, McGarry and Dillon, 2000). In case of DBFO contracts Berg, Bjerre and Henriksen (2010) stated that introducing some green elements in methods of payment and public procurement can motivate public authorities to have more focus in this business model.

6.7 Stability and Good Quality of Service

Higher connection among both parties to PSS contracts can increase gathered data and feedbacks from customers which then can be used for development of better result (Mont, 2004). Moreover engaging experts as well as use of appropriate applications can help companies to make a suitable decision about how to design PSS with better quality and stability. As another solution Lee, et al. (2006) suggested that electronic-maintenance and electronic-networking can be used for dealing with existed uncertainties in process of PSS delivery. Furthermore, implementation of total quality management can increase quality of PSS delivery and competitiveness of a company too (Love, et al., 1998).

6.8 Knowledge Sharing in Design

Different barriers of knowledge sharing in design can affect in success of PSS. In acceptability and self-censorship, familiarity of group persons can be a positive point. Ardichvili, Page and Wentling (2002) stated that participants of many successful design projects have familiar with each other in previous projects. Here knowledge and comfort among people in a project increase their motivation and also make a pleasant environment for showing their abilities (Gebert, Boerner and Kearney, 2006; Bertoni and Larsson, 2010).

Lack of commitment between group members can damage to any PSS design. Here usage of incentives can be beneficial for solving commitment problems in short term (Master, 1999), but it has no positive effect in corporate culture or long-term knowledge sharing of company (O'Dell and Grayson, 1998; Finerty, 1997; McDermott, 1999; Ellis, 2001). In addition, Michailova and Husted (2003) stated that applying incentives is not sufficient for antagonistic environment. Another method which can inspire personnel for more active participation in sharing knowledge is exchange of information among people with similar interest; this can give them a chance to judge and be judged by others (Bertoni and Larsson, 2010).

Designer’s resignation in process of investigating for information can influence in innovation and many research process. Here Bertoni and Larsson (2010) declare three solutions, enhanced filtering capabilities, identification of relevant information, and identification of knowledge owners. Using methods which can enhance filtering of data according to demand of customers, tasks and other factors can be suitable, for example defining different applicable categorization of information. By recognition of relevant information and connection between similar topics, reaching to target can be faster. Moreover Bertoni and Larsson (2010) stated
identification of knowledge owners such as private companies, individual experts, data banks, etc. can reduce resignation barrier. Another solution for this obstacle can be the usage of code based methods for their information which help designers to access this data faster (Bertoni and Larsson, 2010).

Loss of time in decision making can prolong process of designing and reduce the speed of development. Aggregation different knowledge elements can play a big role in reducing this time for decision making (Bertoni and Larsson, 2010). Gathering different required information which is necessary for decision making, and then presentation of these facts in brief and appropriate way can reduce the time of decision making. Emphasis of important items in a report or presentation helps managers and leader of companies to have a better understanding about issues and different scenarios faster and easier.

Bertoni and Larsson (2010) stated that more focusing on social aspect of PSS design such as, communication with people who has knowledge for helping, can mitigate problem related to awareness. For instance new employees can use experience of old and professional workers which have a higher level of knowledge about processes and wide area of connections in their career. Moreover helping other experts for finding useful sources and connection can increase their awareness. Furthermore, up to dating existed data can be helpful too (Bertoni and Larsson, 2010).

One interesting factor which can influence in spread of knowledge is language (Bertoni and Larsson, 2010). Here connection of actors and also sharing information which are in different languages can have a negative impact in this process. A flexible structure for coding, models and standards can increase the eagerness of employees and designer for more contribution of knowledge. Here concept of lightweight, as tools and methods which can be easily learned by all stakeholders; and also requires minimum resource and time for installation and maintenance can be useful for knowledge sharing purpose (Bertoni and Larsson, 2010).

Higher social connections can see as an aspect which can help in creation of trust among designers for sharing information (Bertoni and Larsson, 2010). Mostly people share their information in informal communication (Riege, 2005). Sharing knowledge among people interaction, oral conversation and meeting have a higher level of interest compare to using codification (Hansen, Nohria and Tierney, 1999; Bertoni and Larsson, 2010). Here people with longer work experience have a better understanding toward issues compare to other members. Bertoni and Larsson (2010) stated that in technological viewpoint mutual relation between sharing information and quality of knowledge are essential factors that robust creation of trust among participants.

### 6.9 Contract Documentation and Legal Charges

One barrier in B2B is lack of customers’ information about PSS concept and offering items in contract (Mont, 2004). For analyzing an offer, customers need to know about what they get from a contract. Here a lucid proposal can increase knowledge of customers about different items and also obviate their worries about efficiency and quality of their products and services (Mont, 2004).

One problem which can see in remanufacturing contract is uncertainty about returning of product to companies. Here Mont (2002a) stated that some program such as, exchanging product with new one can be useful. One other solution for this issue can be extension of life time by producers for B2B market (Jacobsson, 2000). Here warranty can help in process of
returning products to company too (Mont, 2002a). In addition, some interesting methods such as the way Fujifilm and Kodak companies presented for their single use cameras can be applied by companies, to affect in behavior of customers for returning products to manufacturer (Mont, 2002a). Here customer for processing of film should bring the camera and film to company.

Berg, Bjerre and Henriksen (2010) in the case of better Place Company stated that different public laws and rules can be named as an obstacle for spreading PSS. Existed tax circulation routine for vehicles lower the interest of people for buying electric vehicles (Berg, Bjerre and Henriksen, 2010). In some cases, these rules maybe prevent including of functional sales in tender documentation, which consequently lower the rate of acceptance among customers Berg, Bjerre and Henriksen, 2010). Moreover existed regulations may put many limitations for providers of PSS which make it hard for them to compete with traditional methods of selling.
7 Discussion

In this chapter, the results from previous chapters are discussed. It starts with a short introduction followed by discussion about three research questions which were stated.

Based on literature review, most of authors in area of environment have referred the need of sustainable production and consumption (Mont, 2004; Berg, Bjerre and Henriksen, 2010; Morelli, 2006; Roy and Cheruvu, 2009). Here sustainability framework contains economic, environment, social dimensions, although in some framework a new dimension of institutional is added too (Labuschagne, Brent and van Erck, 2005). One of approaches which are stated for creating sustainability is the usage of product service system. Here different literature have been described positive effects of PSS in different aspects of sustainability (Mont, 2002b; Berg, Bjerre and Henriksen (2010); Manzini and Vezolli, 2003; European Commission-DG Environment/COWI, 2008). In addition, knowledge about long-term PSS contracts can help providers in dealing with factors which can influence their offering. In the following section, the results which were presented in previous chapters for each of research question will be discussed further.

7.1 PSS Contracts Categorizations

RQ1. What types of PSS contracts are used?

Based on document studies, four types of classification have been identified; however, a unique categorization for types of products service system has not been specified in literature precisely (Meier, Roy and Seliger, 2010). According to research, one of most widely accepted classification of PSS has been described by Tukker (2004). This classification divided different PSS models in three different classes which are product-oriented service, use-oriented service and result-oriented service. The model explains various types of business models from offering pure product to pure service. Types of contracts can vary based on nature and amount of profit motivation which customer offers to the contractor, for reaching to particular goals, and also time and degree of the responsibility by contractor (Federal Acquisition Regulation, 2011). According to this, Roy and Cheruvu (2009) have offered different types of contracts which are used in industries product service system. The main categories of this model consist of fixed-price contracts, cost-reimbursement contracts, incentive contracts, indefinite-delivery contracts, time-and-materials, labor-hour and letter contracts, spiral development contracts. In addition, it can be considered that this classification mostly focus in economic part of contracts. Here Roy and Cheruvu (2009) try to connect these types of contract to different dimension of industrial PSS. According to the result, it can be observed that only incentive contract and spiral contract have more concern about sustainability and other models have more focus in economic benefit. Moreover one of promising types of contract which consider all three dimension of industrial product service system is incentives contract. This can be a good indicator for usage of this type of contract in PSS offering.

Moreover two other classifications have been offered by European Commission-DG Environment/COWI (2008) and Berg, Bjerre and Henriksen (2010). Each of these categories consists of six important business models. Based on reviewing these models, both classifications have been proposed two common categories. Here energy service companies (ESCOs) and design build finance operate (DBFO) have the same definition in both classification; furthermore, chemical management services and chemical management system have the same description too. According to this, they can be put together as one business
This new model can be called as chemical management services. The sharing businesses model has focus in usage part of products and it covers different models of sharing; based on this, car-sharing can be considered as one of sub categories for this model. In addition, product pooling and product lease are two other different business models which can be applied in usage time of product (Tukker, 2004). Based on nature of these models for affecting the usage part of products, this thesis has been classified them in one category which can be named as Sharing and Leasing. Alongside these models, functional sales and other green business models (Berg, Bjerre and Henriksen, 2010) besides resource management and remanufacturing (European Commission-DG Environment/COWI, 2008) are four other business models which have been explained separately by these literature. Here resource management model considers managing of resources and wastes in life cycle of products, which this thesis has been named it as resource and waste management. According to this explanation, these eight models have been classified in Chemical Management Service, Energy Saving Companies (ESCOs), Resource and Waste Management, Sharing and Leasing, Remanufacturing, Design Build Finance Operate (DBFO), Functional Sales and Other green business models which have been presented in Figure15.

![Figure 15. Different categories of green business models](image-url)

The first two models optimize operational processes of a PSS provider; this can be performed by usage of new technologies or optimizing different equipment. In resource and waste management as well as remanufacturing the main concern is about reduction in waste and recycling of resources. Functional sales can consider as pioneer for changing the concept of selling service or product to higher goal of selling satisfaction to customer. Here DBFO offers
higher freedom to providers for managing resources and whole operation activities which can lead to reduction in environmental impacts of a project. Moreover, other business models with applying new conceptual methods have the ability for decreasing usage of resource and waste management. Besides these models, sharing and leasing has the potential to reduce the need for new services and products which can lead to lower amount of resource consumption and waste production.

Selection among these categories or finding a unique type of PSS classification with existed information is not possible. However, three classes of product-oriented, use-oriented and result-oriented have been referred by many authors; but it can be referred as a general model which is described different business models in shifting product to service offering. Here the suggested eight types of PSS which is adapted from European Commission-DG Environment/COWI (2008), Berg, Bjerre and Henriksen (2010) and Tukker (2004) have more focus in connection with different areas of business. Besides descriptions of activities, environmental and economic benefits of these models have been clarified in more details by literature. According to this, it may be more applicable for industry sectors and companies which are interested in PSS models.

### 7.2 PSS Influential Factors

**RQ2. What factors can influence long-term PSS contracts?**

The process of finding PSS influential factors was performed according to primary evaluation of several important literatures in area of product service system. This information plays as a base for searching, and then the results have been classified in twelve main factors. The categorization are based on areas which these factors can influence PSS contracts. However it should be mentioned that, classification and also numbers of factors can vary based on different viewpoints. Here high connection among different factors and their interactions in each other makes the separation of them to be difficult. In the following this factors has described.

One of the main goals of any provider is gaining more benefit; which in long-term PSS contracts this can consider as economic aspect of this business model. Here cost and price is a critical factor which should be calculated before offering any PSS contracts. In literature review different authors such as Roy and Cheruvu (2009), Berg, Bjerre and Henriksen (2010), Meier, Roy and Seliger (2010), Coster (2008), Maxwell, Sheate and van der Vors (2006), Besch (2004), Datta and Roy (2010) and Mont (2001a) are concerned about cost and price of PSS contracts and influence of this factor in spread of PSS. Based on literature, there is not a specified framework for calculation of PSS cost; and there is a need for more development in this area. However the economic aspect has been considered by many research groups but the role of several factors such as discount and commission has not addressed properly. In the sales process discount is generally used to encourage people for buying; here how this factor can be applied in PSS can be an interesting topic. Though, in absorbing customers for refurbished products, Mont (2002a) suggested that lowering the price can be as solutions, but according to change in concept of offering for some models such as functional sales, the way for applying this discount can be different. For example, students in Linköping University for buying a coffee have two options: they can pay for a usual cup of coffee or bring their own cups for pouring coffee which is cheaper. This offering discount model can increase the interest of customers and cut the cost of cups for provider; in addition, it can decrease the impact on the
environment. Finding different ways for applying discount is beneficial for both parties of PSS contracts.

Furthermore, another factor which has potential for influencing the spread of PSS contracts is commission. As Merriam Webster commission can be defined as “a fee paid to an agent or employee for transacting a piece of business or performing a service; especially: a percentage of the money received from a total paid to the agent responsible for the business”\(^{13}\). In the traditional way of signing a contract, intermediate firms and persons have a significant role in connecting different parties. Here commission is used as an incentive for representatives, retailers and also sale sector of company to sell more services or products. In spite of its importance, the literature review has not found any specified information about this topic.

The concept of PSS has been offered as an approach for sustainability which one of its aspect is the environment. According to different definition of PSS, this model tries to reduce the negative impacts from usage of products and services on environment besides generating economic benefit for whole stakeholders. Generally, all the articles such as European Commission-DG Environment/COWI (2008), Roy and Cheruvu (2009), Besch (2004), Berg, Bjerre and Henriksen (2010), Mont (2000; 2001a; 2001b; 2004) have discussed about environmental aspect of PSS contracts, and positive effect of implementation of these models. However one factor which should consider in this area is rebound effect. This factor can influence the environmental performance of product service system contracts. Here Mont (2000), Tukker (2004), Crul and Diehl (2009), Bartolomeo, et al. (2003) and Mont (2004) have explained the effect of this factor; moreover Bartolomeo, et al. (2003) presented a categorization for different kinds of rebound effects. Most of literature explains the importance of this factor; but there is not any integrated information about relation of rebound effect with each of PSS categories. However Tukker (2004) and several other literature have mentioned about possible rebound effect for use-oriented service models such as leasing and sharing; but there is not information for other models. Moreover identifying behavior and platform type of rebound effect requires high knowledge about different areas of science and also relation among them. Here spread of PSS contracts in future which can happen through interest of companies and also support of governments, increase the importance of a comprehensive study about this factor. The result from this survey can show the possible areas for each PSS contracts which can produce rebound effects and also different approaches of companies for obviating the creation of them.

One of important aspects in any contract is the legal aspect; here contract documentation and legal charges tries to consider different problems which can happen during contract. According to this literature review, there is a lack of information in this area which can be related to inappropriate connection between legal and environment in academic level. Here more information is related to traditional long-term and short-term contracts which have been applied in PSS. However, the importance of this aspect and problems related to it have been emphasized by Roy and Cheruvu (2009), European Commission-DG Environment/COWI (2008), Mont (2004) and Berg, Bjerre and Henriksen (2010) but, this information has not explained different legal items in details. Moreover some types of long-term PSS such as functional sales; according to change in relation between provider and customer and especially in types of delivery require more comprehensive types of contract. Here integration of knowledge for different legal items which should be considered in these types of contracts can help both parties. For example, Renegotiation is an important factor in financial contracting which usually consider in problems related to bankruptcy or default \(^{(Roberts and

\(^{13}\) http://www.merriam-webster.com/dictionary/commission, [Accessed October 1, 2011].}
Sufi, 2009). Contracts with possibility in renegotiation about incentive or economic drivers can create more satisfaction for both parties; here the importance of these incentive types of contract has been demonstrated by Roy and Cheruvu (2009) too. However, these items are important in process of preparation for a contract but there is not integrated information for how to apply these items in long-term PSS contracts and what benefit can be gained by applying them. Another factor which has the ability to influence PSS contracts is bankruptcy; nevertheless, literature review has not identified any specific information about it too. Depoorter (1999) stated that bankruptcy is an important legal factor in whole market which a provider should be more concern about it. Here a broke company have the responsibility to its clients and any damages related to service interruption. In some cases the interruption of any services may lead to serious problems.

The importance of internal and external structure which are formed organizational structure of companies have been mentioned by different authors such as Mont (2001a), Schweitzer and Aurich (2010), Meier, Roy and Seliger (2010), Meier, Kortmann and Volke (2007) and Becker, Beverungen and Knackstedt (2008). According to survey, for implementation of PSS different internal and external organization of companies should change (Mont, 2001a). This change in structure is different based on strength of companies in different areas. Here literature study identified that human resources, financial power and inertia of managers are important factors which should consider in this process. Moreover in external structure of company, one of important actors is supplier which has a major effect in suitable delivery of PSS (Mont 2000; 2004; Bartolomeo, et al., 2003), and a suitable relations between provider and supplier can reduce the risk of rise and fall in inflation for market and price of offering.

One of external player in most of PSS offering is the original manufacture company which is responsible for production of products. The lack of incentives for original manufacture companies to have more cooperation in PSS implementation can be an interesting topic. Here usage of different business models such as ESCO and CMS is beneficial for provider and receiver of PSS contract; and both of these models are promising in reduction of required material and energy. But this reduction in material and energy is contradicted with the aim of electricity and material producer which are more interested in higher selling of their products. Here incentives for raw material provider or producer of electricity to go through these new PSS contracts are not clarified in literature. However, as Mont (2002a) stated setting appropriate prices for raw material can increase the interest of manufacture companies for recycling and reuse of product; but there is several unknown factors in here. For example, setting a proper price for raw material can increase the recycling rate based on creation of revenue for manufacture companies; but for energy companies this is more complicated. A wind turbine or dam generate electricity from stream of wind and water which is hard to put a price for them. According to availability and cheap price of these resources, there is no limitation for production which this reduces the incentives for producer of electricity to apply these types of business models.

PSS contracts tries to increase sustainability in consumption and production; according to this, one of aspects that PSS has considered is social aspect (Mont, 2004). Support of government and politics, social norms and intangible factors besides trust are three different factors which have identified for this aspect. In most approaches for spread of PSS models, the role of politicians and support of governments has been highlighted. Positive effect of PSS in environment and also increasing employment were the main drivers for their support. One topic which can consider in this area is the creation of new business models by implementation of PSS; however this area has not been addressed properly by literature. Here long-term relationship between companies and customers can show them some areas that
have not seen before; and it can lead to new types of business. Several examples can be stated such as new business methods of Apple and Google (Teece, 2011); for example Apple store provides a vast area of applications for users of iMac, iPhones and other brands of apple. Here users can buy their favorite application and download it directly to their devices. This type of service not only creates money but also at the same time provides a new scope of business for software developers and people who want to sell their application. In this business all three partners (Apple, Application Programmers, and Customers) benefit and many job opportunities can be created.

The effect of behaviors and social traits in PSS is inevitable; and many social scientists consider social norms as an important factor for economic and market outcome (Hong and Kacperczyk, 2009). Here the existences of inappropriate socio-economic structures as well as wrong selections among options by individual actors are the causes of unsustainability in resources usage (Briceno and Stagl, 2006). For example demand of people to have a separated house in current era increase the need of construction material, electricity, water and many other resources (Vercalsteren and Geerken, 2003). However this factor has been referred by many authors but there is a need for more work in this area. For instance, most of data from literature have been related to different companies or interview with their members; but one of main parts in any PSS contract is the customer. Interest, behavior, ability and different feelings of customers are important in success of different business models. Here survey about these viewpoints of people in society can be useful for improving existed methods of offering. For example, most of old and traditional people have troubles for approval of any alterations; in addition, knowledge level among people is another factor which can influence the acceptability of new models. Here information about their level of knowledge or ability for using a PSS model can lead to better design of offering.

Different literature such as Mont (2001a), European Commission-DG Environment/COWI (2008), Bertoni and Larsson (2010), Mont (2004) and Berg, Bjerre and Henriksen (2010) have addressed the effect of trust in different areas of PSS contracts. According to survey, trust has the potential for influencing other influential factors too, which makes it as an important factor in PSS contracts. For example, the creation of trust among both parties can reduce the cost of transaction (Ploetner and Ehret, 2006); which consequently lead to reduction in cost of PSS. Furthermore, in case of sharing sensitive information, this factor plays a big role; also it can be helpful for knowledge sharing in design of PSS too (Bertoni and Larsson, 2010). Based on high impact of this factor during different stages of PSS, more search about effects of it in PSS contracts and also the way for establishing it among different actors can increase the chance of success in PSS contracts.

This thesis has been addressed three factors related to customers; they have been listed as delivery time of service, simplicity and flexibility besides stability and good quality of service. Each of these factors can affect the acceptability of PSS contracts among customers. However according to literature studies, there has not been specified articles which focus in delivery time of service and only So and Song (1998), Blackburn, et al. (1992) and Berg, Bjerre and Henriksen (2010) have described the importance of delivery for customers. One explanation for this can be diversity of PSS models and uncertainty about types of delivery for some models such as, functional sales or sharing and leasing. However, in sharing and leasing model the time and effort of customers for getting to products and services can be higher Tukker (2004); but on the other hand, new methods of function delivery such as electronic shopping can reduce this time. Anyway based on direct relation between the delivery time with customers’ satisfaction, this area has high potential for further research. Kulviwat, et al. (2007), Eisma, et el. (2004), Richter, Sadek and Steven (2010), Berg, Bjerre and Henriksen
(2010), Wiendahl, et al. (2007) and Mont (2004) have described about the topic of flexibility and simplicity. Here Richter, Sadek and Steven (2010) stated that applying modularization in production can help the flexibility in PSS offering; based on this, a product or service which is consisted from different modules has a greater potential to adjust with various situation. Furthermore, the maintenance can be performed more easily which increase its usage time. However, the company should beware about sub-optimization which can happen during this process. Here each sector is responsible for improving its part but in the final, solution for higher performance of the whole system should be considered.

In research, Sundin, Öhrwall Rönnbäck and Sakao (2010), Roy and Cheruvu (2009), Berg, Bjerre and Henriksen (2010), Schweitzer and Aurich (2010) and Mont (2004) were the articles which have mentioned about quality and stability of services. However the importance of applying suitable tools and applications for organizational structure of PSS providers has been explained by different authors but this also can increase the quality and stability of service too. Here usage of high quality equipment can help the stability of function’s delivering to customers; furthermore, usage of these tools and equipment for implementation of PSS can reduce number and time of maintenance during operational time. The initial cost for these devices can be higher but regard of long period of contract, this investment can be beneficial. Parallel of using high quality equipment, providing required spare parts during PSS contracts can influence quality of PSS delivery too. Some services require types of equipment which have specific operational lifetime, and some parts of them should be replaced after this time. Here any delay in preparation of these parts can affect stability of service in PSS contracts. Identifying types and numbers of spare parts which will be required during long-term PSS contracts can prevent any operational interruptions.

In addition another factor which has been described by Bertoni and Larsson (2010) is knowledge sharing in design. The importance of design phase of PSS has been stated in Berg, Bjerre and Henriksen (2010), Holman, Kaas and Keeling (2003), European Commission-DG Environment/COWI (2008) and mostly all articles in this literature review. The effect of an appropriate design can improve the performance of delivery in PSS and also adaptation of customers. According to research, one of factors which can improve the design phase of PSS is the knowledge sharing among designers. The effect of technology in design phase and other factors such as cost and price, quality, simplicity and delivery time are important. For example, in offering good and fast delivery, provider requires appropriate information about the customers’ demand or distribution of customers; here feedbacks from clients and usage of different technologies such as information technology are important for success of this activity. In addition, applying suitable technologies for designing, managing and controlling can improve these factors. Based on high connection of these factors with technology, this thesis have been categorized them in technological aspect. These identified factors and related aspects have presented in Figure16 in alphabetically sort.
### Figure 16. Different factors which can influence in PSS contracts

<table>
<thead>
<tr>
<th>Economic</th>
<th>Cost and Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>Rebound Effect</td>
</tr>
<tr>
<td>Legal</td>
<td>Contract Documentation and Legal Charges</td>
</tr>
<tr>
<td>Organizational</td>
<td>External Structure of Service Provider, Network &amp; Partners &amp; Suppliers</td>
</tr>
<tr>
<td></td>
<td>Internal Structure of Service Provider</td>
</tr>
<tr>
<td>Social</td>
<td>Social Norms and Intangible Factors</td>
</tr>
<tr>
<td></td>
<td>Support of Government and Politics</td>
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<tr>
<td></td>
<td>Trust</td>
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<tr>
<td>Technological</td>
<td>Delivery Time of Service</td>
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<td></td>
<td>Knowledge Sharing in Design</td>
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<td></td>
<td>Simplicity and Flexibility</td>
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<tr>
<td></td>
<td>Stability and Good Quality of Service</td>
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</table>

#### 7.3 Companies’ Approaches for Dealing with these Influential Factors

**RQ3. How can companies deal with factors that influence long-term PSS contracts?**

Based on result, partnership, creation of trust, training, advertising and support of governments are five important factors which can be used for several problems during PSS contracts. Here, lack in budget, human resource and technology are some problems which partnership among companies can mitigate them. In addition, different authors have suggested, that cooperation and creation of higher trust among companies can consider as a suitable approach for solving problems related to high cost for transportation and transaction. Besides of that, lack of interest among companies for sharing their sensitive information can be solved by creation of higher trust during implementation of PSS. Moreover, training is another solution which can mitigate the problem related to low involvement and knowledge of personnel and also it can change attitudes and social norms in society.
Advertising is another technique which can influence approval of customers and change their routines; furthermore it can be applied in most of areas which require increasing knowledge of customers and institutions. Here demonstration of successful projects is one of important ways of advertising which is referred by different authors such as Berg, Bjerre and Henriksen (2010) and European Commission-DG Environment/COWI (2008). This factor can increase knowledge about economic benefits of PSS among actors such as financial institutions and also reduce inertia of internal managers. Another approach which has been discussed by Mont (2004) Berg, Bjerre and Henriksen (2010), Roy and Cheruvu (2009) and European Commission-DG Environment/COWI (2008) is support from governments which can be in financial or changing public legislations. Here developing policy frameworks and setting proper conditions by governments can lead to benefits for whole society (Mont, 2004).

Besides these important factors, other incentives and approaches have been suggested by different authors for correcting problems related to factors which can influence long-term PSS contracts. Profit sharing, using total quality management, reduction of price and establishing a minimum period for renting in PSS contracts are some other solutions that this research has identified. In addition, for solving some of these problems, companies can apply different approaches together. For example, cooperation among companies can mitigate the problems related to lack of budget and human resources in small companies (Berger, et al., 2004). Here as another solution, support from governments and financial institution can be helpful too. Furthermore, in problem related to number of defect items, authors have explained different approaches of companies such as, decentralized service facilities or cooperation with local service companies. As a suggestion, applying quality control in production line can reduce this number of defected products too.

One attractive topic which requires further research is the effect of each factor in other factors. Here beside the influence of these factors in PSS contracts, some of them have the abilities for amplifying or reducing the effect of others. Knowledge about relation among them may help companies to select more proper approaches for dealing with these factors. Here a company can use one factor for correcting the problem related to another factor. For instance, as Ritter, Ryssel and Gemünden (2000) stated, speed in delivery of service can produce more trust between providers and clients. As another example, in case of cost and price, increasing the trust among companies can reduce transaction cost (Ploetner and Ehret, 2006); which it leads to reduction of cost and price for PSS offering. However, some literature have been explained these relations; but this information is not integrated properly.
8 Conclusion

In this chapter, the conclusions are made from the research. Each research question is presented again and then the results connected to the question are presented. Answer of these research questions, addressed various factors which can influence in PSS contracts and how can companies deal with these factors.

RQ1. What types of PSS contracts are used?
This research has identified four different PSS classifications. The most accepted categorization among literature divides PSS models in three classes, product-oriented service, use-oriented service and result-oriented service. Furthermore fixed price contracts, letter contracts, incentive contracts, indefinite delivery contracts, cost reimbursement contracts, spiral contracts, time and material contracts and labor hours contracts are different types of PSS contracts which are used in industries. Here, literature review has identified two other classifications, which based on similarity and connection of their models, this thesis synthesizes them in new classification. This classification contains eight PSS models which are chemical management service, energy saving companies, resource and waste management, sharing and leasing, remanufacturing, design build finance operate, functional sales and other green business models.

RQ2. What factors can influence long-term PSS contracts?
Based on literature review, twelve factors which can influence long-term PSS contracts have identified. These factors have been classified in six aspects of organizational, economic, social, technological, legal and environmental. One factor which requires more development in PSS contracts is cost and price; the research has not identified specified method for calculation of this factor. In environmental aspect, rebound effect is one factor which can affect the performance of PSS. For entering to a long-term PSS one of important step is preparation of contract. Contract documentation and legal charges as a factor tries to explain some legal dimensions which should be considered in contracts. In organizational aspect, internal and external structures of service provider are two influential factors; here this internal and external structure of PSS provider should be changed before offering long-term contracts. For social aspect, trust, social norms and intangible factors besides support of government and politics are some factors which have been identified. Trust has a prominent effect in various aspects of PSS contracts; in addition, support of government and politics has been considered as an indisputable factor for success and spread of PSS contracts. This thesis has suggested three factors which are related to customers’ demand such as delivery time of service, simplicity and flexibility besides stability and good quality of service. Each of these factors can influence the acceptance of customers for PSS contracts. Designing is the most important step in PSS contracts; here sharing knowledge among designers can help in achievement of PSS.

RQ3. How can companies deal with factors that influence long-term PSS contracts?
The result has addressed five important approaches that can mitigate several problems related to long-term PSS contracts. These approaches are partnership, creation of trust, training, advertising and support of governments. Furthermore, different incentives and other approaches have been suggested by authors. Profit sharing, using total quality management, reduction of price and establishing a minimum period for renting in PSS contract are some of other approaches that this research has identified. Here one topic which requires further research is the relation between these factors. Based on research, some of these factors can
change the effect of others. Here change in one factor can correct or improve the result of another one; the knowledge about relation of these factors can be used by PSS providers for increasing the performance of offering.
9 Future Research

This dissertation can be considered as the start point for understanding different aspects of long-term PSS contracts. There are many topics in this area which require more research. Some of these topics that have been found after conducting this thesis are:

- Understanding about effect of each factor in others can be helpful for PSS providers. Here providers can use these related factors for improving the effect of specified factor. Understanding about connection of these factors is required more detailed search.

- The legal aspect describes different issues which both parties of contract should be concerned. Higher risk of contingencies according to long time of contract requires a strong structure and legal clauses in written contract. However most of articles in these fields explain topics of business or law separately; here further study about connection among legal, economic and environmental aspect of PSS contracts can fill this gap.

- Concepts of simplicity as well as flexibility in production and delivery stages of service are two important factors but there are less information about these topics compare to other recognized factors. Both of these factors have direct effect in provider’s profit and also customers’ satisfaction. Further research about these topics and specifically in delivery of service can increase current knowledge about them.
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References Chapter


Bibliography


Appendices

Appendix A

Primary papers for identifying influential factors to PSS

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<td>Introducing and Developing a Product-Service System (PSS) Concept in Sweden</td>
<td>Mont (2001a) – Sweden</td>
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<td>Green business models in the Nordic Region</td>
<td>Berg, Bjerre and Henriksen (2010) – Nordic region</td>
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<td>Product-service system concept as a means of reaching sustainable consumption?</td>
<td>Mont (2001b) - Sweden</td>
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<td>Industrial Product-Service Systems--IPS²</td>
<td>Meier, Roy and Seliger (2010) - UK</td>
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<td>Product-service systems: Panacea or myth?</td>
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<td>Eight types of product-service-system: eight ways to sustainability?</td>
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<td>Experiences from Suspronet</td>
<td>Mont (2002b) - Sweden</td>
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<td>Clarifying the concept of product-service system</td>
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Highest populous countries in 2009 and 2050 (Population Reference Bureau, 2009)

Top 10 populous countries in

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