Challenges and Opportunities in Transforming Laser System Industry to Deliver Integrated Product and Service Offers

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Abstract. Laser system industry is a complex network entity that includes laser component manufacturer, laser manufacturer, system integrator, laser job shop, laser process developer and end product manufacturer. Currently this market segment is predominately product-centric in which the common business model is to sell laser systems with two years warranty. However increasing competition within this segment is forcing some stakeholders to go further than the existing business model, and aim to build long-standing relationship between others. In this paper, the current structure and level of servitization in laser industries, the implications of higher levels of servitization for the various stakeholders of the industry, and the opportunities to develop and deliver higher levels of servitization are discussed. Analyses of semi-structured interviews with managers of laser system manufacturer and laser job shops reveal that any servitized solutions would primarily require the transfer of capabilities between various stakeholders.

Keywords: Servitisation, Product-Service System, Laser System, Stakeholders

1 Introduction

Globalized economic pressures and competitive business environments are forcing industries to look beyond product-centered business proposition. Many studies have point out that manufacturing industries in developed countries need to compete on the basis of value delivered rather than on the basis of cost [1]. Servitization can be considered as a shift from selling products to selling an integrated combination of products and services that deliver value in use [2]. Product-Service Systems (PSS) are proven to add beneficial advantages in terms of increase in revenues, to establish closer relationship with customers, and act as a mechanism to understand interactions and product usages better [3]. Irrespective of these proven advantages, designing innovative servitized offerings is challenging, and the design process is often ad-hoc, and procedures are not well documented both in academia and industrial practices. This situation is due to obstacles in transferring lessons learnt across varying industrial environmental conditions, and different stages of maturity levels in offered

products and services. Also difficulties raised due to many stakeholders and organizations involved in value co-creation of servitized offerings. To bring cross transformational knowledge exchanges, there is a need to benchmark critical parameters involved in designing servitized offerings.

In this paper, we aim to generate generalized critical parameters involved in designing servitized offerings through undertaking a study in the laser system network. These parameters are based upon the detailed analyses of literature reported case studies results. The rest of this paper is structured in four sections: detailed literature summary on the case studies results from designing servitized offerings, research questions and methodology used, presentation of results, and discussion and conclusion.

2 Related Literature

Reviewing the existing literature, Baines [4] noted that there is a paucity of previous work that provides guidance, tools or techniques, that can be used by companies to servitized. There are many descriptive studies are required to understand this domain in-depth. To provide a focused review, only latest descriptive studies on success factors and challenges involved in offering integrated product-service solutions are summarized in this section. Martinez et al. [5] categorize the following challenges faced by a company while moving from being a product oriented organization to a product-service oriented organization: embedded product-service culture, delivery of integrated offering, internal processes and capabilities, strategic alignment, and supplier relationships. In continuation with this list, Stargård and Hassan [6] have identified comprehensive list of success factors to be considered in PSS development.

The identified factors are senior management clarification of strategic intent, cultural change management, teamwork culture, internal communication mechanisms, external communication mechanism, customer relationship, motivating breakthrough ideas, project core competency, cross-functional collaboration, cross-functional development, allocation of resources, training and education, knowledge management, customer satisfaction data, risk management, product positioning, portfolio of product opportunities, product functional content, knowledge of market potential, product service processes, product environment, development process, responsibilities of team members, concurrent development, internal task coordination, organizational readiness for sales, internal marketing and external marketing.

Durugbo [7] finds that technical requirements of competitive PSSs are best fulfilled in work systems that emphasize individual timeliness/ buy-ins, synchronous communications managed by strategic roles and tie-ins offered by service contracts. Baines [3] summarized that a shift in culture, contracting structures, governance, risk management mechanisms and financing systems will allow companies to deliver services while building their capabilities to innovate technology along the way. They noted that initial cost savings, on-going cost reduction, transfer of fixed costs into predictable variable costs, improved asset security and improved asset reliability are the priority factors for customers to be attracted in product-service offers. Vasantha et

al. [8] noted that the critical productivity factors that define industrial product-service systems are performance, availability and reliability.

Ng et al. [9] proposed the three transformations needed for developing complex engineering service systems, namely: transform materials and equipment, transform information and transform people. For life cycle design, Masood et al. [10] classify uncertainties into the dimensions of engineering uncertainty, operation uncertainty, affordability uncertainty, commercial uncertainty, performance uncertainty and training uncertainty. Nordin and Servadio [11] identified critical issues during servitization using three main conceptual dimensions the organizational dimension (internal), the procedural dimension (hybrid), and the relational dimension (external). They studied these dimensions in terms of separating product unit from service units, shifting the manufacturer's mind-set, developing formal processes and procedures, generating new competences in terms of organizational and operational capabilities, creating strategic partnerships with suppliers, and to engaging with customer through learning interactions.

Although common themes such as internal processes, external processes, product and service characteristics and business elements are emerging as overlapped themes, the list of sub-factors within these themes are expanding and only few overlapping factors could be identified between studies. The primary reason for this divergence could be due to different market domains covered in every study. To bring convergence there is a need for comprehensive cross-sectorial case studies. However, many industrial sectors are not yet studied to undertake cross-sectorial case studies. One of the industries not yet covered is laser cutting manufacturing industry which is the focus of this paper. We aim to study the factors influencing to develop PSS offers in this industrial sector.

3 Research Questions and Methodology

In this paper, we aim to present answers for the following research questions:

- What is the current structure and level of servitization in laser industries?
- What are the implications of higher levels of servitization for the various stakeholders of the industry?
- What are the opportunities to develop and deliver higher levels of servitization?

These questions were answered by undertaking semi-structured interviews with managers of laser system manufacturer and laser job shops. Interviews were conducted with three laser job shop managers and two senior sales people of laser system manufacturers. In this paper, the core information collected from these interviews is summarized and presented. Figure 1 explains the network of three stakeholders, and their roles in the network. Primarily, Laser system integrator sells laser system to Laser job shop and End product manufacturer. End product manufacturer either outsource laser cutting jobs to Laser job shop or buy Laser system if the volume of laser cutting production is very high and have required capabilities to do laser cutting jobs themselves. End product manufacturer will post an open request

for quotation across laser job shops if they decided to go with the outsourcing option. The key criteria chosen in outsourcing laser cutting jobs are delivery time and price. So Laser job shop who proposes quicker time with lesser price will mostly likely to win the order. The next section answer the above mentioned research questions in the respective order.

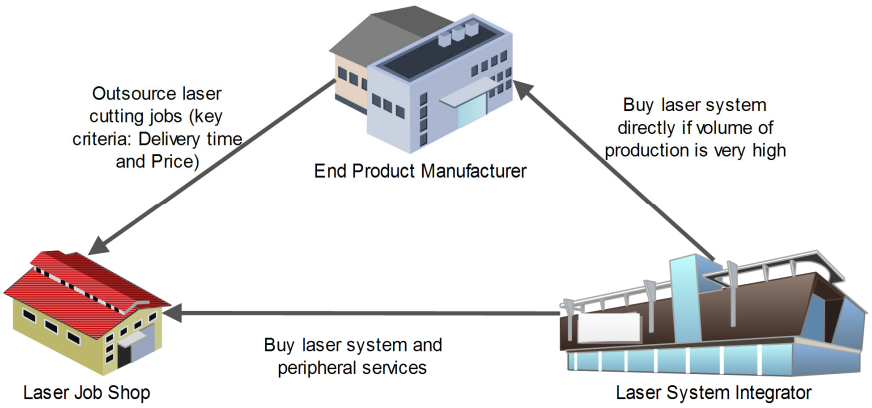

Fig. 1. Illustration of network between three stakeholders

4 Results

Current structure and level of servitization in laser industries
Table 1 summarizes the current servitization level between Laser job shop and System integrator, and Laser job shop and End product manufacturer based on the criteria summarized by Martinez et al. [5]. Both these relationships have low level of servitization. The primary reason for this low level of servitization is that there is no relationship established between these stakeholders. This environment is primarily price-driven and there is no trust established between them.

Table 1. Identification of Laser Network's servitization level

Level of Servitization	**Laser job shop and System integrator**	**Laser job shop and End product manufacturer**
Value Basis of Activity	Mostly transactional based	Completely transactional based
Primary Role of Assets	Primarily asset ownership	Pay-per-use basis
Offering Type	Offered as Laser system plus peripheral services	Price driven environment
Production strategy	Mass production	Mass customization
Offering type	**Low Servitization**	**Low Servitization**

Although each outsourced job from End product manufacturer is driven by pay-per-job basis, and each job is different and manufacturing operation needs to be optimized for each setting, there is no relationship exist between Laser job shop and End product manufacturer. The reason for this scenario is that laser cutting operation is now commoditized and it is no longer considered novel to improve manufacturing efficiency through laser operations.

Implications of higher levels of servitization

The common business offering proposed by System integrator is selling laser system with two years warranty. System integrators have less competitive impetus to propose novel business offerings because this market segment is predominately dominated by only two integrators, and also laser job shops segment comprises only small percentage of their total business. System integrator also argues that since this market is price driven, there is no reward for faster service response time. However, System integrator do offers five year warranty replacement and buy-back option but without any uptime guarantee. Table 2 provides the rationale mentioned for choosing the particular business offerings than others.

Table 2. Rationale for (not) choosing the particular level of Product-Service offers

Product-oriented	Use-Oriented	Result-oriented
Most of Laser job shops prefer to buy and own laser system with specific period of warranty.	Only one of the four laser job shops interviewed mentioned that they are leasing the machine rather than purchasing.	Pay-per-use laser system model is not currently offered by System integrator. It was used initially only for market penetration.
Although good residual value of laser system is expected only up to 5-7 years, it can be used as long as 10-12 years.	Good residual value of the machine provides accuracy, less downtime, reliable, updated technology if any, and most importantly provides predicable running cost.	This offering is avoided by Laser job shops itself because they perceived that although it reduces initial investment, it has high financial risk and could be more expensive in longer run.
No major technology change is expected in near future.	Reduce initial major investment cost and ensure smooth cash flow. Upgrading old system is not a cost effective solution.	Also Laser job shops are nervous about this offering because they believe that System integrator could directly interact with their customers leading to their elimination in the network.
No restriction on Laser system usages and	But placing a proper leasing contract is a challenge. Various terms and conditions did not	System integrator apprehension about operator's misuse, and

consumables used.	match between Laser job shop and System integrator such as fixed insurance premium, place of return and usage of premium consumables.	delayed and improper fault reporting.

Opportunities to develop and deliver higher levels of servitization

The primary question emerges from this laser system network study is that, how can price-driven scenarios could be changed to relationship and trust driven industry? To find answer for this question, strengths and weaknesses existing within this network are analyzed.

The strengths of laser job shop are processing quickly on product design data, optimizing material usages, and efficient machine operation and material handling. The weaknesses are not having trained machine operators, lack resources to support data management for remote monitoring devices, and in remote location for some of their customers. The strengths of system integrator are services provided are generally excellent (e.g. next day service engineer visit along with well-equipped spare parts required, well networked service operations throughout the UK), and system failures are tracked well through error logs and failure causes identified 60% of the time. The weaknesses are less transparency in service operations leading to doubts for higher price for simple failure (e.g. replacing whole sub-system rather than repairing the particular component), and not well-versed with establishing suitable leasing contract.

End product manufacturer is a key stakeholder in this network and any system network modification should consider their business criteria as critical factors. Fast delivery time, less price, high quality, and local and friendly stakeholders are the critical requirements for End product manufacturer. Although End product manufacturer needs are important, the proposed solution should be win-win for all stakeholders. A new business model could be developed considering the three forms of customer engagement noted by Baines [3]: customers who want to do it themselves; customers who want us to do it with them; and customers who want us to do it for them. Considering these factors and engagement modes, a new business model is proposed which intends to build relationships between stakeholders. The proposed higher level of business model intends to build on strengths of each stakeholder and eliminate weakness though transfer of capabilities and resources. In this scenario the engagement mode "customers who want us to do it with them" is chosen because it avoids elimination of stakeholders in the network. Figure 2 illustrates the proposed higher level of servitization solution.

In the proposed model, Laser job shop move closer to a large and valued customer and provide the operators to run the surrounding laser cutting processes. The infrastructure and space could be provided by End product manufacturer. The laser system could be supplied by System integrator on a pay-per-use basis provided that a minimum payment is guaranteed and that risks can be finely calculated and shared between stakeholders. In this way, each stakeholder would share its expertise and resources. This servitized business model would cultivate long term relationships and ensure very competitive rates and immediacy of delivery for guaranteed volume of business. The strengths of this proposed business model are it takes into account the core capabilities of each stakeholder, and eliminates the drawbacks in the current laser

system network. Similar kind of business model is noted by Baines [3] for emergent facilities practice where facilities are located in close physically proximity to the customers operations. However, the limitations of this model are it could lead to monopoly in Laser job shops and whiplash reduction in job shops, and also unassured whether service transparency (knowledge know-how) could be established by this network.

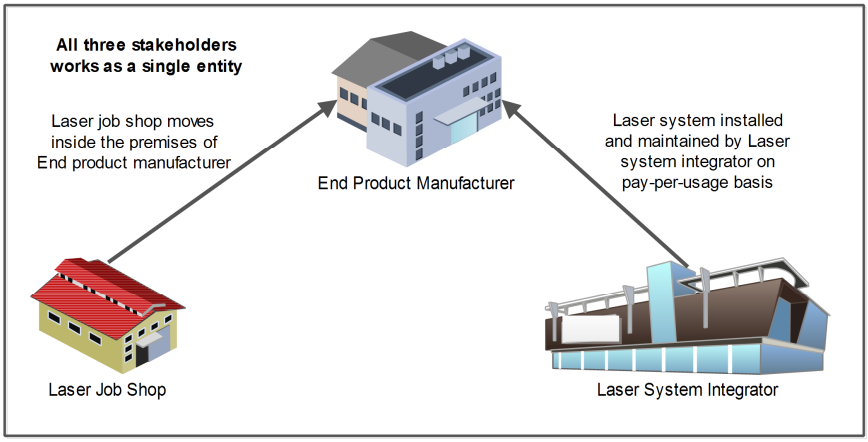

Fig. 2. A proposed new servitization model for the laser system network

5 Discussion and Conclusion

The foremost observation from this study is that "Pay-per-Use" business model and customization should not be considered as de-facto standards for higher level servitization model. The de-facto factor for higher level servitization model should be establishing long lasting relationships with stakeholders and delivering value-in-use to end customers. The list of factors that primarily influences to downgrade pay-per-use business model is tabulated in Table 3.

Table 3. Critical factors influencing to develop higher level of servitization

Characteristics	**Situation**
Value definition	Price driven environment and not trust
Interrelationships	Transactional basis rather than relationship
Product maturity	Performance levels are achieved to required needs and drastic technology changes not expected soon. Product life is longer. Product upgrades are considered infeasible.
Service maturity	Services are advanced with immediate fault registration and causes identification. Advanced services are not appropriately rewarded. However transparency is a critical issue.

Market competition	Contradiction of competition between stakeholders. Laser job shops environment is highly competitive whereas System integrator environment is dominated by two key players.
Consumables usage	Many restrictions imposed on laser system consumables usage such as to use only premium gases.
Business contract	Establishing suitable terms and conditions between stakeholders are challenging.
Capabilities	Mismatch perceived with skills and resources such as operator's skills.

Although with above mentioned difficulties, it is possible to develop higher servitization model if focus placed on predictable cost and enables smooth cash flow for all stakeholders. The following servitization study on this sector will focus on possible influences of technology substitution on laser system by additive manufacturing.

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