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PRODUCTION + PROGRAM: AN INTEGRATED APPROACH FOR THE REVAMPING AND EXPANSION OF AN IRON AND STEEL MAKING FACILITY – A CASE STUDY

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ABSTRACT

Iron and steel consumption is a vital indicator for the development of any industrialized country. The major steel consuming sectors are construction, automotive and machineries. The recent years have brought an increasing trend of steel consumption in the ASEAN countries due to the positive economic growth. So these countries are now expanding their steel producing capacities in order to achieve self-reliance in this sector. The construction of the first ever Blast Furnace-based steel plant in Malaysia is a landmark project for attaining sufficiency in meeting national steel demand. Generally, an iron and steel making plant has all the developed facilities starting from the handling of raw materials to the final finished products. Once in operation, these plants require periodic major overhauls and up-grading besides routine repairs and maintenance activities to ensure their smooth operations. This study discusses an integrated approach named 'Production+' which was envisioned for the revamping and expansion of a public sector iron and steel making plant in Pakistan. The plant was commissioned in 1984 – 85 and after 20 years of its successful operation in 2004, the then management decided to revamp and expand its production capacity of steel up to 3.0 million metric ton (mmt) per year. For achieving this objective, it was planned that numerous strategic decisions would be taken during the course of the revamping and expansion program. This mainly included the improvement of existing maintenance practices to a more advanced plant maintenance level, energy conservation program that cut down energy and utility costs, and process optimization to detect and remove bottlenecks and inefficiencies in the production process. So, in order to get the maximum synergy it was proposed to integrate all the revamping and expansion program activities under one program named Production+. The + (plus) stands for more production, profitability, quality and serviceability of the steel making facility on a sustainable basis.

Keywords: Plant management, Revamping and expansion, Production management

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INTRODUCTION

The iron and steel industry is the backbone of economy and considered as the 'mother' of all industries. Despite the global recession, the importance of the steelmaking capacity of any industrialized country can never be undermined for meeting its needs of infrastructure development. According to the Iron and Steel Institute (2015), the global annual production of steel remained at 1,599.5 mmt and China is one of the leading producers of crude steel with a share of 50.3% of total world steel production. During the period of 2015 – 2020, it has been forecasted that ASEAN countries' steel markets will steadily grow by 6% mainly due to the consumption of steel in the automotive, mechanical machinery, infrastructure and construction industries (Technavio, 2016). Among the ASEAN countries, Malaysia is the 4^{th} largest steel consumer and had an annual steel consumption of 10 mmt in 2014. This high demand of steel consumption in the country is largely dependent on the imported steel mainly from China (Research and Markets, 2015). A report published by the Malaysian Iron and Steel Industry Federation (2014) stated that the local steel industry would grow by 4% during 2015 – 2018, depending on the economic environment and government policies in this sector. Malaysian steel manufacturing companies are mainly associated in processing semi-finished products to the desired specifications of the items required for industrial and commercial usage. The first ever integrated iron and steelmaking plant of Malaysia (i.e., Eastern Steel Sdn. Bhd.) is under construction and has a designed capacity of producing 3.0 mmt of steel stage-wise.

The planning, construction and operation of an iron and steel plant is a complicated long term and capital intensive project involving multifarious issues of technical, economical, financial and commercial nature. The operation routes of such an integrated plant are dependent on a number of factors including the type of technology, the availability of raw materials, demand and supply situation and the skilled work force. Although, the solid state reduction of iron ore for making iron was already established more than 500 years ago, with the development of Blast Furnace and various processes for steel making utilizing liquid iron, solid state reduction was superseded in the industrialized world. Mass production of steel based on the reduction of iron ore (oxides) and refining it into steel is based on two main routes, i.e., conventional Blast Furnace – Basic Oxygen Furnace (BF-BOF) route and Direct Reduction – Electric arc Furnace (DR – EAF) route. The Blast

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Furnace (BF) route still remains the world's chief source of iron units, for steelmaking as long as adequate supplies of suitable coking coal remain available at compatible costs (Sinha and Sivaramankrishnan, 1994). The conventional BF route is a universally established way of producing steel and providing a variety of carbon steel products, including hot and cold rolled sheets, plates, tin plates, welded and seamless tubular products, wire products, structural items and bars etc. The efficiency, productivity, reliability, stability of operation and product quality has been extremely optimized in the BF route. A BF-based iron and steel plant is comprised of a vast array of basic facilities and auxiliary units such as raw material handling units, sintering and coke producing plants, air separation units and basic oxygen furnaces for reducing iron ore to liquid or molten iron (Ray et al., 2005). Apart from these, the downstream facilities include a steelmaking plant and casting units for producing long and flat products (billets, blooms and slabs) along with rolling mills for fabricating semi-finished products. Infact, an iron and steelmaking plant is a complex entity that has many production and service departments to support the entire process.

Iron and steelmaking processes are non-stop, continuing for maintaining the commercially viable production. During the operational phase of the facilities, malfunctioning, troubleshooting and shutdowns are unavoidable. The probability of such miss-happenings increase with the increase of the plant service life. Therefore, to keep the equipment and machineries of the plant in the best operating conditions, engineers and technicians execute scheduled maintenance and overhauls in a timely manner. The average service life of a steel making facility is 20 – 25 years. After which, major revamping and modernization is required to keep the plant abreast with the latest technology. This paper has discussed an approach which was devised for modernizing a 20 year old iron and steelmaking integrated plant in Pakistan. The case study has explored an indigenous approach known as Production+ (plus) for balancing, modernizing, revamping and expanding the steelmaking capacity of the plant.

BACKGROUND

Pakistan got independence from the then British empire in 1947. After post-independence, the non-existence of an iron and steel making industry had shown its adverse effects on the industrial and economic development of the country, which continued to suffer various setbacks because of dependence on the import of iron and steel products. A stage had been reached when it was realized that the import bill to meet the requirements of steel could not be supported indefinitely. Thus, the idea of setting up a steel mill in the country was proposed in 1955, which laid emphasis on the domestic production of iron and steel. Debates over the manufacturing process, supply sources of the requisite machinery and raw materials, plant site, domestic ore versus imported ore, ownership pattern, product-mix and above all, foreign financing credits, kept the project on hold over a period of two decades. In 1968-69, the Government of Pakistan (GOP) concluded an agreement with the then Union of Soviet Socialist Republics (USSR) for the preparation of a feasibility report for the establishment of a coastal-based integrated steel mill at Karachi. Later on, in January 1971, Pakistan and the USSR signed an agreement under which the latter agreed to provide techno-financial assistance for the construction of a coastal-based integrated Steel Mills at Karachi. The foundation stone of Pakistan Steel Mills Corporation (PSMC) was laid on December 30, 1973. Some key milestones for the PSMC are illustrated in Figure 1. The PSMC with an installed capacity of producing 1.1 mmt of steel is the country's only integrated iron and steel manufacturer and accounted for approximately 23% of the country's total demand for steel products in 2004. There is an ever-growing mismatch between domestic production and demand for steel in Pakistan. Total domestic steel production in 2004 was estimated at 3.0 mmt, as compared to the total consumption of approximately 4.2 mmt. The short fall in the domestic supply has been met through imports, the share of which in the country's total consumption of steel had grown from 27% in 2000 to 31% in 2004. This domestic demand-supply imbalance has effectively provided the PSMC with a captive market for its entire production. Pakistan's per capita steel consumption levels have not only been below those in developed countries, but also below levels in many developing countries in the region. Therefore, there is a significant growth potential for the country's demand

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for steel over both the medium and the long term.

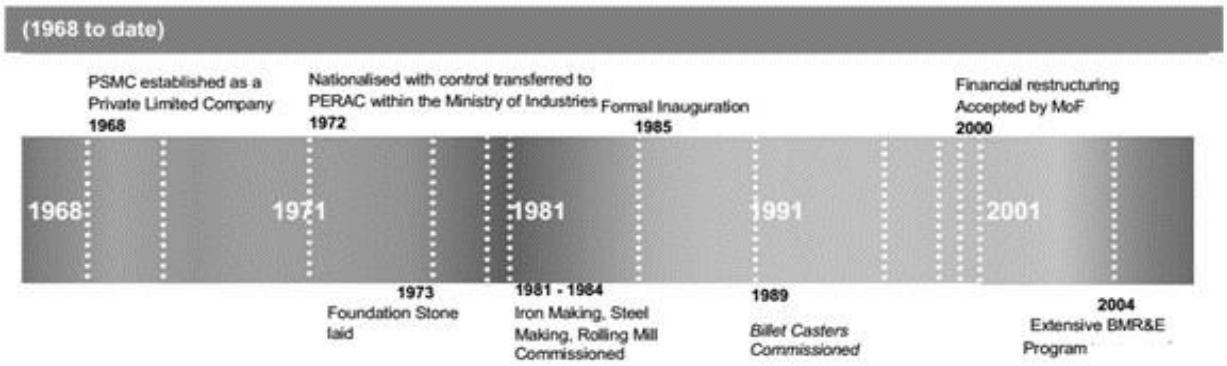

Figure 1: Key Milestone of the PSMC (Source: PSMC, 2004)

The PSMC started commercial operations in phases over the period from 1981 to 1984. Since inception, due to various reasons, the PSMC faced financial difficulties, due to which it lacked the financial resources needed to upgrade and modernize the facilities. However, with the financial turnaround and the resultant availability of resources in 2004, the management had been able to embark on an extensive program known as the Production+ for ensuring full capacity utilization on a sustainable basis. Based on this program, the PSMC firmed up a list of Balancing Modernization Renovation and Expansion (BMR&E) projects to be carried out to arrest the deterioration of the plant and equipment.

NEED FOR REVAMPING AND EXPANSION OF PSMC

Since the PSMC started its full scale operations in 1984 – 85, it had exhibited a week financial position due to many underlying reasons, such as over staffing, political interference and corruption which had negatively impacted the yield, efficiency and productivity of this integrated iron and steelmaking plant. All these factors had turned the PSMC into a dilapidated and pathetic state which was the culmination of years of neglect of maintenance, upgrading and refurbishment. As far as the general condition of the plant was concerned, it can be said that breakdown maintenance seemed to be the normal practice and all the control systems were completely degraded and the systems were manually operated. The overall level of automation relied on twenty-five year old technology. In addition to this, the operational reliability of the plant became extremely suspect

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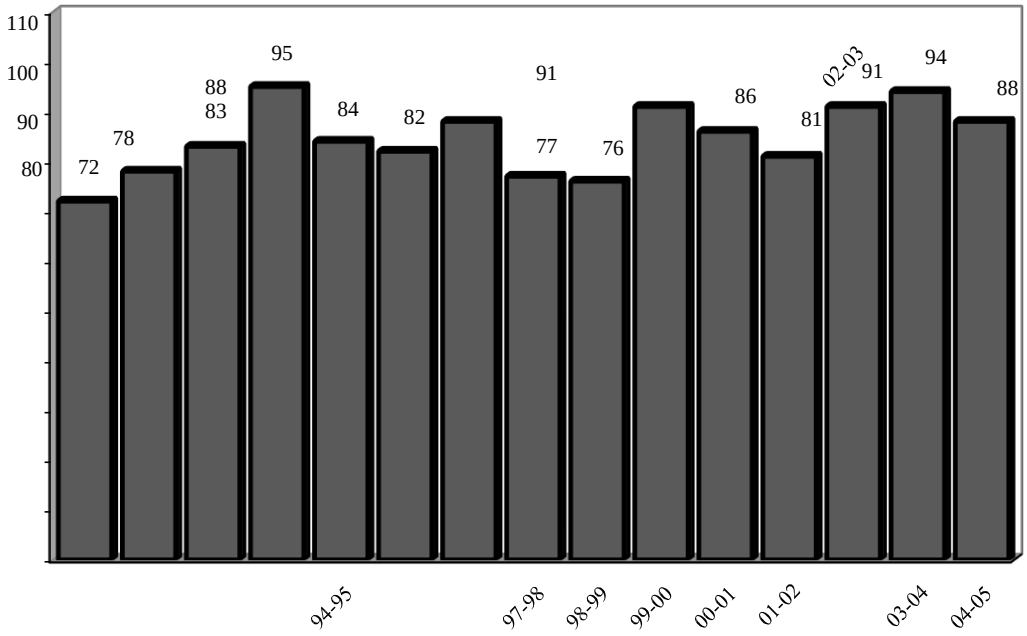
due to the neglect of timely capital repairs. It was often observed that the breakdown of any machine or piece of equipment would lead to a slowdown of the entire production activity. Figure 2 shows the capacity utilization of the PSMC during the period of 1990 to 2004. It is evident from the data that the PSMC had never achieved 100% capacity utilization during this operational period. The trend of capacity utilization also shows that from 1999 to 2004, the plant had achieved more than 90% of the utilization for a short span of time. This was mainly due to the good governance from the new management of the PSMC in that era. But, even with a high level of commitment from the management and the show of skills by the operating crews, it had not been possible to consistently produce quality products under these circumstances.



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PRODUCTION+ PROGRAM

In order to meet the above challenges, the PSMC has started a number of activities to increase the production of steel output up to 3.0 mmt with sustained profitability and consistent quality. To achieve this target, it had been decided to launch the Production+ Program. Figure 3 provides an overview of this program. It shows that numerous strategic decisions had to be taken during the course of this program and they had to be based on objective business criteria. Most of them had a technical and commercial dimension. The technical aspect focusing on production was covered by the Process Model that modeled the flow of material into, inside and out of the works. A corresponding Financial Model reflected the flow of money into, inside and out of the works over time. The combination of the Process Model and the Financial constituted the Business Model. The effects and consequences of strategic options could be simulated using different scenarios and the optimal course of action could be taken. The Business Model became a powerful management tool. The decisions were translated into the Masterplan for their implementation. It coordinated the following components.

Revamping Projects
Expansion Projects
Process Optimization
Advanced Plant Maintenance
Energy Conservation
Information Technology

All the activities were interrelated and envisaged to be executed simultaneously and needed close coordination. The sequence of activities, in particular of the major investments, had a substantial impact on profitability. The development of a Master Plan covering the complete picture ensured systematic planning and monitoring of all activities. Potential delays and cost overruns were able to be detected in a timely manner and countermeasures were able to taken and this would reduce the risks of not achieving the above objectives. A brief detail of each of these Master Plan activities is described below:

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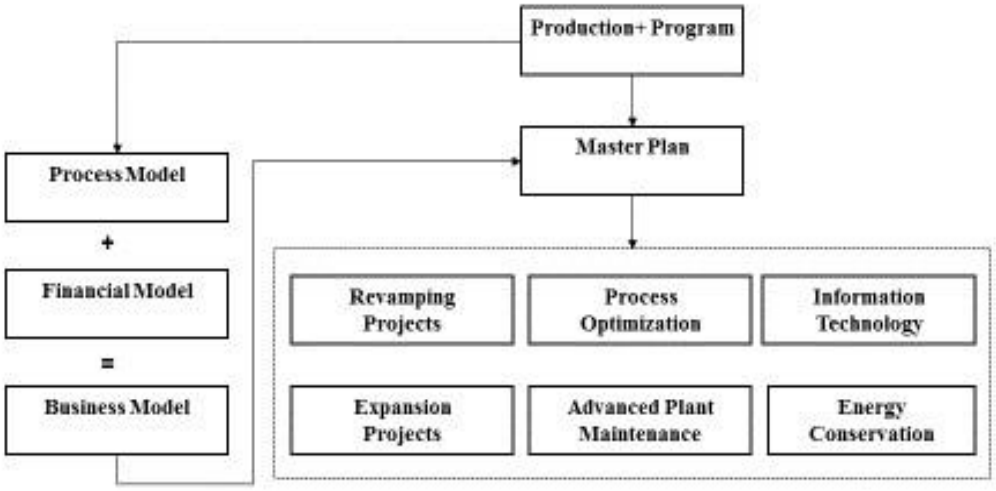

Figure 3: Overview of Production+ Program

Revamping Projects

Revamping projects were identified and listed in the category of "Essential Repairs of existing Equipment". These were grouped in three categories as:

Local Material and local Services
Imported / local Material and local Services
Imported / local Material and foreign / local Services

In addition, there were tasks to be completed by in-house expertise using the central maintenance department and other service units.

Expansion Projects

The PSMC engaged a consulting firm to conduct a technical audit of the production facilities along with a market survey, and provide specific short term and long term recommendations for ensuring full capacity utilization on a sustainable basis to meet national steel demand. Based on its recommendations, the PSMC planned expansion projects to be carried out increasing production capacity beyond 1.1 mmt to 3.0 mmt stage wise.

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Process Optimization

Production processes were systematically reviewed for potential improvements with regard to:

Bottlenecks affecting the flow of material

Changes in processes to improve quality

Changes in processes to increase output

Changes in processes to increase productivity

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Advanced Plant Maintenance

The pervious Maintenance practices were mainly based on information provided by the equipment supplier at the time when the equipment was commissioned. Since then, the maintenance approach has changed from time-based planned maintenance to condition-based planned maintenance with various policies and strategies. Furthermore, the Information Technology (IT) support had to be used for effective planning, monitoring and reporting of maintenance activities.

Energy Conservation

The efficiency of combustion processes in the PSMC was very poor. They were inefficient mainly due to non-availability of proper control systems, especially the effective air to fuel ratio control. Moreover, metering facilities were also very old and obsolete and flow measurements of gaseous fuels were mostly without temperature and pressure variation corrections. Under the production+ program, energy consumption in the different units of the plant had to be reviewed and revamped with the objective to reduce the wastage of energy.

Information Technology (IT)

A plan for the replacement of the previous Mainframe System with an Enterprise Resource Planning (ERP) System had to be developed. Resources for inputs for compilation of the IT Plan had to be identified.

BENEFITS OF THE PRODUCTION+ PROGRAM

The following benefits were envisaged as an outcome of this revamping program:

Availability of additional quantity of prime quality and high grade steel products to the engineering industries at competitive prices would reduce the gap between demand and local supply presently met through imports. The increase in local supply of steel products would result in annual foreign exchange savings. General improvement in economic activity resulting from unrestricted availability of steel, creation of industrial stimuli by setting up of more downstream

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units, creation of job opportunities in the downstream and allied industries, upgrading of technology and acquisition & assimilation of new techniques in engineering, construction and related industries. The surplus manpower presently carried by the PSMC was absorbed and the financial burden on this account was removed. Development of mineral resources of the country for industrial utilization, overall improvement in the financial position from present loss and liquidity crunch situation to profitability and healthy cash flow position.

CONCLUSION

The PSMC had an expansive plant layout and the then management expected that it was adequate for accommodating future capacity expansions. Furthermore, the plant had been designed such that the basic infrastructure was already present to cater for plant expansions. Keeping this in view, the Production+ Program was the best option to achieve this goal of national interest. It was also an indigenous concept to support the smooth operation of the state owned steelmaking plant in Pakistan. It was the first ever comprehensive approach which was planned for the revamping and expansion of this steelmaking facility. As steelmaking plants are capital intensive, revamping and expansion were considered as viable options for meeting the higher demand of iron and steel in the country.

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