ORGANIZATIONAL INNOVATION AND COST REDUCTION ANALYSIS OF MANUFACTURING PROCESS – CASE STUDY

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Abstract:
Innovation is the key to the growth of each business in a fast-changing world. Innovations affect financial activities because the successful innovation opens the new markets, gives the opportunity to reduce costs or introduce new products and services with a higher profit margin. Each organization, institution, enterprise or individual can be innovative. Innovations may not be implemented only in large enterprises, but also in medium or small. The aim of this paper is to innovate and optimize the polishing process in production plant with variant production. In this paper case study is used as research method which includes measurements and observation. The paper is focused on five variants of one product. We obtained the required data by measuring in a manufacturing plant in southern India in Madurai. At the end the results are summarized, and the optimization of the polishing process is proposed.

Key words: case study, innovation, small and medium enterprise (SME)

INTRODUCTION

In recent years, we face a high pressure on the modernization and digitalization in several areas of the economy worldwide. The modernization and digitalization were supported even more by implementation of the Industry 4.0 platform. For Small and Medium Enterprises (SMEs) this implementation requires a consistent sequence of introducing new innovations with an emphasis on monitoring costs of individual processes that are aimed to increase competitiveness. The main purpose of the innovation and digitalization is on the one hand to interconnect individual processes in the production and on the other hand the sustainability of the entire industry [4, 9]. SMEs in developing countries must face the new requirements and fast modernization of production processes. During the last decade, India dragged attention thanks to high recorded GDP growth rate. According to World Bank [21] India will be the world's fastest growing economy in following years, hence we consider examining local SMEs beneficial. In this paper, we focus on a company operating in the steel industry in Madurai, Tamil Nadu, South India. Considering steel industry, India was the world´s third-largest steel producer in 2017 and second largest in 2018 [17].
Various studies [6, 14, 16] point to the importance of the SMEs in the centre of Indian economy, arguing that most of these enterprises are complementary to large trading companies, while lagging and less developed SMEs cause infrastructure problems that consequently lead to slowdown of the region development. Realizing necessity of innovations and limits bounded to SMEs´ options, in this study we attempt to provide affordable and beneficial innovation solution in order to increase productivity of small-scaled local steel-fabricating producer using case study approach. Paper is therefore organized as follows: section 2 provides theoretical framework linked to case studies and productivity, while section 3 describes data collection and calculations. Consequently, in section 4 results and key findings are presented, section 5 concludes.

THEORETICAL FRAMEWORK

In this chapter we focus on methodological aspect of our study. Case study as a methodological approach and productivity as a measure of outputs´ efficiency are described.

Case study

Case study, as a method widely used in empirical analyses, examines the current phenomenon in real situation in which multiple sources of information are used. The case study allows the researcher to examine the data in a specific context. As we present in Figure 1, in most cases, the case study is dealing with a particular area as a subject of investigation. Essentially, case study examines the current

phenomenon of a real situation through the detailed contextual analysis with a limited number of events or processes, which represent the key input information. Observation methods have the potential to go beyond other methods that rely heavily or exclusively on their own research characteristics and procedures [5, 11].

Direct observation has been described as one of the most effective methods among the qualitative data collection techniques. Observing manufacturing processes avoids problems and simultaneously can also reveal shortcomings that are not accessible from other data collection methods, however, remain occasionally underestimated [19, 20].
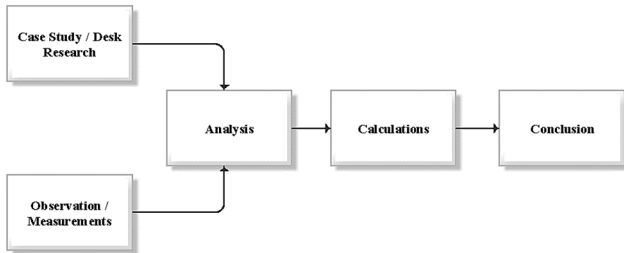

Fig. 1 Data collection methods and data analysis

Case studies are relatively flexible methods of scientific research. The Figure 2 shows the design of case study observational research, because the researcher himself is designing a research project, he provides the project with great freedom to discover and solve the problems he encounters during his research.

The case study enables the researcher to engage in more open and wider issues, and gradually narrow down and refine them according to the focus of the research [5]. In general, case study is important and useful method of collecting data, especially in cases of rare occurrences.
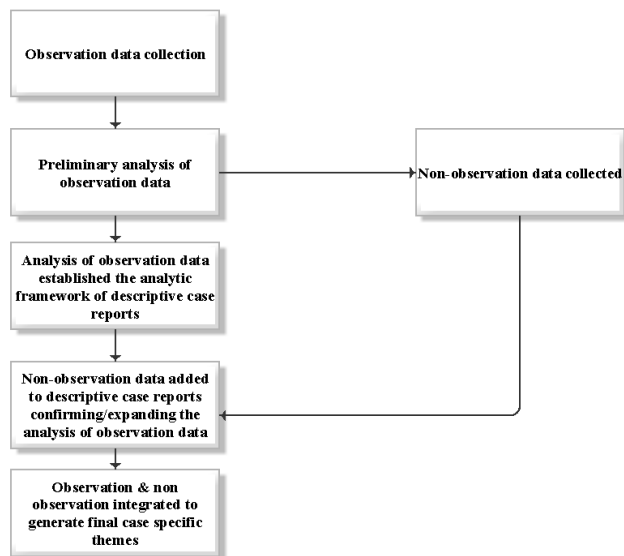

Fig. 2 Case study observational research/Single case
Source: [12].

Productivity
The production process has been ongoing since the industrial revolution, for example in the area of logistics, information and innovation in machinery. Productivity is a long-term concept that includes a component of profitability, which is heavily influenced by the price paid for inputs and their transformation to outputs by the business entity. Productivity is a basic measure of the efficiency of the transformation process. As is shown in Figure 3 the productivity cycle consists of four main areas: measurement, evaluation, planning and improvement.
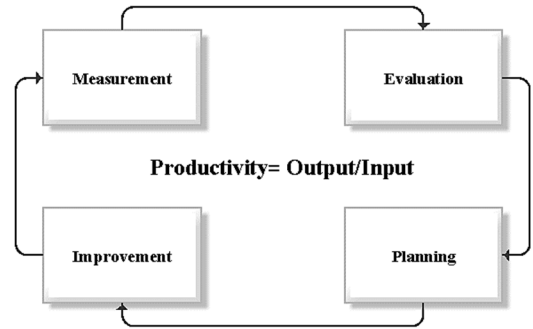

Fig. 3 Productivity
Source: [18].

Productivity measurement activity is crucial for an enterprise. Proper implementation and evaluation can lead towards reducing costs of production, storage or other work. Productivity of the company is being measured for several reasons such as monitoring the internal development of the enterprise, monitoring employees, monitoring the usage of material or outputs [3, 10].

The process of increasing labour productivity can be divided into several parts [18]:
− criteria selection – identifies measurable criteria on which productivity improvements will be assessed
− analysis of the current state
− draft concept of change – after analysing and defining the criteria, a proposal of methods and procedures will be developed to help increase productivity
− realization – designing and implementing changes
− evaluation and analysis.

Application in local SME
Even though case study is widely used, proper subject for effective and robust case study must be selected. We consider SMEs to be more appropriate for performing such case studies in contrast with large corporates, which often dispone with its own research resources. On the other hand, getting access to local SMEs with aim to collect data is often complicated. Background of this study is further explained in following paragraphs.

Company examined
Our empirical study has been performed based on observations and data collected from Pechiamman Stainless Steel, Ltd.[1] (referred as "PSS"). PSS is a small-scale[2] indus-

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[1] We would like to express our sincere gratitude to PSS representatives for providing an open minded and wide support and access, however, only limited information was permitted to be mentioned in our paper.
[2] At a time of data collection, number of employees was 19.

try, operating in Madurai (Tamil Nadu, India), as a manufacturer of stainless-steel products. Its portfolio consists of (both final products and products intended for further adjustment) fabrication products such as vessels, chimneys, boilers, stoves, bakery stalls, tea machine stalls, sugarcane machine stalls, water heaters, staircase guides etc (see Table 1).

Table 1
Size of production

Name of the Product	Size of Production February 2018		Actual Cost (INR)*/kg	Sales Price (INR)/kg	Profit (INR)
	2018	February 2018			
Vessels	180	15	360	440	80
Chimney	24	2	340	440	100
Boilers	**600**	**48**	**380**	**450**	**70**
Stove	111	9	360	440	80
Bakery stall	12	1	340	420	80
Tea machine stall	12	1	360	440	80
Sugarcane machine stall	120	10	360	440	80
Water heaters	240	20	360	440	80

*INR: Indian Rupee
Source: Own elaboration based on observations in PSS.

Considering productivity and effectiveness, after initial observations and discussions, we focused on fabrication of boilers considering budget and plant layout limitations based on discussions with PSS representatives. At the time of data collecting (for purposes of this study, we got permission from PSS only for one-month period – February 2018), producing boilers consumed almost half of production capacity PSS (based on observations shown in Table 1).

Data collection and calculations
Main separate inevitable operations of boiler fabrication are shown orderly in Table 2. These operations are same for various sizes of boilers (referred as "Products").

Table 2
Main operations

Operations	
Drawing	O1
Cutting	O2
Rounding	O3
Welding	O4
Malleting (Hammer)	O5
Tinkering	O6
Grinding	O7
Polishing	O8
Finishing	O9

Source: Own elaboration based on observations in PSS in Feb. 2018.

Since 2018 PSS was producing five types of boilers with different parameters (volume in litres, weight in kg and size described by height and diameter in millimetres) as presented in Table 3 for products 1 (P1) to 5 (P5).

Table 3
Types of boilers produced in PSS in February 2018

Products (Boilers)	Volume (Litres)	Weight (kg)	Size (height x diameter in mm)
P5	50	28	600 x 450
P4	80	32	791 x 483
P3	100	42	902 x 524
P2	125	50	1067 x 524
P1	150	60	1255 x 524

Source: Own elaboration based on observations in PSS in Feb. 2018.

Consequently, median time was calculated separately for each product, based on 25 observations for each operation. For purposes of this paper, calculated median time will be considered as basic time [7]. Adding relaxation allowances (15%) to basic time then should represent standard time – time needed for completing particular activity under standard circumstances [8]. Table 4 shows median observed time in minutes, which is described as basic time and median observed time in minutes included allowances (15%), which points to standard time for each product and operations explained in Table 2. The time was measured by using stopwatch, while seconds were converted to cent minutes (for detailed discussion of using stopwatch methods in case studies see e.g. [2, 15]). Cost per kilograms was calculated based on data provided by PSS.

Table 4
Existing time of operations

| Operations	Median Observed Time in Minutes (Basic Time)					Median Observed Time in Minutes + Allowances (15%) (Standard Time)					Cost
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5	
O1	58.35	53.68	50.24	47.98	46.01	67.10	61.73	57.78	55.18	52.91	30
O2	49.50	45.54	43.26	40.71	39.08	56.93	52.37	49.75	46.82	44.94	30
O3	33.66	30.97	29.42	28.09	26.94	38.71	35.62	33.83	32.30	30.98	30
O4	61,19	56.30	53.65	50.46	48.39	70.37	64.75	61.70	58.03	55.65	100
O5	33.01	30.60	29.33	27.51	26.09	37.96	35.19	33.73	31.64	30.00	100
O6	61,19	56.47	52.78	49.88	47.60	70.37	64.94	60.70	57.36	54.74	20
O7	50.49	46.45	43.26	41.32	39.66	58.06	53.42	49.75	47.52	45.61	30
O8	59.40	54.65	51.92	49.58	47.60	68.31	62.85	59.71	57.02	54.74	30
O9	32.67	30.60	28.55	27.09	26.00	37.57	35.19	32.83	31.15	29.90	10
Total	439.46	405.26	382.41	362.62	347.37	505.38	466.05	439.77	417.01	399.48	380

Source: Own elaboration based on observations in PSS in Feb. 2018.

Polishing is process for reducing, cleaning and shining defects on raw products. Firstly, we observed all the operations and measured the time they require. Next, we performed critical analysis [1, 13] in order to identify possible obstacles for processes of boiler manufacturing. Our critical analysis showed, that manipulation with raw products without proper machine, no proper fixation of product and size of polishing disc (during polishing process) are crucial for boiler manufacturing effectiveness.

As Pischupen [13] suggests, performing critical analysis should lead to reducing time of operations or increasing efficiency of current operations, which can consequently reflect positively in reducing existing costs.

Suggested implementation

Firstly, we examined operations that require maximum time. From Figure 4 we see, that Operations 1, 4, 6 and 8 require high, similar portions of time. Additionally, considering 5 different product sizes, we can observe, that operations 1, 4, 6 and 8 tend to change more dynamically then other operations. Hence, we consider them more interesting with respect to possible time cutting.
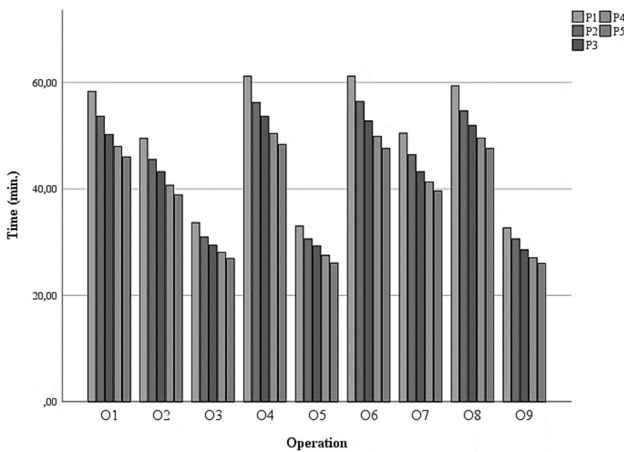
Fig. 4 Median time of operations
Source: Own elaboration based on observations in PSS in Feb. 2018.

Considering further plant layout, budget restraints given by PSS, and ability to implement innovative solutions in reasonable time frame, we focused further on operation 8 – polishing process, where implementing new machine (see Figure 5) was suggested. The Table 5 shows the specifications of the innovative component, which (based on our critical analysis) should reduce time needed for polishing process and consequently reduce costs of boilers production.
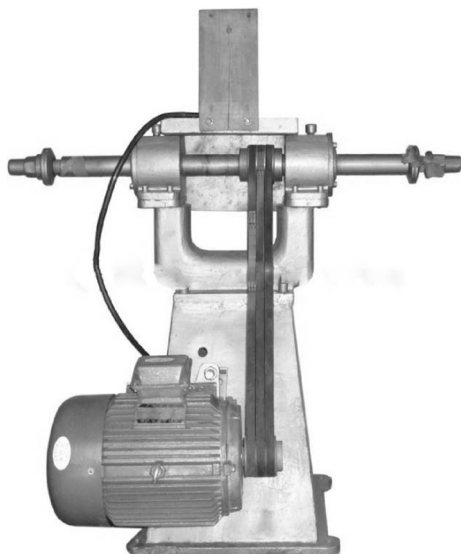
Fig. 5 Double head polishing machine
Source: Prem Brothers, Inc. (New Delhi, India).

Table 5
Polishing machine specification

Price	800 US $
Size	1200mm x 1200mm x 600mm
Motor power	5.5 kW
Weight	200 kg

Source: Prem Brothers, Inc. (New Delhi, India).

The Use:
- for polishing and grinding from different angle on different work pieces;
- two work stations allow 2 workers polishing or 2 polishing processes by 1 worker at a time;
- all casting parts ensure durable use;
- widespread use in process of polishing in different industries.

Results and Discussion

After implementing polishing machine, new time for polishing part of fabrication was set based on critical analysis of polishing process, respecting limitations of proposed machine, taking into account mainly size of surface of polishing disc, and less exhausting operational needs from workers´ perspective. In general, we expect time needed for polishing via proposed way to be halved. After applying critical analysis, we provided the measurements with implemented polishing machine and we have obtained new data on the basis of which we expect costs of boilers production to decrease 40% [13].

Estimations

Actual cost is 380 INR/kg, sale price equals to 450 INR/kg, while actual time needed for polishing is stated in previous chapter. The Table 6 shows the measured times and cost of boilers production after proposed polishing machine implementation for each product:

Table 6
Measured time of operations after polishing machine implementation

Products/ polishing operation	Measured Basic Time in Minutes	Measured Basic Time in Minutes + Allowances (15%)	Cost INR/kg
P1	29.70	34.16	
P2	27.33	31.42	
P3	25.96	29.85	**18**
P4	24.79	28.51	
P5	23.80	27.37	

Source: Own elaboration based on critical analysis of polishing process. Time presented in cent minutes.

Cost/Benefit

Based on time set by measurements and cost per kg in context with initial investment needed, we consequently present break-even point for this investment.

According to Table 7, proposed innovation would increase profit per kilogram from 70 rupees to 82 rupees, or 17.14%. Considering initial investment 56800 INR (800

USD[3]), we provide following calculations, suggesting kilograms or pieces of each product needed to be sold to return initial costs, also working days needed for reaching break-even point.

Table 7
Profit

Conditions	Actual Time	Measured Time
Cost INR/kg	380	368
Sales Price INR/kg	450	450
Profit INR/kg	70	82

Source: Own elaboration based on observations in PSS in Feb. 2018.

From Table 8 we can conclude, that if we consider whole profit per kilogram as a repayment of initial investment, PSS will return those initial costs from 12 working days (or 12 pieces) considering P1, to 20 working days (or 25 pieces) considering P5. On the other hand, considering only excess return made of decreased time required for polishing, these results vary from 78 working days (considering P1) to 169 days (considering P5), respectively, to reach break-even point.

Table 8
Break-even point

Pieces needed to break-point	Considering excess profit per kg (12 INR)	Working days needed	Considering whole profit per kg (82 INR)	Working days needed
P1	79	**78**	12	**12**
P2	95	**86**	14	**13**
P3	113	**97**	17	**15**
P4	148	**120**	22	**18**
P5	169	**131**	25	**20**
Kilograms needed to break-point	4733.3		692.7	

Source: Own elaboration based on observations in PSS in Feb. 2018.

CONCLUSION

In this paper we focused on small-scaled company, Pechiamman Stainless Steel, Ltd., located in south India, Madurai, which operates in steel fabricating industry. Adopting case study approach, we firstly measured operations and processes within the company, secondly measured and observed data were analysed. Based on implemented critical analysis, we obtained new data and we are proposing innovation, which should reduce the polishing time by 40%, and increase profit per kilogram sold by 17.14%. We conclude, that proposed innovation of complex process is cost efficient. On the other hand, we faced layout and budget restraints, hence possibilities to provide more complex, innovative and effective solutions for examined enterprise were rather limited. To add on, we consider further case studies among similar industries and SMEs as crucial in order to support sustainability of region.

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