

Application of Product Service System (PSS) in Gear Manufacturing Industry

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Abstract

A product-service system (PSS), is a function-oriented business model, which aims at providing sustainability of both consumption and production. This approach emphasizes on selling utilities rather than products. In the present study, a case of a gear manufacturing company was taken who used to buy the finished gears from other company. In our study we have done calculations for the total costs, both for the manufacturing company and the supplying company; first considering the present situation where they simply buy and sell the product, and then for the case when they adopt the Product Service System. It has been shown that PSS comes out to be beneficial for both companies.

Keywords: Product Service System, Gear Hobbing, NPV, Gear Manufacturing

Introduction

Gear hobbing is a gear production process which includes conversion of raw material (Gear Blank) into finished product (Gear) through a sequence of gear generation and finishing processes. The automobile company, which is the customer company in our case, requires gears for gear box assembly. Presently, they procure the gears from a Chennai based gear manufacturing company which results in higher cost and longer lead times. Hence, to solve the problem, we have applied the Product Service System approach to the situation.

A product-service system (PSS), also known as a function-oriented business model, is a business model that is aimed at providing sustainability of both consumption and production (Sakao *et al*, 2010). Product Service Systems, put simply, are when a firm offers a mix of both products and services, in comparison to the traditional focus on products (Tan *et al*, 2006), (Goedkoop *et al*, 1999). Thus it creates a dependency between operations of Provider Company and activities of client company (Tan *et al*, 2006).

The concept of PSS is quite new, but it is gaining popularity due to its advantages. Today is an era of customer satisfaction and relationship management. Hence, we can see a large perspective shift in corporate and business strategies, where it can be observed that product focused strategies are now being replaced by strategies involving mix of both product and services (Morelli *et al*, 2003). Along with the monetary benefits, greater emphasis is given on the sustainable and green production, so that environmental performance of system can be increased by a factor of x , where x can range from

4 to 20 (McAloone *et al*, 2004). PSS proves to be excellent option for achieving 'factor 4' (Tukker *et al*, 2004). The 'total care package' offered by Rolls Royce underlines both the business and environmental benefits of PSS (Baines *et al*, 2007).

In our case, the Faridabad based automobile firm has been buying the above gear from Chennai. A PSS is suggested with a Gobindgarh based gear hobbing machine manufacturing firm (Provider) and the automobile company (User). The Gear Hobbing machine manufacturer firm have their own foundry required for the casting of Gear Blanks is the service provider in this project and they are required to provide the final gear at the assembly line of User Company. The service provider company will set up gear hobbing machines at the automobile company's premises. The maintenance activities and other run time inspections are in the scope of service provider firm. The system will be having following advantages.

- 1) Lower cost of gears for user company
- 2) Reduced Lead times
- 3) Better Quality Control
- 4) Beneficial for Hobbing Machine Manufacturer also.

Cost Model Preparation for the Proposed System

The total cost of gear production for the production company can be classified into further categories. These categories are a) Initial investment cost, b) Annual running cost, c) Labour and overhead cost, and d) Raw material and conversion cost. The first component is the initial investment cost which contains the one-time expenses that have to be made before the start of production. The

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investment is to be made in purchasing the machines, material handling equipment, building and furniture costs, registration charges etc. One important component of the running cost is the maintenance cost

Categories of costs

As far as costs are concerned there are three major categories:

- Capital Investment which comprises cost of two Hobbing Machines to deliver 400 nos. / Day approx.
- Operation Cost which includes the labour cost, tooling cost, electricity charges etc.
- Maintenance cost required for the smooth running of both the machines to ensure the timely availability of gears without any major breakdown.

Present Landed Cost of the Gear for User Company is Rs. 155/ No.

Cost calculations for the proposed system

- The total annual requirement is 90000 nos. The total annual production of various models of tractors is 45000 nos. in escorts. The subject gear is standard to all models and the quantity required is 2 nos. per tractor. So the total annual requirement of the gears will be 90000 no.
- In client company, there are approx. 250 working days in a year. It will result in the daily requirement of 400 gears approx.
- The life cycle of the system has been taken as 5 years, the initial minimum contract between user and provider.
- The inspection will be in the scope of escorts as the inspectors are available in the same premises and it is a part of the contract.

NPV Calculations

The NPV approach is used to find out the value of money at present time (or with respect to present time), which is invested/profited at some other time, or vice versa. The net present value of investment or revenue is the time adjusted value of capital [reference].

NPV for the PSS provider company before implementation of PSS

Initially, the service provider firm was selling the machine to clients. So, in this case, we calculate the present value of money. The firm is selling the machine at Rs. 25, 00,000 per machine, which includes the profit of Rs. 5, 00,000 per machine also. The company has to pay tax also on this profit, which is estimated around Rs. 2, 50,000 [reference]. Thus, the net profit of the company comes out to be around Rs. 7, 50,000. This will be the NPV for profit because all the profit is earned at present time only. On the

other hand, the client company is purchasing the finished gears from some vendor at Rs. 155 per gear.

Sale price of each machine = 40, 00,000

Profit for each machine = 10, 00,000

Total profit = 20, 00,000

Approximate tax for these

Two machines only = 40, 00,000

So, $NPV_{SP1} = 16, 00,000$

NPV for the PSS provider company after implementation of PSS

After implementing the PSS, the client company allows the PSS provider company to install its gear hobbing machines at their (client's) premises. For that, the PSS provider company is required to pay the rent for the space. The total cost of PSS Provider Company after implementation of PSS can be categorized in for categories. First component of cost is the expenditure made on initial set ups. It includes the costs of two gear hobbing machines and other initial investments. Total initial investment cost comes out to be near Rs. 45, 00, 000. The second component of cost is annual running cost which is about Rs. 6, 00, 000. The third component, Labour and Overhead cost add up around Rs. 14, 40, 000 to the total cost. Fourth component is the Raw material and conversion cost which comprises of cost of gear blank and tooling, which is nearly Rs. 67 per piece.

The client company, the automobile firm needs the gears to use them in their tractors. The annual demand of gears is 90, 000 per year. We are assuming that the overall quality of gear production process is 90%, which means that company needs to produce 1, 00, 000 gears per year, out of which 10%, i.e. 10, 000 gears per year will be discarded. Also, the gears that fail in the quality test will not be reworked, but will be simply discarded as the reworking cost is more than the gear generation cost. The scrap value of each piece of gear is Rs. 15.

Thus, taking all the costs into account, the cost of gear production is calculated. The PSS provider firm is in an agreement that they have to supply the gears to the to the client company @ Rs. 150 per gear. Thus, the provider company enjoys a margin of Rs. 4.5 at every gear they sell to the client firm, without considering any tax. To calculate the tax on this profit, the depreciation of the gear hobbing machine need to be calculated. The gear hobbing machine has a life time of 5 years and it can be scrapped out for Rs. 2, 00, 000 after 5 years. Thus, the net profit of provider firm is calculated after considering annual depreciation machine and tax rebate on annual depreciation.

The net profit we calculated in last paragraph is occurring every year, assumed to be occurring at the end of each year. Thus, to find the time adjusted value of these

money, we apply the NPV approach. For applying this approach, we consider following inflows and outflows of money: Initial investment cost, Net profit earned, scrap value of the gear hobbing machines and the rent of space paid by the PSS provider firm. Initial investment cost is one time occurring cost which occurs at the start of 1st year, hence it is the NPV of this outflow will be equal to initial investment itself. The net profit (inflow) and rent (outflow) occur annually. Net profit occurs at the end of year and rent has to be paid at start of each year. Scrap value of machine is considered as inflow of money and occurs at the end of 5th year. Annual Production =1, 00,000 nos. (To finally deliver 90,000 acceptable gears as the quality yield is 90%)

Sale Price =Rs. 145/no.

Total Cost per no. =

$$6,00,000/1,00,000+14,40,000/1,00,000 +72 = 92.4$$

Taking 10% defective Gears,

$$\text{Cost per no.} = 92.4/0.9 = 102.6$$

Scrap Value of 10% rejected Gears

$$\text{@ Rs. 15 per no.} = 1, 50,000 = 1.6 \text{ per accepted gear}$$

$$\text{Net Cost per no.} = 102.6 - 1.6 = 101$$

Operating Margin = 44 per no.

$$\text{Operating Profit} = 44 \times 90,000 = 39, 60,000$$

Scrap value of each

$$\text{Machine after 5 years} = 3, 00,000$$

$$\text{Total scrap value} = 6, 00,000$$

$$\text{Depreciation} = (60,00,000-6,00,000)/5 = 10, 80,000 \text{ per year} = 30, 96,000$$

Interest Rate at Capital,

$$i = 12\%$$

$$r = 1/(1+i) = 0.89$$

$$\text{Rent} = 2, 50,000 \text{ per year}$$

(To be paid at the starting of every year)

$$\text{NPV}_{SP2} = 30, 96,000 (r + r^2 + r^3 + r^4 + r^5) - I + S.r^5 - 2, 50,000(1+r+r^2+r^3+r^4)$$

$$= 1, 10, 61,690 - 65, 00,000 + 3, 35,000 - 10, 03,600 = 38, 92,800$$

$$\text{Taxable Income} = 39, 60,000 - 10, 80,000 = 28, 80,000$$

$$\text{Tax @ 30\%} = 8, 64,000$$

$$\text{Net Profit per year} = 39, 60,000 - 8, 64,000$$

Difference between NPV's of Profits of Service Provider firm in case 1 & case 2:

$$\begin{aligned} \text{NPV}_{\text{Difference}} &= \text{NPV}_{SP2} - \text{NPV}_{SP1} \\ &= 38, 92,800 - 16, 00,000 = \mathbf{22, 92,800} \end{aligned}$$

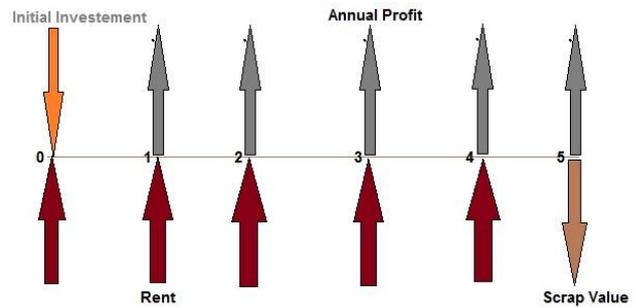


Figure 1: Cash flow diagram for gear hobbing process before implementing PSS (For five year period)

NPV for the client company after implementing the PSS

Before going for the PSS, the client company was purchasing gears from an outsider vendor company at Rs. 155 per piece. There was an agreement made with the PSS provider company that the provider company will supply gears at Rs. 150 per piece after implementation of PSS. Thus, the client company observes a margin of Rs. 5 per piece after the PSS has been implemented. Calculating it for the whole supply and adjusting the tax deductions, net profit for the client company can be found out. Thus net profit is occurring at end of each year; hence NPV of this inflow can be calculated. Profit per year = 90,000 × (155 - 145) = 9, 00,000

$$\text{Tax on this profit @ 30\%} = 2, 70,000$$

$$\text{Profit after tax} = 6, 30,000$$

$$\text{NPV}_U = 6, 30,000(r + r^2 + r^3 + r^4 + r^5) = \mathbf{22, 51,000}$$

Thus we see that the client company observes a profit of around 22.5 lakh in a period of five years (lifetime of hobbing machine). But along with monetary benefits, there are lot more benefits for the client company. After implementing the PSS, they can check for quality of gears in their premises as the PSS provider firm is going to manufacture gears in their premises only. This will ensure better quality and better control of quality for the process. Also, it leads to better control of production as the lead times and other delays in manufacturing of gears after implementation of PSS will be minimized. In fact, if operations are effectively controlled, the PSS approach can lead to JIT and leanness in manufacturing. Thus, PSS serves for environmental causes also.

For the provider firm also, PSS is a better option. Earlier, the firm was only selling hobbing machines to their customers. After participating in the PSS, their focus shifts on providing services also. After implementation of

Initial Investments Costs (C_i)		
1	2 Hobbing Machines (3000000x2)	60,00,000
2	Bins for material handling (5000x10)	50,000
3	Building and furniture costs	2,00,000
4	Computer, Printer, Scanner etc	1,00,000
5	Registration charges	1,50,000
	Total	65,00,000/-
Annual Running Costs (C_r)		
1	Maintenance cost	1,00,000
2	Electricity Charges	2,80,000
3	Stationary	20,000
4	Rent	2,00,000
	Total	6,00,000
Labour & Overhead Cost (C_o)		
1	2 Supervisor (1 @ 25000/month, 1 @ 20000/month)	5,40,000
2	4 Machinist (all @ 15000/ month)	7,20,000
3	Accountant (@ 10000/month)	1,20,000
4	Attendant/Peon(@ 5000/month)	60,000
	Total	14,40,000
Raw Material and Conversion Costs (C_c)		
1	Blank Cost per no.	60
2	Tooling	12
	Total	72 per pc.

PSS, they get better value for their investments as well as better customer satisfaction. Thus, PSS leads to better service provider-client relationships also.

Conclusion

The user firm, a Faridabad based automobile company required gears for the gear box assemblies which were procured from a Chennai based firm which resulted in large lead times and costlier gears. Hence, a PSS based contract was visualized between the automobile company and a Gobindgarh based gear hobbing machine manufacturing firm. After applying the Product Service System, it was seen that not only the user company realized shorter lead times and cheaper gears with increased reliability of operations, but the service provider company also sought monetary benefits from it.

So, we see that both the user and service provider are very much beneficial by adopting this PSS by making extra profits in a win-win situation.

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