

**POLITECNICO DI MILANO**

Faculty of Industrial and Management Engineering

*Master of Science in Management Engineering*



# Exploring emerging servitisation trends in industrial services

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Academic Year 2017- 2018

## *Abstract*

Nowadays we are living in a world that is changing rapidly. In this fast-changing situation companies should make themselves ready for the movement in every direction to survive. One of the recent alters in the business environment is manufacturing farms' tendency toward servitisation. In other words, every company tries to expand its offers portfolio with the services that market needs and customers expect. However, servitisation concept, is not a familiar and easy to do task for manufacturing companies which focused on the product offering and they need more hints and guidelines to be aware about requirements and prerequisites.

The purpose of this thesis is to provide a comprehensive guideline and framework for the manufacturing OEMs that wants to offer some new services to the market. In this direction, companies need to understand the market characteristics and possibilities to provide services. In addition, they need to map themselves in the dynamic environment of the business in which they are operating. This means that the market research and competitors analysis can be considered as the primary steps toward servitisation process.

This thesis suggests a framework through which companies visually find themselves in the service market and can decide about the market gaps and opportunities that they have for entering the market based on the competences and resources they possess. It provides necessary information about the servitisation process for each company pursuing servitisation. Information such as different kinds business models, variety of service offer units, and indicators through which companies can measure their performance in offering services. Then, firms can decide about what kinds of services they want offer, their business models for offering desired services, and choosing indicators to monitor their performance.

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# Chapter1.

## Introduction

Manufacturing companies have experienced more economic pressure in the recent decades. In fact, evidence showed that they should prepare themselves for competing in a broader concept as a service provider accompany with their production. In other words, competing on the basis of cost reduction is not enough (Porter & Ketel, 2003) and they should empower their competitiveness power by seeking innovation and exploiting servitisation as one of the best ways for this goal.

According to historical data of the last decades driven from the companies in different manufacturing fields, it can be seen that there is a special movement in the companies' strategy toward service-based offerings. This change in the companies develops a completely different business environment with variety of operating activities. Usually new business environment means new way to create value for the customers. This changing direction, called Servitisation, makes a win-win situation for the manufacturer and customers usually by adding some services on the product offerings (Guajardo and colleagues, 2011). Then defining new business model is an unavoidable truth for every manufacturer that wants to change its direction.

Before going into more detail, it seems that defining the term “Servitisation” is a prerequisite for further discussion. This term is invented in an article conducted by Vandermerwe and Rada (1988) by a simple definition; “the increased offering of fuller market packages or ‘bundles’ of customer focused combinations of goods, services, support, self-service and knowledge in order to add value to core product offerings”. This definition has been subjected to change by the different authors until now. For example, Ren and Gregory (2007) defined the servitisation as a change process wherein manufacturing companies embrace service orientation and/or develop more and better services, with the aim to satisfy customer’s needs, achieve competitive advantages and enhance firm performance.

As companies find the servitisation as a new way to create value and propose it to the customers, this concept created in the value chain and suppliers of the manufacturers also involved in this context. Then, starting from the B2C, servitisation concept started to be spread in the B2B environment. Various Original Equipment Manufacturers (OEMs) started to look outside of their current business boundaries and move downside in the value chain to benefit from the service offering profits. There are well known examples in this movement toward servitisation process which can be mentioned to demonstrate better the importance of this phenomenon. For instance, Rolls Royce company in 2007 began reforming its relationship with the customers and entered in servitisation area by introducing Power by the Hour (PBH) program in which company takes all the risk and extra services needed for the engines to fly, like maintenance, and sell only operating hours. For further illustration let look to another example in this field. General Electric Company introduced Navy Performance Based logistics (PBL) for four years duration which is covering all the services and component needed for the F414-GE-400 engine that is using in the U.S. fighter aircrafts. These two examples are merely a small sample of the big companies that undertake the servitisation pattern to benefit from the long-term impact of this new area, something which is proved in the following chapters.

### *1.1 Study objectives*

In spite of the advantage of this shift toward servitisation like sustainable profit, higher profit margin and in some cases co-creation, it should be noted that the servitisation has its own risk for different businesses such as new responsibilities and uncertainties that companies should deal with them. Therefore, deep understanding of the industrial environment that company wants to enter in it as a service provider is a subject from the high value. Generally, in this research, exploring main elements which have most influential impacts on the servitisation of companies in different areas is the primary objective. It is not something that can easily be obtained and needs further research from the analyzing business environments, competitors' portfolio and their reactions, and forecasting trends etc.

### *1.2 Study methodology*

In this article, first it is tried to describe the general industrial equipment market by dividing overall environment into main offering parts and then define product and service market in each part. Indeed, after splitting industrial market with the main offering like Energy, Process Material, and wastes, main offerings as products or services are categorized to make a clear provision of the market situation. In ensuing sections, servitisation process for the market, is characterized by providing additional information on the different aspects of the servitisation such as business model types, effect of the servitisation on companies' performance, and overall types of services offered to market through servitisation. As the next step, it is tried to create a comprehensive framework through which manufacturing companies will be able to visually understand their competitors and servitized market situations to make further decisions on their strategies toward the servitisation choices. Then, some real companies are mapped on the framework which will be demonstrated in the following chapters to make a clearer vision.



## Chapter2.

# Overview of the industrial services market

In this section we try to clarify industrial service systems environment with classification of different equipment/system types based on different situations of service and product markets in each class. Generally, in this research, industrial system products can be categorized in three separated groups; Energy, process materials, and wastes. Also, market is divided in two sections to distinctively describe product and service markets for each product group. With this approach entire market can be included in a broader sense. It is worth to mention that our main objective is to focus on B2B environment. Information used in this chapter completely collected from the sector providers websites and secondary data available on the internet. List of provider websites and their addresses are available in Appendix section in the end of this report.

## *2.1 Energy*

This group of equipment system includes electricity, heat, and air fresheners which can be described separately as its subgroups. These subgroups can cover the main part of Energy market. In the following sections characteristics of each subgroup presented.

### *2.1.1 Electricity*

With economic perspective, electricity is a commodity which can be traded, bought or sold. Commodities in the electricity market divided in two groups: i) power, which is the net electrical transfer rate at any given moment that is measured in MW ii) Energy, which is the electricity flows through a metered point for a given period that is measured in MWh. In spite of different regulations in different countries about the electricity markets, some concepts are the same. For instance, there is separation between competitive functions in generation and distribution. Also, establishing a wholesale market and a retail market which have different roles. Wholesale market role is providing opportunity for the generators, retailers and intermediaries to trade between each other for both short term and future delivery of electricity.

#### *2.1.1.1 Electricity Product Market*

There is a significant difference between this market product which separates it from the other ones and it is about the nature of proposed product. Electricity is difficult to store and almost is non-storable and should be available on demand. As a result, it cannot be produced under normal operating conditions to be stored in stock or even it is not possible to have customer queue for it. In addition, demand and supply are having fluctuation continuously. With this reason, presence of transmission system operator, to control and coordinate dispatching units to meet expected demand, is justified.

This market can be expanded outside of national boundaries. Three main types of electricity markets as the product market can be mentioned:

- i) Wholesale Electricity market

Something that usually happens in the wholesale electricity market is that the generators sell output to the retailers to offer it to market after re-pricing. In the recent years and in some countries, generators directly sell their electricity output to the end customers. Transaction in this market has its own risks. For example, if you buy wholesale electricity, you should deal with issues like market uncertainty, collateral investments etc.

## ii) Retail Electricity Market

If final customers are able to choose their electricity energy provider, a retail electricity market will shape. In most of situations, end customers do not pay based on real time consumption and use annual average cost. Then there are no incentives for them to reduce their consumption in the peak price of wholesale market or transfer their demand in other periods.

Although the main output in the electricity market is obvious, but if the electricity providers have the problem with offering following services to their end customers, they will face serious problems in financial terms. In fact, these services can be considered as add-on service which become as the “Must Have” term for the suppliers.

- Billing
- Credit control
- Customer management via an efficient call center
- Distribution use-of-system contract
- Reconciliation agreement
- "Pool" or "spot market" purchase agreement
- Hedge contracts - contracts for differences to manage "spot price" risk

Considering these services, the main area of the provider companies weakness can be risk management and billing when they face high spot prices and they do not have ability to collect money from the end customers. To be a competitive retailer in the retail market, companies should have confident access to distribution and transmission wires. Accessing fee to the owner

of wires should be considered at the first and choosing location of the plant should be as efficient as possible.

New technologies available to calculate real time usage calculations in the market. Even driven software allows customers to customize their consumption to achieve desired level of comfort and economy. They could automatically respond to the price changing by controlling electrical devices in the home.

### iii) Capacity Market

In this market, electricity supply will be ensured by paying a regular fee alongside of electricity revenues, to make sure that they deliver electricity when it is needed. This can be an incentive to replace older power plants and providing more backups for inflexible sources.

#### *2.1.1.2 Electricity Service Market*

In addition to above mentioned services there is another category for services in the electricity service market which is ancillary services. According to United States Federal Energy Regulatory Commission (FERC) ancillary services are those services necessary to support the transmission of electricity from seller to buyer with using the interconnected transmission system. Ancillary term is used for the variety of operations needed to have a stable and secure generation and transmission of the electricity power. FERC identifies six different kinds of ancillary services:

- scheduling and dispatch
- reactive power and voltage control
- loss compensation
- load following
- system protection
- energy imbalance

Furthermore, there are some value-added electricity services that includes new roles for third party providers. These services are proposed in the retail markets.

- Sophisticated energy management services for homes and businesses
- Integrated distributed energy resource (DER) services that comprehensively address energy efficiency, demand response, distributed generation and energy storage options
- Electric vehicle (EV)-related services, such as charging stations, fleet management and EVs as storage
- Microgrids
- DER aggregation and market participation
- Special power quality services

### *2.1.2 Heat*

With rapid industrialization trend across the world, significant growth in the heating equipment market is unavoidable. Heating equipment has a one of the most important roles in the processing of various kinds of metals, mining, oil and gas, and automotive sectors. Based on the most recent trend in world economy, one of the most influential factors in the heating equipment industry is the demand for the certified products as energy efficient. Growing energy consumption in residential and industrial context is inevitable and as a result demand for finding solutions in energy saving and operation cost decreasing, will go higher and higher.

#### *2.1.2.1 Heat Product Market*

Generally, five main product offers can cover almost all the market:

- Heat Pumps: it is also called two-way air conditioner and used in the regions that require moderate cooling and heating. The name of two-way conditioner is stemmed from the kind of operation that this product performs. In fact, during the cold seasons it extract heat from the cold outdoors and push it inside and reverse in the hot seasons.

- Furnaces: the most usage of this kind of heating products in the industries is whenever high-temperature is needed. They heat surrounded air and distribute it through the installments with the aim of ducts. Gas and electrical furnaces are the most popular in the industries and houses.
- Boilers: the main purpose of boiler usage is to boil water to use the resulted heat or hot water or steam for the different applications. By using a proper network of pipe lines, it is possible to distribute generated steam through steam radiators. Also, hot water can be used to heat the air.
- Unitary heaters: they are usually used to generate required heating in the building or complexes with the commercial or residential applications. They have enough low initial cost and ease of implementation.
- Others: other products that are not introduced in the previous groups, have not enough importance to be in a separated group, then they can be categorized in a united group. This subgroup consists of fan heaters, immersion heaters, and electrode heaters etc.

If it is needed to categorize these products based on their applications, it is possible to divide them into three distinguished groups:

- Residential: this group of products refers to the equipment which is used in the single resident such as house or complex.
- Commercial: refers to products used in public areas, like shops, schools, malls, etc.
- Industrial: the equipment used in the industrial areas and has contribution in production process.

Knowing enough knowledge about general categories of the heating system products and their application is necessary before market segmentation. For better and more targeted segmentation geographical scope can be considered.

#### *2.1.2.2 Heat Service Market*

In this industry usually, services are in the shape of add-on to the main products which maintenance of installed products is the most sensible and familiar one. However, this is not the

only service that companies offer. Services which are offered in this sector include nine main groups:

- Research Contract and technology development: services which guarantee sustainability of the industrial heating system.
- Data management: services for data managing with the aim of cloud platforms and technologies to maintain enough level of flexibility.
- Project Management: it is possible that in the commissioning and installation phase, provider takes the responsibility of project by itself.
- Special services: these services are dependent on the customer situation and need in which provider designs maintenance activities and implements them or plays consultancy role.
- Commercial catering services: big and commercial kitchen requirements in heat equipment services and their application when need to consult.
- Gas pipework: implementation of some especial services for gas pipe lines and boosters like leak test and pipe line installation.
- Air Handling Unit ventilation and heat recovery: AHU related services and maintenance, and also services needed for heat extraction and recovery units.
- Plumbing: general plumbing and fixing pipework problems.

### *2.1.3 HVAC & Air Freshener*

If we separate HVAC sector from the air sector (HVAC can be considered under the Heat Industry), the main purpose of the offering in this market is to provide and maintain pleasant atmosphere in the offices, households and vehicles.

#### *2.1.3.1 Air Freshener Product Market*

Air freshener market is expected to grow based on almost all the recent market research. With increasing disposable income and higher global acceptance of luxury products, it is expected

that this industry sector experience higher demand and have a bigger market in the future six years. This market can be described by these products in the following categories:

- Sprays/Aerosols
- Electric Air Fresheners (Plug-in)
- Gels
- Candles
- Others (Liquid, Solid, Pot Pourri, Papers, Vents, Clips, and Crystal Beads)

Which is used in by both Enterprises and individuals. New research show that among these products categorizes Sprays will dominant the market until 2020 and producing companies focus on product development by using organic flavors to increase their market share.

#### *2.1.3.2 Air Freshener Service Market*

The type of services provided as an add-on for this sector products is limited to maintenance and installation of some products and equipment or in some cases customization of the shape and perfume used in them. Companies competing in this sector, provide services for all applications of their products in Residential, Corporate Offices, Cars, Others (Hotels, Malls, Hospitals, Railways, Public Bathrooms, Theaters, and Government Buildings & Institutions).

#### *2.2 Process Materials and Compressed Air*

Among the material used in different process, in this research we focus on the compressed air. Compressed air refers to under pressure gases which this pressure is higher than the normal atmosphere that can squeeze the air into a cylinder or can. It is made of combination of some gases and has a broad applicability in the different industries. For instance, it is used as air hammers, drillers, wreckers or it can be used for cleaning some computer or electronic components which cannot be cleaned in normal ways. One of the other especial usage of this tool in the industries, is air brakes. These brakes are applied in the large railway trains that are safer and more effective and efficient. One of the other important and familiar application of compressed gases is using them in the breathing gas used by underwater divers. Generally,



pressurized cylindrical gases for breathing can be used in any dangerous environments for the workers.

### *2.2.1 Compressed Air Product Market*

In addition to the above-mentioned applications of compressed air, briefly, compressed air has the following application in different industries:

- Pneumatics, the use of pressurized gases to do work
  - Pneumatic post, using capsules to move paper and small goods through tubes.
  - Air tools
  - HVAC control systems
- Vehicle propulsion
- Energy storage
- Air brakes, including:
  - railway braking systems
  - road vehicle braking systems
- Underwater diving, for breathing and to inflate buoyancy devices
- Refrigeration using a vortex tube
- Air-start systems in engines
- Ammunition propulsion in:
  - Air guns
  - Airsoft equipment
  - Paintball equipment
- Cleaning dust and small debris in tiny spaces

- Sandblasting in machine shops
- Injection molding
- Food and beverage capping and fermentation

### 2.2.2 Compressed Air Service Market

In this sector, most of the services are carried out by the vendor itself and about 10 percent by the consultancy agencies. Service activities mainly are based on Preventive maintenance and system management and monitoring. According to the U.S Department of Energy report, Table 1 shows the most requested services from the customers and offered by compressed air providers.

Services	Percent Mentioning
Preventive maintenance on compressors	67%
Preventive maintenance on auxiliaries	44%
Emergency repair	33%
Leak repair	20%
Assessment of control strategies and equipment	14%
Leak detection	13%
Load profiling	5%
Energy use monitoring	3%
Number of customers	64

Table 1 services offered by the CA service providers

SERVICE	PERCENT OF 1998 REVENUES	
	Mean	Maximum
Compressed air equipment sales	37%	75%
Compressed air parts sales	22%	50%
Compressed air equipment service	19%	70%
Compressed air system design	5%	30%
Compressed air efficiency services <sup>1</sup>	4%	16%
Other compressed air related services	9%	45%

Table 2 CA service providers revenue streams

Also, this study claims that Table2 shows the main sources of revenue for the CA service providers.

### *2.3 Waste Management*

Nowadays, waste management is more influential on many different industries from various aspects. This effect that waste management has on the industries comes from three main benefits which it has for them:

- i) Economic benefit: the cost of waste refinement or disposal is a considerable part of overall production cost. It can be reduced if company has a good and efficient plan and choice for its wastes.
- ii) Environmental benefit: today's global concerns are far beyond than economic aspects.
- iii) Safety benefits: safety is tied with the companies' strategies and is a significant part of waste management.

#### *2.3.1 Waste Product Market*

In this sector it is not too easy to distinct industry products and services. However, based on the most companies claims products in this industry can be grouped with this way:

- 1- Recycled oils: for preventing extra oil producing for basic needs, recycling black lubrication oils is needed by a green production. Recycling oils contains gathering and processing oils to eliminate extra particles and have a good quality reused oil. Industrial waste oils can be segmented in three categories:
  - Industrial used oils with having good lubrication quality
  - Industrial used oils
  - Vegetable driven oils
- 2- Recycled Plastics: reusing of plastic products is a common way in almost all companies. They use recycled plastic to create a kind of plastic that can be used as the first raw

material. Generally, if a company wants to efficiently use its materials, recycling plastic products can be as the first step.

- 3- Bio oils: this oil is produced from a wood-based raw material. In fact, bio oil is created from the finishing woods and can be used instead of using fossil fuels because of its feature that produces less amount of CO<sub>2</sub> in comparison by fossil fuel. It can be widely exerted in different sectors.

### *2.3.2 Waste Service Market*

Various services are offered in this market which are critical parts of companies costs in some especial industries like nuclear plants that has significant decommissioning cost contribution on the total cost.

- 1- Construction services: there are some providers that totally take the responsibility of environmental friendly construction in industrial or residential scale. Construction of roads, streets, and protecting ground waters can be considered as a sample of this group services.
- 2- Waste treatment services: wide range of services in this area is based on physio-chemical treatments that companies suggest for hazardous wastes.
- 3- Licensing and safety design methods: companies always need to prepare a proper safety instruction for their operations. This matter becomes more important when a company operates in a dangerous environment with high level of criticality like a nuclear power plants or similar firms. Then, it is needed that a company itself or a provider creates a clear instruction for safety issues which some waste management players take this responsibility as a service provider or consultant.

# Chapter3.

## State of Art on Servitisation

As it is previously mentioned the servitisation term and notion is something that almost every company that operates either in B2B environment or B2C, is dealing with and should adapt itself with the servitisation features. Then, it is vital for companies are operating in today's market analyze it well and understand its requirements to be successful in their business. According to the importance of this subject, in this section it is tried to show the most important aspects of the servitisation in a comprehensive pack of information.

### *3.1 Business Model types*

Nowadays moving toward servitisation became a usual approach for manufacturing companies to gain higher competitive power. However, this movement probably creates some serious

challenges for firms. In fact, transition from manufacturing company which just produces products to a Product-Service System (PSS), needs not only redesigning its proposition from product to product-service, but also reconfiguring its business model (BM) (Baines et al., 2009). Then, it is worth to think about this question that how a product centric company can redesign its BM toward PSS and what will be its servitisation characteristics?

Adrodegari and colleagues 2015 proposed five PSS business models with combining different revenue streams and value creation ways for moving from product centric BM to a service oriented one. Actually, the BMs proposed in this research are different from previous works in this field (Tukker; 2004) which are based on Business Model Canvas. According to the Figure1, it can be identified that there are two different categories in PSS Business Models.

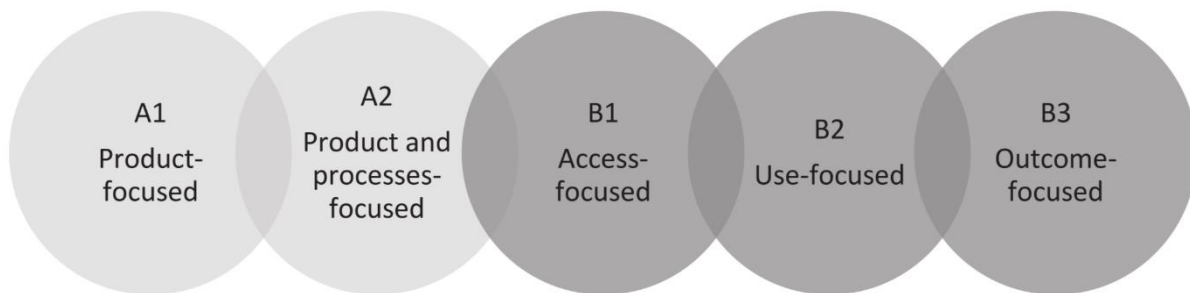


Figure 1 different kinds of business models (Source: Adrodegari, F. 2015)

- 1- This group demonstrates BMs in which ownership of products remained for the company as the main source of revenue and service is considered as add-on for the products.
- 2- This group is the representative for the BMs that are service-oriented and its linkage to the product usage is the main source of making revenue for the company. In this group ownership of the product will not transfer to the customer and services will be sold with generally long-term duration contracts.

A1: Product-focused BM. The Final goal is to deliver product to the end customer which will be tangible product. From both side of the supply chain, this BM is the most familiar one. In this kind of BM, company has no responsibility for the lifecycle of the product and add-on

industrial services will not be customized services. They include some usual activities such maintenance and repair. Apparently, company will not invest so much in the service R&D segment and the main revenue stream is selling product. As a result, main cost structure will be related to production cost. In this group, sale channel and after sale service channel will be separated. In addition, customer relationship contains some informality which defined in the contract with customer entity top management.

A2: Product and process focused BM: there are similar features between this model and previous one (product-focused). The most important difference can be identified in the before and after sale services that company offers to its customers. The aim of these services will be optimization of customer processes. Actually, company will suggest all the possible optimization for the product to its customers to achieve higher level of efficiency and effectiveness. To this end, operator training with aim of consultancy capability will be so important. To have enough knowledge about the customer process and optimize situation of the product feature according to the process, IT systems and infrastructures for the company becomes so critical and important. Sale and after sale services can be integrated and include some extra services mostly about consultancy related to maintenance activities. It can be inferred that main revenue stream in this BM, would be before sale service related component in addition to product sale.

B1: Access-focused BM: obviously, the main difference of this kind of BM from previous ones can be explained by the fact that customer will not take the ownership of the product, but by paying regular amount of fee, gets access to the product. With keeping ownership by the company, it will be responsible for all activities related to keeping product completely usable for the customer such as maintenance, upgrade, etc. As a result, this fact may create a proper motivation for the provider, to design the product to have longer life as much as possible, focusing more on product lifecycle management. This includes offering some product lifecycle related services by the company. With this approach, customer will be beneficial from the positive effect of financial flexibility, because customer will no more bear fix capital for buying the asset. Then, BMs in this group can be desired solution for small companies which wish to enter the market but do not have enough capital to deal with fixed capital entry barrier. Customer relationship changes to the intimacy level. Having close and long-term relationship with

customer has a significant importance. Also, human resource capability is an important part of the provider value proposition delivery. Training staff should be not only in the consultancy and technical parts but also, in marketing activities parts to make company's offer more attractive to the customers. According to lifecycle management activities, having strong IT infrastructure could as a high importance. Usually, payment will be in the monthly shape which covers both product and services expenditure. Generally, all the service-oriented BMs try to create value for the customers instead of internal fixed cost. On the other hands, financial resource becomes a critical element for the provider to cover all the products costs which will be no more bought by the customers.

**B2: Use-focused BM:** in this business model customers do not buy the product but pay variable amount of money proportion to their usage from the product. Ownership of the product by the provider will be remained reason for the company to design the product lifecycle activities to have higher life. It is worth to mention that the main reason for the customer to choose companies with this BM is that these group of companies try to improve their product continuously and use some kind of maintenance plans like Total Productive Maintenance. One of the interesting points in this BM, is that customer focuses on the value-in-use at the moment of consumption instead of value-in-exchange that added to the product, in the production process. This leads to co-creation of the product with coordination by the customer that makes a different value proposition from the others. As a result, having a very close and long-term relationship with customer becomes critical element in the company BM. With this perspective, having extensive knowledge about the customer preferences and needs is the prerequisite of this BM and company should be able to analyze the behaviors and worries of the customers and their partners. Moreover, health management knowledge should be embedded in this business model to actively monitor the condition of the products and optimize maintenance plans. Companies which choose this kind of BM, should grow organization capability and culture for interacting with customers and having continues improvements. Also, company should be ready to bear higher amount of risk and uncertainty. Then, having considerable pricing capability is essential for the provider to somehow cover these risks.



B3: Outcome-focused BM: payment fees in this BM depend on the goals achievement that already defined in the contract between the provider and customer. This business model is very similar to B2 but there is different in the value creation for the customer that is expressed by the minimization of operational costs and initial investment and then value-in-use changes to some elements like availability of the product. It means that provider is user of the product that provides itself which results in using product with more precision and consciousness about the outcomes. In this BM, also, monitoring the condition of the products is significantly important and need precise information sharing between partners to get better results. It arises importance of ICT infrastructure for sharing information. Value proposition can be case by case different and company may use dynamic pricing approach to have a reasonable revenue generation. In the BM, having enough financial resource is crucial as well.

### *3.2 Servitized OEMs & Value Chain*

Recently research shows that goods manufacturers tend to have the innovative offering by adding some services to their existing products to better satisfy their customer needs. For instance, as previously mentioned, Rolls-Royce Aerospace is a good example of this tendency. It changed its configuration from a sole manufacturer to the maintenance service provider for its products and spare parts by “power by the hour” package for customers.

Although some studies like Kim et al. (2007) and Kim et al. (2010) show the positive effect of servitisation on the customer value of the product and its performance, the impact of such an innovative service on the manufacturer can be ambiguous. This uncertainty can be stemmed from the upcoming challenges in the formation of a new business model (Martinez et al., 2010).

For finding a better solution to this ambiguity, Tapio Melgin (2015) conducted a research on 44 subsidiaries of Atlas Copco company over the period 2001-07. This research tried to demonstrate literature gap for the process of value creation and appropriation for manufacturer servitisation.

Atlas Copco is the manufacturer of durable industrial compressor that recently decided to extend its products package with some services. Research shows that in the new business model, services prolong products lifetime and postpone product replacement. On the other hand, adding

services results in customer proximity when the company decides to do its products maintenance. Another finding of this research shows that in terms of profitability, in spite of decreasing profitability in the medium-scale levels, after the critical mass of servicing, profitability will be obtained.

Servitisation presents a “make or buy” question in the customer mind. Actually, a customer can provide service to products in-house, outsource it to a service provider, or outsource it to the OEM. The customer probably will choose among these options according to the cost-effectiveness relation.

OEMs can benefit from the economy of scale and economy of scope. For further demonstration, the economy of scale arises when a manufacturer provides service for the entire products and economy of scope can be beneficial by using OEMs resources for both product and service together (Gebauer et al., 2008). According to this explanation following hypothesis can be supposed:

Hypothesis A.1. increasing product sales volume will result in increased service sales volume.

Hypothesis A.2. increasing service volume will result in increased product sales volume.

Hypothesis A.3. increasing customer proximity which is measured through the share of labor-intensive services, will result in increased product sales volume.

Hypothesis B: there is a curvilinear relationship between profit margin and service activity scale which has two saddles. Very low level of service activities demonstrates an increase in margin, low level of service activity results in decreasing margin, and then, increasing margin when we have enough economy in service activities.

In this research for testing hypotheses, data is collected from national sales and service subsidiaries of Atlas Copco.

After testing actual data, this research shows that product sales volume and service sales volume complement each other, and customer proximity enhances positive feedback from services to product sales volume.

These findings demonstrate that integrated product-service business model is important from this perspective. Service should be considered as a strategic complementor for the products. In other words, if the services are considered occasional and as add-on, increasing in revenue will be insignificant in comparison with installed products that encourage company to go toward independent services. On the other hand, if services become unrelated to products offering, firms will lose their economy of scope as a source of value creation and then customers may choose specialized service providers which are more efficient. In addition, results show that H.B. illustrates nonlinear and nonquadratic relationship between service sales and profitability. Indeed, there is cubic relationship between them. Actually, results confirm the Hypothesis that with small service activities, product-service provider can experience high margin. With moderate level of service activities firm will face with reduction in profit margin which can be explained by need of company to invest in the provision service activities. Finally, large enough level of service activities will compensate initial needed investment. In addition to economy of scale, accumulate learning can have a positive effect. It means that after some attempts, product-service provider will be more familiar with customer needs and get more information about the maintenance requirements.

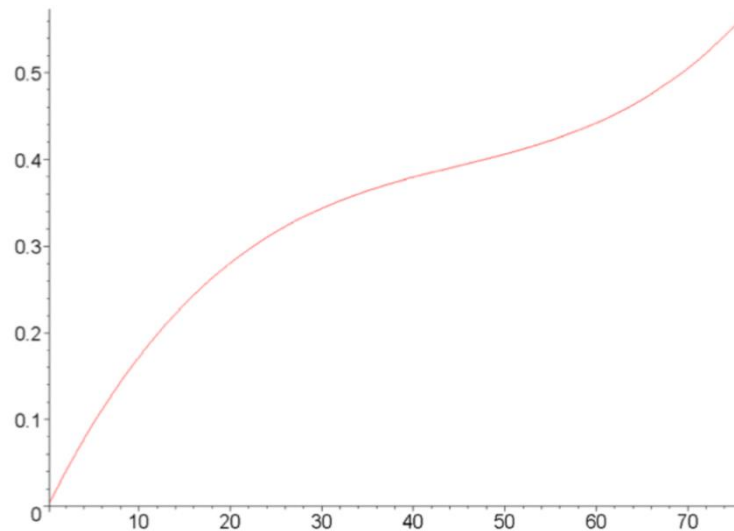


Figure 2 Relationship between service level and profit margin (Source: Melgin, T. 2015)

Finally, this paper suggests three recommendation which are worth to mention for OEMs who are interested in entering service market:

- i) Exerting product-service business model as a way to create reciprocal value for the products and services.
- ii) Focusing on activities which generate customer proximity.
- iii) Be careful about necessary investment as well as enough customer base, to reach long-term profitability and not to fall in decreasing slope of profit decreasing.

As a complementary research, Matthieu Crozet (2017) conducted a research with using a comprehensive database from the French companies in manufacturing sector during 1997-2007 to illustrate effect of servitisation on the manufacturing firms.

This research used BRN database information for covering 67,385 firms with average 55 worker employees and 12 million turnovers.

According to the data driven from these database, firms can be categorized in these groups. I: Manufacture of food products, beverages, and tobacco. II: Manufacture of textiles and leather products. III: Manufacture of wood and wood products; manufacture of pulp, paper, and paper

products; publishing and printing. IV: Manufacture of chemicals, chemical products, and man-made fibers; manufacture of rubber and plastic products. V: Manufacture of other nonmetallic mineral products, basic metals, and fabricated metal products. VI: Manufacture of machinery, electrical, optical, and transport equipment. VII: Manufacturing, n.e.c. it is omitted firms in the manufacture of coke, refined petroleum products, and nuclear fuel as only four firms existed in 2007. Firms are divided to three categories according to their sizes based on European Commission (Micro 1-10, small 10-50, large >50). Size is defined by the number of workers.

Population of French firms is composed by three different groups: pure goods manufacturer, companies with additional services which mainly focused on goods, and service companies. For instance, in 2007, 25% of firms produced purely goods, and 56% and 19% are the other servitized groups relatively. These groups are different in the size and profitability. Overall, servitized firms have the better performance in comparison with the first group and they are bigger, however, difference between second and third one is not so significant in terms of profitability and size.

Based on this observation, decision of starting to servitize is on the center of concentration not the intensity of servitisation. In fact, selling more or less services has the ambiguous impact on the company performance.

In this article performance of the firms is evaluated by using 4 indicators: profitability (with using EBITDA), Employment, total sales (turnover), and production sales of goods.

Testing results shows that firms which moving toward servitisation will face increase in their profit margin and positive relation between profitability and servitisation is verified. Also, about the other indicators of the firms' performance, there is a positive relationship between servitisation and Employment and Turnover. However, it seems, servitisation has a negative impact on the production sales of goods or at least does not have any positive relation.

As it is obvious and mentioned in the literature of the subject, servitisation usually shows its complete impact in the long-run and needs time to compensate its elementary investment. Then, long-run effect is tested for the consequent years of study (t+1, t+2, t+3). The relationship between servitisation and firm's profitability remains positive in this period. About the

employment the positive relation persists, in spite of declination. Servitized companies employ more worker in comparison with pure manufacturers. Calculations about other two indicators do not provide precise results but it can be inferred that servitisation not necessarily support production sales of goods.

These results also tested with considering correlation with the firms' sizes which may have an significant impact on the results. Results of this test also shows similar behavior which previously mentioned.

According to the fact that adding service to the product is mainly dependent on the product and overally sector features, considering different sector to evaluate impact of servitisation will be useful. Although the results of this test verified previous results which obtained from the overall data, but coefficients are significantly different in each industry: 1- servitisation has higher impact in profitability and employment in the agri-food, mineral and metal products, and machinery, electrical sectors. 2- servitisation has positive impact only on the employment in the wood and printing, chemical and plastics, and n.e.c. sectors. 3- in the textile and leather sector, servitisation does not have impact on the firm performance.

### *3.3 Servitisation Offering Unit*

Andy Neely in 2007 conducted a valuable research by using OSIRIS database from 10,078 companies in 23 different countries to show the extent of servitisation in different countries, types of services which these companies offer and the impact of company size on the probability of the servitisation.

According to his research, US has the highest rate among these countries for offering service besides of its companies of product offerings while China has the lowest. From the other aspect, this article showed that there are twelve different categories for service offering which is included: [i] Consulting Services; [ii] Design and Development Services; [iii] Financial Services; [iv] Installation and Implementation Services; [v] Leasing Services; [vi] Maintenance and Support Services; [vii] Outsourcing and Operating Services; [viii] Procurement Services; [ix] Property and Real Estate; [x] Retail and Distribution Services; [xi] Systems and Solutions;

and [xii] Transportation and Trucking Services. Table3 shows the percentage and share of each service division.

Which services are offered?	% of firms offering service	Number of firms offering service
Consulting Services	2.69%	291
Design and Development Services	21.92%	2,373
Financial Services	3.89%	421
Installation and Implementation Services	5.10%	552
Leasing Services	1.07%	116
Maintenance and Support Services	11.94%	1,293
Outsourcing and Operating Services	1.68%	182
Procurement Services	1.15%	125
Property and Real Estate	3.83%	415
Retail and Distribution Services	12.18%	1,319
Systems and Solutions	15.70%	1,700
Transportation and Trucking Services	0.20%	22

Table 3 share percentage of service types (Source: Neely, A. 2007)

As it is visible in the Figure3, well developed economies like US have the highest rate of combined product and service offering and not surprising China has the lowest. It should be mentioned that countries with lowest 77 firms eliminated from the 23 countries list.

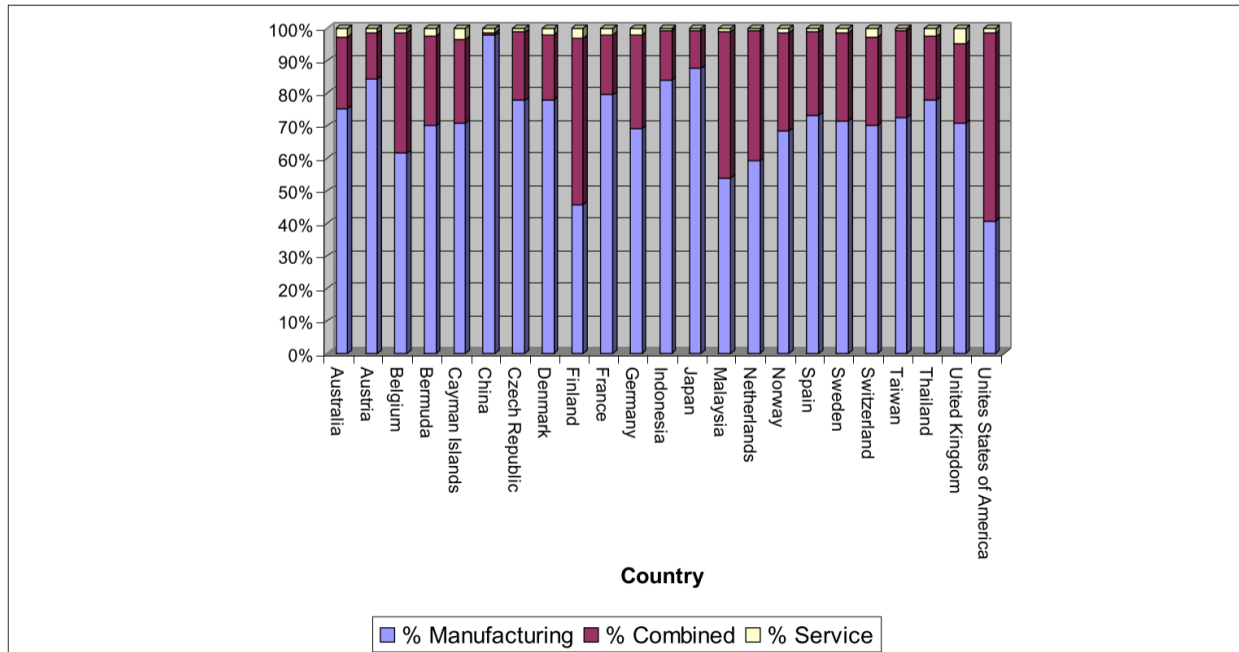


Figure 3 proportion of Manufacturing, pure service, and combined firms (Source: Neely, A. 2007)

Figure 4 shows relationship between the firm size and probability of being servitized among this sample of companies. Size of companies is measured based on the number of employees.

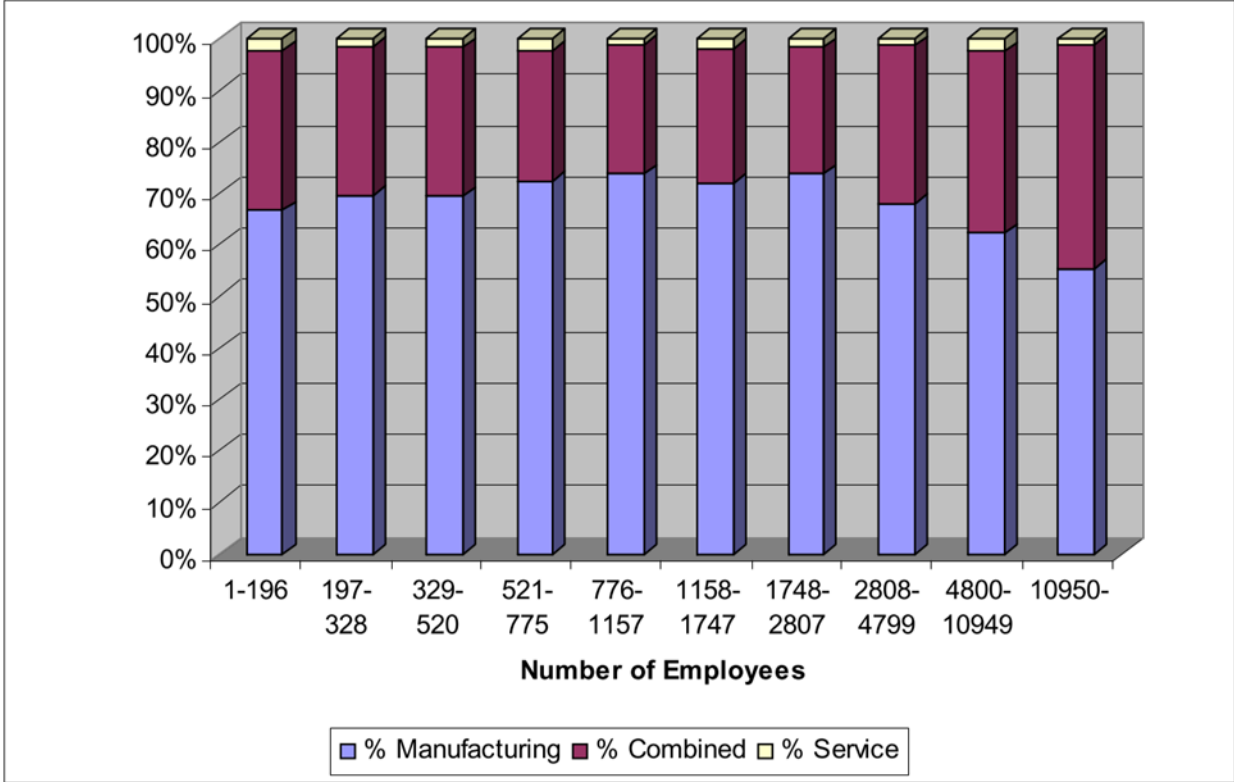


Figure 4 size and profitability relationship (Source: Neely, A. 2007)

3.4 Toward Servitisation in B2B environment

To pass from a sole manufacturer to a servitized company, in addition to previous discussed issues, there are some subjects that are partly prerequisites and partly facilitators in this process. Here, two main subjects are discussed which help firms to servitize themselves in a better way. Firstly, Business Model Innovation (BMI) which is one of the ways for servitisation (Visnjic et al. 2013) can be a useful tool in B2B environment. Simonchik 2015 tried to test applicability of service design tools in BMI for servitisation in B2B context. Service designing will have considerable contribution in prototyping complicated PSS with two level of interventions.

- i) value understanding.
- ii) value proposition.



<b>Tool category</b>	<b>Level of iconicity</b>	<b>Relation of time</b>	<b>Examples of relevant service design visualization tools</b>
Maps and Matrixes	Abstract	Synchronic	Service Ecologies (Manzini, Collina, & Evans 2004; Morelli 2006; Polaine, Løvlie, & Reason 2013) Stakeholder Motivation Matrixes (Manzini et al. 2004) Activity Maps (Sangiorgi 2004) Behavioral Mappings (Larson, Bradlow, & Fader 2005) Desktop Walkthroughs (Stickdorn & Schneider 2010)
Service Flows		Diachronic	Blueprints (Bitner, Ostrom, & Morgan 2008; Shostack 1982; 1984)

<b>Tool category</b>	<b>Level of iconicity</b>	<b>Relation of time</b>	<b>Examples of relevant service design visualization tools</b>
Maps and Matrixes	Abstract	Synchronic	Service Ecologies (Manzini, Collina, & Evans 2004; Morelli 2006; Polaine, Løvlie, & Reason 2013) Stakeholder Motivation Matrixes (Manzini et al. 2004) Activity Maps (Sangiorgi 2004) Behavioral Mappings (Larson, Bradlow, & Fader 2005) Desktop Walkthroughs (Stickdorn & Schneider 2010)
Service Flows		Diachronic	Blueprints (Bitner, Ostrom, & Morgan 2008; Shostack 1982; 1984)

Table 4 different visualization tools (Source: Simonchik, A. 2015)

For managing these interventions, service design develops specific visualization tools (Morelli 2006). These visualization tools which includes maps, flows, images, and narratives are represented in Table4.

Abstract in the iconicity part represents visual synthesis of PSS based on signs and symbols, while realistic shows exact PSS offering.

Maps represent overall configuration of PSS. This tool tries to connect all the contributing factors in the service delivery with the help of iconic manner. These maps are useful to analyze the relationships between different actor in the PSS and set some incentives for each of them.

Flows show how customers interact with value propositions. In this tool, the focus is on the customer experiences. More important aspect is the emotional part rather operational. For evaluating operational part Blueprinting is a proper mean which is introduced by *Shostack* (1982; 1984),

Images exerted in two parts. It can represent customer profile with Personas analysis and also, it is able to demonstrate service touchpoints.

Visual narratives represent service value-in-use through sequence of service moments. They are, also, used to represent customer experiences.

According to this research, if we focus in early phases of BMI for servitisation, i) customer identification ii) value proposition design (Eucher & Ganguly 2014), configure PSS as a result. For having effective configuration, it should be

- i) be clear about PSS value features with added value-in-use.
- ii) includes both elements and processes of PSS that are able to deliver the intended value to the customers (Nordin & Kowalkowski 2010).

Service design will have effect on two levels of intervention. First customer value perception and second value proposition production process. These intervention objectives coincide with those that are defined in the BMI early phases. Also, this designing has both emotional and operational focuses.

Generally, different service design tools are able to create value for BMI in servitisation context. These tools are relevant for both identification of customer value and designing of value proposition.

Second subject which can be influencing on the servitisation process is Internet of Thing in Industrial 4.0 Revolution. Nowadays big data analytics has a crucial importance for companies with considering productivity issues that are related to rapid decision making. From this perspective, most of the companies are not ready because of having scarcity of smart analytics tools.

Germany is a good example of leading country for transformation toward Industry 4.0 Revolution with using CPS systems in manufacturing industries. As more embedded intelligent software and components are used in the manufacturing equipment, it is more probable to use predictive algorithm which are enough intelligent to be self-x and able to predict their performance and degradation. In other words, these intelligent components and systems will not

need to be optimized by someone else and are able to understand their service needs. Generally, achieving better machine performance and management need higher ability of machines to interact with their surrounding environment. One of the problems which is not yet completely tackled and remained far from the optimal situation is the self-learning machine issue. According to Lee 2014, problem can be divided into following categories:

- Manager and Operator interaction: which can be mentioned as operator awareness of the health condition of the machine components.
- Machine Fleet: strong assumption about similar working conditions of identical machines that are actually assigned to completely different working conditions.
- Product and Process Quality: which is related to lack of feedback loop for the product quality backward reasoning.
- Big data and Cloud: data management is a critical step for obtaining self-aware and self-learning ability of the systems that needs more research and development.
- Sensor and Controller Network: it is more related to have a higher precision with data sensing of sensor that is subjected to failure and degradation.

Factory capabilities of self-awareness, self-comparison, self-maintenance and self-reconfiguration are accompanied by two types of new technologies that are in center of concentration by the academia and industries: Big data and service innovation.

Countries that were pioneer in manufacturing industries and got power from their ability to produce products much more better than the others, nowadays try to add some services to their sole products because of new thread that easily is felt in the new emerging markets. Then, a lot of big manufacturing companies are seeking toward development of manufacturing servitisation. Servitization concept invented by Vandermerve and Rada 1988 showed the fact that manufacturing industries should focus on the customer and combine product and service to create value added to enhance their core business. Combination of product and service is a notion that Banies (2009) proposed it as organizational capability as an innovation.

Then, servitisation can be defined as a strategic innovation in the organization process and capability to shift from the sole selling product to integrated product service offering (Martinez 2010). Inventing Product Service-System (PSS) can be seen as a special case of servitisation in which company develops product with value added services as a solution for satisfying customer unmet need (Mont 2004).

Industrial Big Data that is so popular between industries, is a powerful tool which can be used in different aspects such as customer relationship clustering, sale prediction, customer opinion clustering and recommendation systems, etc. in this section which is proposed by Lee 2014, our focus will be on the human generated data and not machine generated or industrial related data. An appropriate platform is needed to transform data acquired from different sensors to the meaningful data.

The advent of new sensing technology and progressive framework of IoT, made humans and systems closer and connect to each other. Also, advancement of cloud and CPS systems will make future industries able to have self-aware fleet. Self-ware machine is a term about condition of a machine that is intelligent enough to evaluate its health condition and proposes a maintenance plan based on the analytics of obtained information. This kind of intelligent awareness can be used in individual or Fleet level in a company to prevent probable performance problems and critical degradation.

In the current industries application of self-aware fleet is still far from being realized. This issue can be stemmed from the fact that current prognosis algorithms are not flexible enough to cope with complicated information. Lee 2014 summarizes reasons as follows:

- i) Lack of close human-machine relation, passive machine which only listens to the operator command cannot have a significant contribution to the productivity and quality of output product. Some task arrangement suggested by the machine itself can be noticeable element to optimize task design and scheduling.
- ii) Lack of full exploitation of available information and adaptive learning, generally PHM systems are not used widely in industries because of its limitation which results in reduction of the system robustness in health monitoring. The problem behind of

this issue is that development and implementation of PHM systems are separated. The health monitoring data usually generated by the experiments in Labs and they will not be updated unless they re-implement. Then such situations are far from being optimal. Lee et.al 2014 proposed a unified CPS framework which is shown in Figure5.

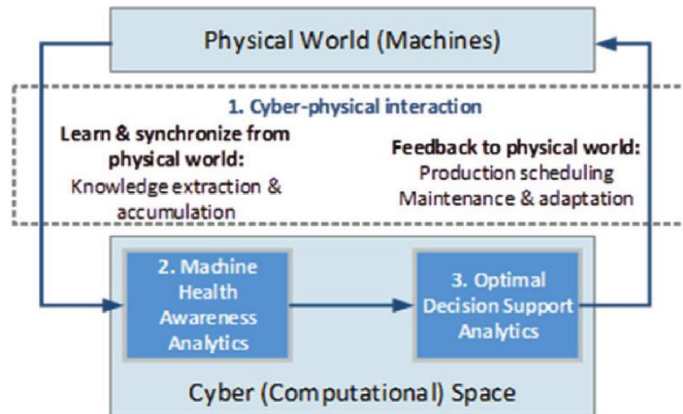


Figure 5 Unified CPS framework

Unlike most of the existing CPS that use simulation as their data set, this one uses knowledge base data set for degradation in the physical world. This knowledge base data set will be able to work in the complex working condition and collect data in real-time to compare both horizontally (with other machines) and vertically (with other times) to extract new knowledge. In such a way, fleet of machines is able to be self-learning and be adaptive to the most complicated working environments.

If meeting production effectiveness and efficiency in production planning considered as the main objective of designing decision making systems, two key factors can be mentioned as practical leverage for achieving system target: i) reduction of production uncertainty which leads to reduction of unplanned downtime and improving efficiency ii) better utilization of resources in the stations that are detected as bottlenecks in the production plans. Rich PHM in the CPS environment is able to help decision making in production control and maintenance planning.

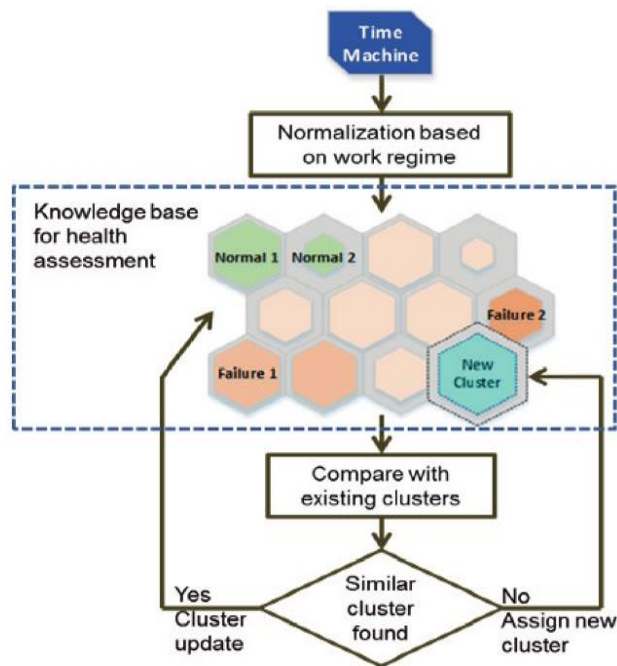


Figure 6 Adaptive learning clustering

Key advantage of such CPS framework can be:

1. Unified CPS for the all identical machine fleets.
2. Enabling self-aware fleet to use PHM algorithms that is self-learning.
3. This system is able to design proactive maintenance scheduling and planning.

## Chapter4.

# A framework for mapping servitisation strategies in Industrial Services

In this section a comprehensive instruction will be proposed to show the servitisation process steps for manufacturing companies which want to initially map themselves in the current market and move toward servitisation based on requirements and tools that discussed in the previous sections. With this aim, companies firstly should find their exact location in the service and product market according to their competitors and industrial system that they are working for. As it is previously mentioned, industrial Production type can be categorized with Energy, Process Materials, and Waste Management. On the other hands, the market is dividing in

product and service market, based on the offers that companies provide. Figure7 can summarize this format;

With more concentration on industrial production types, current trends that obtained from the secondary information show that Energy segment is more deserved to be focused. This segment is usually broken to Electricity, Heat, and air industries. Further research on the information persuades us to go in more detail on the Heat sector. In fact, Electricity product and service markets are saturated by plenty of competitors that makes it difficult to enter the market anymore and boundaries of the market are well defined. Air Freshener markets also, do not have enough variety in the products and especially for the services and it seems that there is not any significant innovation on it. The only segment that worth to work on the servitisation is the Heat production system.

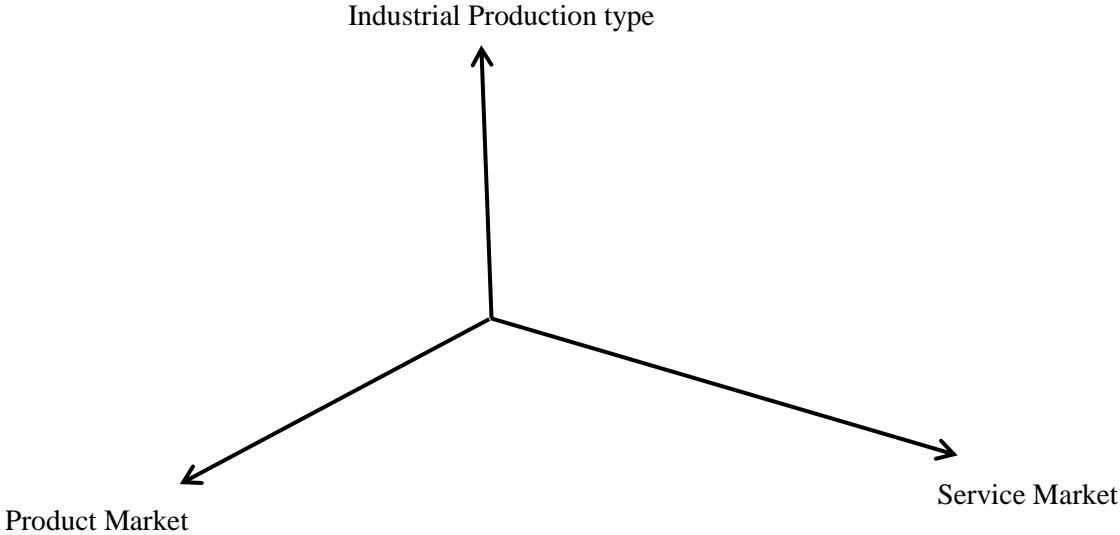


Figure 7 Industrial equipment market

As it is demonstrated in *chapter2* Heat production markets divisions include Heat Pumps, Furnaces, Boilers, Unitary heaters, and Others in the product market and Research Contract, Data management, Project Management, Special services, Commercial catering services, Gas pipework, Air Handling Unit ventilation, Plumbing in the service market. Table5 illustrate the Market for the Heat Production system.



Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other								

*Table 5 Market segments for the Heat Production System*

With the help of this table, a manufacturing company can map itself in the market based on its products and services portfolio. It will be so important that companies always compare themselves with their competitors and monitor the market situation. This segmentation of the market makes it possible to find market niches to invest. In other words, companies firstly can understand their position, then finding market segments that it is possible to go further in those segments, and after analyzing their situation based on resource and competences they have, to choose the best one. This fact becomes more important for manufacturing companies that they want to servitize themselves in some parts of service market.

After company decision about expanding its service portfolio in the market, it needs to think about the servitisation strategy that company wants to exert. For understanding better this notion company should think about the business model that it is needed, type of services in the servitisation area in which company wants to operate and estimate benefits that company will obtain from this movement. Another time it is possible for companies to map themselves in the servitisation area by this area features which well defined in the previous sections. In fact, it is possible to facilitate servitisation process, if the business model types, benefits, and service offering units are well defined. With this aim, Figure8 can briefly shows each element types and categories.

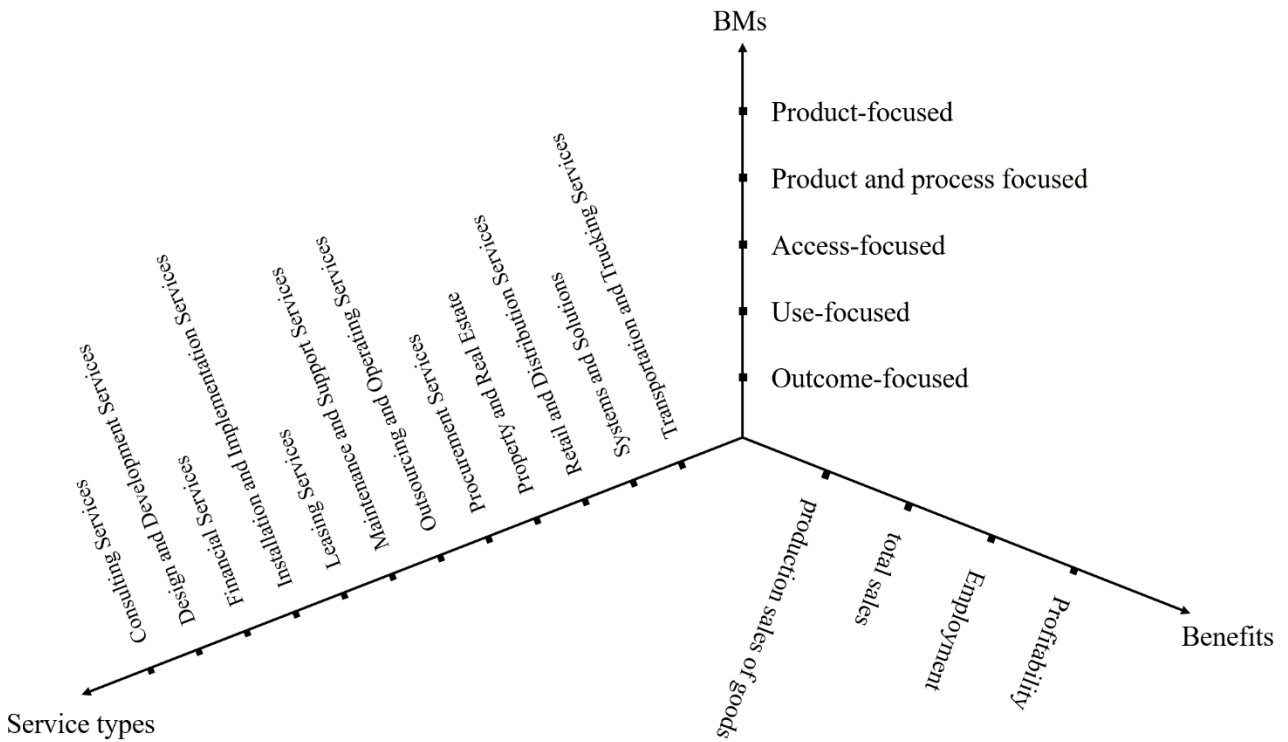


Figure 8 Servitisation process elements and their categories

It should be noted that benefits of servitisation will be calculated based on its effects on company performance. As it is mentioned in *Chapter 2*, there are four indicators for analyzing performance of a company: i) Profitability, which can use EBIDTA as a reference ii) Employment, it is the number of company's employee iii) Total sale, or turn over iv) Production sales of goods. This proposed framework can completely help companies through the servitisation process to find out which type of services they want to choose, which business model they must choose, and how it will affect their businesses.

# Chapter5.

## Data collection and analysis of sample companies

Obviously, every model needs to be analyzed to ensure practicality and trueness. For demonstration of the proposed model practicality in the servitisation process, in this section a sample of companies is considered. These companies are currently operating in Heat production system and have some dedicated products and services portfolio.

### *5.1 Justification*

Selection of the companies' sample should be precise and purposeful to clarify the strength and weakness of the proposed model. The suggest sample contains companies which are operating in different roles of the Heat market to cover most significant part of the market. Actually, considered companies are spread in several industrial countries around Europe like Germany, France, United Kingdom, and Italy. They are working in different area of the Heat operating market and play different roles such as Manufacturer or Installer. In the next sections every company is further introduced and analyzed.

## 5.2 Bosch

Bosch Thermotechnology is one of leading manufacturers of energy-efficient heating products and hot water solutions in Europe. The company has strong international and regional brands and offers revolutionary technology both in the area of residential buildings and in commerce and industry. Food and beverage manufacturers, chemical and pharmaceutical companies, power plants, hotels or hospitals – they all rely on different types of energy such as process heat in the form of steam and hot water, electric power, cooling energy or compressed air. Bosch tries to provide necessary products and services for different industries. For further detailed analysis, it is logical to have a look on the company product and service portfolio. Bosch company provides some products in the industrial heat sector like:

- Heating boilers
- Hot water boilers
- Steam boilers
- Combined heat and power units
- Variable Refrigerant Flow systems
- Heat pumps
- Heat recovery systems
- Domestic hot water
- Water tube boilers
- Controls and connectivity
- Components

This company also provides some services for its customers such as:

- Spare parts service
- Boiler service
- 24-hour service
- Troubleshooting
- Overhauling
- System analysis
- Modernisation

- Remote access

According to these catalogs of the company service and product, now it is possible to build company operating market segments to further illumination of the company situation.

Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other								

Table 6 Market segments for the Bosch Heat Production System

Bosch company is producing most of the components and products by itself. Then, it is possible to say that this company can be considered as a Manufacturer which also provides additional services for its customers. Services that the company offers includes consulting service for implementation trouble shooting or finding solutions, design and development of the product or service, implementation and maintenance, procurement services by providing spare parts for its customer through its spread warehouses in all around Europe, and also system and solution services. Considering above mentioned information about the company, it can be inferred that Bosch is using Product and Process-Focused business model. In fact, it offers some additional services to the customer that makes the product portfolio more attractive. Based on the assumptions that have been proved in the previous sections, these services have positive effect on the product sales volume and vice versa. According to the company forecasts, Industrial Technology part of the company which also includes the Heat market segment, will face an increase in the sales revenue about 7.8 % in 2018 in comparison to previous year. This can be a proof of positive effect of the servitisation on the company performance. Bosch always claims about the product innovation and usage of IoT technology in its products and services that is obvious in the company product and service portfolio like remote control service.

### 5.3 *WatkinsHire*

Watkinshire has many years of experience in providing complete rental solutions for critical temperature control requirements across all industry sectors. Actually, this company does not just provide rental equipment but the complete temperature control rental solution from system design through to installation and commissioning. In addition, with GSM Telemetry systems Watkinshire can monitor fuel usage, manage fuel deliveries and provide fault reporting on boilers and chillers for a total peace of mind solution. For both planned maintenance and emergency requirements, the company offers a comprehensive total service including site surveys, advice on product selection, technical advice and full installation and commissioning. The product portfolio of the company is including six main categories:

- Steam generators
- Boilers
- Heaters
- Chillers
- Air conditioners
- Dehumidifiers

Services that the company provides for its customers include:

- Temperature Control Emergency Planning Services (TCEPS): has been introduced to assist all clients that rely on steam, hot water, heating or cooling for uninterrupted business continuity.
- Watkins Annual Steam Protection Service (WASPS): has been introduced to assist all clients with production critical steam boiler plant located across multiple sites.
- Dedicated National Account Team
- Specialist dehumidification: proposing a rental climate control solution tailored to fit customers' specific needs.

Watkinshire also claims that it can fit its services to different industry sectors needs. Sectors include Education, Construction, Manufacturing and Process, Public sector, Retail and commercial, Petrochemical, Utilities, Facilities management, and Transportation.

With above-mentioned company situation expression, now it is possible to build product service system that currently the company offers to the market.

Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other*								

Table 7 Market segments for the Watkinshire Heat Production System

\* dehumidification systems

Watkinshire provides different Heating systems product models with different features to meet customers’ needs. It also offers some additional services like maintenance and installation of its own products. The company provides some packages of services for different industry sectors of its customers that work with it besides its products. It tries to optimize the service package for each sector to show that the package is dedicated to that industry. In addition, for some products like dehumidification systems, the company is able to consult with customers to understand their needs and location situations like humidity and temperature, then try to tailor products with location features and customer’s needs. These explanations verify hypothesis that the company is using Product and Process focused BM, but it is not the full story. Actually, for some products and in some services, Watkinshire offers rental products to its customers which put the company BM in the third category, Access-focused. Then, it is possible to show that the company is operating in Consulting, Installation and Implementation, Maintenance and support, Leasing parts.

#### *5.4 Caldaiemelgari*

CaldaieMelgari is an Italian company that is experienced in designing, constructing, selling, and installing some Heat system products and also providing rental services. The company emphasizes on the customer relationship and providing backup supports for them. In other words, the company guarantees high level of after sale services for its customers by providing customizable maintenance plans. The company claims that it has right boiler for any kind of production needs, from 200 KW up to 8 MW and reconditions used boilers and their equipment, replacing worn components and making new CE-marked electrical boxes. It also deals with burners, new and overhauled, working on both liquid and gaseous fuel. Caldaiemelgaria offers portable containerized boilers which comply with latest quality and safety standards and are inspected by approved organizations. They are ready-to-go solutions; It means that they're complete with burner, circulation pumps, electric system, expansion tank and also flexible pipes which make the connection phase faster than ever. The products that the company offers can be grouped by following categories:

- MVI - Three smoke passes with inversion flame back steam boiler
- MV3 - Three real smoke passes steam boiler
- MVB - Three smoke passes with inversion flame back low-pressure steam boiler
- SRH/SRV - Horizontal and Vertical Coil steam boiler, for rapid steam production
- MAC3 - Three smoke passes hot water boiler, up to 109°C.
- MAC - Three smoke passes with inversion flame back hot water boiler, up to 109°C
- MAXI - Electrical and automatic steam boiler
- SOH - Thermal oil heater for temperature up to 320°C

The services that the company offers are:

- Water treatment
- Customizable maintenance



- Direct data acquisition and remote control

Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other								

Table 8 Market segments for Caldaiemelgari Heat Production System

CaldaieMelgari tries to use the cutting-edge techniques to keep itself update. For instance, the company offers the remote system through which a boiler can be controlled by a PC in the company, home, or somewhere else. The company offers ready to use fleets in which the start-up time is near to zero and it can be company difference from the others. On the other hands, Caldaiemelgari provides ad hoc rental solution for its customers. These rental solutions can be fit by the customer needs. Based on the company offers it can be claimed that the company is providing Consulting, Installation and implementation, Maintenance and support, and Leasing services. It seems that the main source of the company revenue is selling its products but also sometimes it provides rental offers for willing customers. Then, BMs that company is following is not only product and process focused but also it can be considered as access-focus for ad hoc services. Data acquisition modules that the company is using in its products can provide a data management platform for users and it can be considered as industrial 4.0 revolution usage in production. The company performance also shows a good trend for instance, its revenue from 5 billion euros in 2015 became more than 6 billion in 2016 with more employees.

## 5.5 LTS

LTS was created in June 2008 with a single objective: Meet the temporary thermal energy needs of industrialists and operators. The company offers rental industrial boilers with complete fleet. Each boiler is equipped with dual fuel burner to fire either light fuel oil or natural gas. LTS company's values can be summarized through: Enthusiasm, team spirit, innovation and creativity, respect for our clients, quality and the environment. Since January 17, 2018 LTS is integrated within the Atlas Copco Specialty Rental Division of the Swedish industrial Group Atlas Copco. It operates as a part of the Rental Europe entity of the Division. The common technical and commercial approaches of the two companies allowed for this smooth integration. The international development of LTS will now be supported by Atlas Copco Rental Europe's extensive existing structure.

Generally, company products can be put in three main groups:

- Steam boilers
- Hot water boilers
- Superheated water boilers

Services that the company provides are based on customer order and its features:

- Preliminary studies of the implementation before installation
- HAZOP studies
- Transportation of Equipment
- Unloading by crane
- Erection on-site
- Connection of the equipment to your installation
- Regulatory checks in accordance with AQUAP ES20
- Commissioning of the installation
- Training your operators on how to handle our equipment
- 24/7 on-call phone assistance
- Technical on-call assistance with on-site intervention within 1 hour (24/7)

- On-site system operation
- Removal of the equipment at the end of the rental period

Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other								

Table 9 Market segments for LTS Heat Production System

The company product portfolio is focus on producing boilers. It can start from the beginning of the project by studies and design of the project and doing safety studies or making connection between products and customer’s fleet by itself. It also provides some services in decommissioning periods and also some rental services for its customers. With this description, it is possible to categorize the company’s service units; consulting, implementation, maintenance and support, and leasing services. Like the previous cases, LTS provide product and process focused BM evidence and also access focused one.

## 5.6 Viessmann

Viessmann offers complete solutions for plants that guarantee steam production up to 120 tons per hour, heating up to 120 MW, cooling up to 2 MW and electricity up to 50 MW. In this way, all energy sources can be used - fossil fuels, biomass and waste heat, as well as the soil heat or the external air or the residual heat generated in industrial processes. Viessmann develops and implements integrated energy concepts based on the analysis of the entire energy production system, supply structure and consumption. The analysis of all the processes forms the basis for determining the potential and coordination of all the components of the system. Complete services from planning to installation and after-sales service complete the offer.

The company product offers include:

- Steam boilers
- Boilers for hot and overheated water
- Biomass boilers
- Cogeneration
- Heat pumps

In addition, the company provides some services:

- Consulting and planning
- Realization
- Maintenance / Support / Training

Following table can show the company product service offers combination:

Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other								

*Table 10 Market segments for Viessmann Heat Production System*

It should be mentioned that this company is not working only on industry scale and is operating also on the commercial, residential, and district heating applications. Viessmann offers special opportunity for its customers to have cogeneration products which are relied on the customer's orders characteristics and consultancy with the company. The company claims that it is able to support its customers from early phase of the projects until installation and after sale services. It means that the company offers most suitable combustion systems and technology that should be used on the customer's project in the consultancy phase, installation of the products and performance test in the realization phase, and remote control and diagnosis and execution of tests and general maintenance support in the maintenance phase. Then, it is possible to say that Viessmann service offer units are Consultancy, Design and development, Installation, Maintenance and Support, and System and solution services. It should be noted that Leasing cannot be considered as primary services that company offers because of the fact that this service is under the company maintenance services and it is not for making revenue by itself. Viessmann provides wide range of products and broad range of additional services for its customers. As a result, business model that company is using is product and process focused. Remote control which is used by the company for diagnosis and data acquisition modules on the company's products prove the fact that Viessmann pays special attention to Industry 4.0 revolution and IoT technology.

### *5.7 Bono Energia*

Bono company which is established in 1958 is dedicated to design, manufacturing, installation, service and maintenance of industrial boilers. Main objective that this company seeks is to increase long lasting performance of their products and services by efficient after sale services like offering original spare parts, maintenance activities, updating of the software, energy efficiency improving interventions and NOx reduction. Bono claims that it is continuously investing in R&D department to find the best way for increasing the efficiency of boilers and thermal plants through waste gas heat recovery and optimization of electric energy consumption. Actually, the company states that it is committed to provide primary energy saving, energy efficiency's improvement, emission reduction, low impact environment solutions and keeping high energy efficiency during service lifetime of the plant. This company joined Cannon Group in 1988 to become a worldwide player. The company offers the range of products including:

- Steam Generators
- Superheated Water
- Thermal Fluid Heaters
- High Efficiency Boilers
- Heat Recovery (HRSG)
- Boiler Control System

The main services that the company provides in after sale services can be described as below:.

- commissioning and start up assistance
- refurbishment and upgrade of existing plants
- retrofitting and revamping projects
- installation of control and safety electronic systems
- burner management systems

- repair and replacement of pressure parts
- delivery and installation of original spare parts
- quick repair and preventing maintenance
- training courses for clients' technicians
- remote assistance

according to the services and products mentioned above, it is possible to construct product-service combination as following table:

Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other								

Table 11 Market segments for Bono Energy Heat Production System

Bono claims that it is able to support its customers from the early phase of the production of parts and commissioning phase. However, it is not about the research contract for tailoring products according to the customers' needs. Also, the company provides a new service with the name of energy efficiency with the aim of optimization of thermal plant for saving fuel and electricity consumption and reducing pollution emissions. Then, according to the company's product-service offering it can be inferred that Bono is operating in Consulting services, Installation and implementation services, Maintenance and support services, and Procurement services with considering the fact that the company is able to provide some spare parts for its customers. Business model that Bono is using obviously is product and process-focused. It should be noted that the company is using IoT technology with remote control services in the company's service portfolio.

### *5.8 Babcock Wanson*

The company offers a complete range of products and services in the boilers production section. In addition, it is able to help its customers to optimize energy production with high quality products and efficient service. In fact, Babcock Wanson is a specialist in the sales and service of industrial process heating solutions for the UK, Italy, Ireland and selected export markets. The company believes that success stems from its ability to offer multiple, customized solutions. UK competitors tend to be single solution based, whereas Babcock Wanson offers customers genuine choice, including a range of Thermal Fluid Heaters, Coil Steam Generators and Fire Tube Boilers. All products supplied by Babcock Wanson are supported 24 hours per day in all weeks, which can be in the form of a contract created according to the precise client needs. In addition to a range of quality engineered products, Babcock Wanson also provides turnkey solutions. In other words, the company benefits from the engineering expertise and experience to customize systems and to develop innovative solutions. Product offerings of the company includes:

- Industrial boilers
- Industrial burners
- Thermal oxidizers
- Water treatment solutions
- Process and space air heaters
- Turnkey installation

The company services combination is including:

- Maintenance service contact
- Refurbishment & upgrades
- Boiler rental
- Spare parts



- Energy efficiency
- Training

Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other								

*Table 12 Market segments for Babcock Wanson Heat Production System*

The company provides a full range of products research contact to optimize the products according to the customers' needs. Also, the company itself will do the needed pipe work for the products installation. The, it is possible to say that Babcock is working in the services like Consulting, Design and development, Installation and implementation, Maintenance and support, Leasing, Procurement, and System and solutions. Business model that the company is using mainly is product and process-focused according to the fact that most of the company's services are based on additional after sale services but in some cases like rental boilers services the company is exploiting access-focused business model.

### 5.9 Cochran

Cochran is recognized as one of the global leaders in efficient use of costly fossil fuels for Steam and Hot Water generation. Energy efficiency know-how gained building and improving leading boilers like the Wee Chieftain, Borderer and Thermax units has enabled the Cochran to develop a range of upgrades for existing plant, covering all aspects of combustion control and monitoring on both Cochran and other maker's systems. The company is operating on the upgrading systems and heat recovery fields as well as industrial boilers production. It is able to renew older systems by replacing parts and fuel conversion. Generally, products that the company offers are:

- Steam Boilers
- Hot Water Boilers
- Heat Recovery Boilers
- Wood Fired Boilers
- Combustion & Control products
- Packaged Boilerhouses
- Economizers
- Biomass Boilers
- Water Tube Boilers
- Blowdown Vessel
- Integrated boiler control

Services offered by the company includes:

- Service inspection and repair
- Emergency Breakdown Response
- Insurance Survey Preparation

- Operations and Maintenance solution
- Contract Energy Management
- Technical Risk Assessment
- Training
- Remote monitoring
- Turnkey projects
- Hiring

Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other								

Table 13 Market segments for Cochran Heat Production System

The company is able to start the projects related to its products from the early steps to the final ones. Also, it is able to manage data driven by its products to create a unique integrated system for controlling them in a remote manner. Cochran provides some hiring services for its customers who do not invest high amount of capital for buying boilers. Then, it is offering Consulting, installing and implementing, Maintenance and support, Leasing, Procurement, and System and solutions services for its customers. According to the fact that the company provides some services related to after sale, it uses product and process-focused business model. However, Cochran offers some rental boilers which turns it to an access-focused using company. In addition, the company shows interest in using industry 4.0 revolution system by using remote control and integrating products manufacturing.

### *5.10 ICI caldaie*

The company operates in the industrials and residential heat production systems. It focused on the energy efficiency and environmental sustainability as well as cost saving from the customers perspective. With continuous attention to the environment, ICI Caldaie has further enhanced its products with control systems that allow a reduction in fuel consumption while optimizing the operation of the boiler and the elements connected to the system. The company emphasizes on the its great productive capacity and focusing on the new technologies that make it a leader in Italy and one of the Heat industry leaders in Europe. During recent years, ICI Caldaie has been focused on pursuing a strategy for reducing polluting emissions and energy consumption. The design, creation and choice of accessories for ICI generators provide users with an absolute level of safety and operational reliability with the best possible efficiency while completely respecting the environment. The company's industrial product portfolio includes:

- Steam generators
- Superheated water generators
- Thermal oil heaters
- Hot water boilers
- Boiler house
- Plant components
- Industrial range accessories
- Heat recovery generators
- Components for energy saving

The company also provides some services for its customers:

- After sale services
- Spare parts

- Fuel cell cogeneration
- Remote control

Product Market	Service Market	Research contract	Data Management	Project Management	Special Service	Gas Pipework	AHU ventilation	Plumbing
Heat pump								
Furnace								
Boiler								
Unitary Heater								
Other								

*Table 14 Market segments for ICI caldaie Heat Production System*

The company is able to produce the boiler house according to the customer's need and specification. In addition, using remote control making it able to manage data driven by the products. The company provides some components for its boilers to reduce energy consumption which can be considered as a special service. Then, ICI is operating in Design and development services for its boilers, Installation and implementation, and Maintenance and support, Procurement services fields. According to the above-mentioned information it can be inferred that ICI is using mostly product-focused and in some cases product and process-focused business models. It should be noted that the company is intended to use IoT technology specially by using remote control systems in its products.

# Chapter6.

## Discussion of Results

According to PSS results obtained from the analysis of cases and outcomes of the servitisation process in the Heat industry section, now it is possible to show results summary on a more integrated manner with using three dimensions of the servitisation process which are mentioned in chapter 4, to illustrate better practicality the proposed model. Contribution of industry 4.0 revolution and Internet of Things technology will be considered in further analysis because of the fact that this technology may create superiority for the using companies in the servitisation process. With this aim, Table 15 is formed with three dimensions with applicability of Industry 4.0 Revolution instead of three dimensions proposed in the previous chapters and third dimension which is companies' performance, will be discussed in a separate part. This table will show business models that companies are using from the general five categories (product-focused, product and process-focused, access-focused, use-focused, outcome-focused), the units

of services that companies offer (Consulting, Design and development, Financial, Installation and implementation, Leasing, Maintenance, Outsourcing, Procurement, Property and real estate, Retail and distribution, Systems and solution, Transportation and trucking services), and usage of industry 4.0 revolution.

		Bosch	WatkinsHire	Caldataemelgari	LTS	Viessmann	Bono	Babcock	Cochran	ICI
BMs	product-focused									✓
	product & process-focused	✓	✓	✓	✓	✓	✓	✓	✓	✓
	access-focused		✓	✓	✓			✓	✓	
	use-focused									
	outcome-focused									
Service offer units	Consulting	✓	✓	✓	✓	✓	✓	✓	✓	
	Design & development	✓				✓		✓		
	Financial									
	Installation	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Leasing		✓	✓	✓			✓	✓	
	Maintenance	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Outsourcing									
	Procurement	✓					✓		✓	✓
	Property									
	distribution									
	Systems & solution	✓				✓		✓	✓	
	Transportation									
Industry 4.0										

Table 15 Servitisation process result in the Heat Production System cases

Based on Table 15, it is possible to find the market niche to be servitized in it. In other words, if a company wants to servitize itself, with using this table, it can find possible ways to enter the market with the right choice in the BMs and service offer units that the company wants to offer based on the other competitors in that sector. In fact, this table can be considered as a visual tool for companies to select right approach for the servitisation process to effectively enter service market.

As it is mentioned before, companies' performance is analyzed separately. Financial situation of the sample companies is a logical indicator for comparison performance. Among the financial indicator, in this study companies' Turnover will be considered. It is able to show the companies; ability to capture value from both sides of product market and service market. To show the companies' ability to grow with considering financial concept, Compound Annual Growth Rate on companies' Turnover is selected. The CAGR is able to illuminate the mean annual growth rate of Turnover in a determined period of time. Its formulation can be described as following equation:

$$\text{CAGR} = \left( \frac{\text{Ending Value}}{\text{Beginning Value}} \right)^{\left( \frac{1}{\# \text{ of years}} \right)} - 1$$

If we put 2012 companies' turnover as beginning value Figure 9 can illustrate the companies' turnover CAGR in 2012-2016 period. All the financial information is extracted from CompanyCheck website.



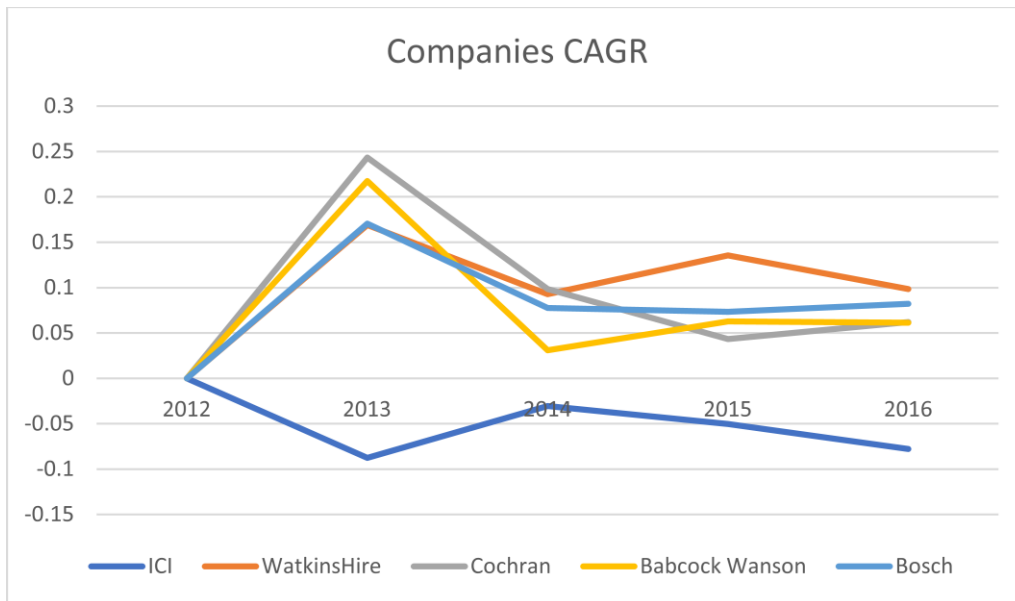


Figure 9 Sample companies' Compound Annual Growth Rate

Combining Figure 9 with Table 15 reveals interesting results. As it is obvious in Figure 9, the only company that is under zero CAGR with negative trend, is ICI Caldaie. As it is clear in Table 15, it uses product-focused business model and limited service portfolio. Then, it is possible to consider this company as a pure product manufacturer. As it has been expected focusing too much on the product market without considering service market can be problematic for ICI and the Figure 9 and obtained results prove it. On the other hands, other companies, without considering companies' size, show more or less, the same behavior and stable growth. It can be inferred that more complete service portfolio can be considered as a leverage for companies to capture more value from the customers. Also, these results approve hypothesis A which is mentioned in section 3.2, increasing services has a positive effect on the product sales volume which can be seen by the companies' turnover. Then, it is vital for companies to focus on both part of the market to have enough power to compete and exploit their competences as efficient as possible.

# Chapter7-Conclusion

In this article, it is tried firstly to analyze the service market and find the most effective elements on the companies servitisation process. With this aim, overall market is divided to three main product categories including Energy, Process materials and compressed air, and waste management. According to the study objective, service and product market for each product category is separated to find the offer units in each part more precisely. Then, servitisation process is described and the main factors through which a company can take decision based on them are explained. It should be noted that the role of data management and industry 4.0 revolution in the servitisation process cannot be neglected and this matter should be well understood and explained. Generally, overall aim of this study is to provide a comprehensive framework for manufacturing companies which want to servitize themselves. As a result, a framework including three main factors is provided; business model that companies should select for servitisation, service offer units which companies willing to provide for their customers, and performance indicator through which they want to measure their servitisation. After proposing this framework, practicality of the suggested model is evaluated through sampling some companies from the Heat market. This market is a subgroup of Energy market. The reason behind of this selection is the importance of Energy market and according to the fact that this market is divided to electricity, air freshener, and heat market, it is possible to take more detailed look in the subgroups. However, it could be inferred that heat market is more plausible to work. Then, a sample of five different companies which operates in different part of this market selected and proposed servitisation process tested. The final results of the test showed on the Table 15 and could demonstrate the service market in the heat industry for every company that wants to servitize itself in comparison to competitors.

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