Development of a robust frame work to sustain in the tool and die making business

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ABSTRACT:

The paper describes an effective business framework for tools and dies manufacturing companies. Tools and die manufacturers construct dies for sheet metal, plastic, rubber and casted parts, along with Jigs, fixtures, and machining of precise components. Tools and dies for different industrial parts and goods can only be produced in bulk through the different tools and dies. Due to different shapes, dimensions, material and standard of quality to meet the customers' needs and expectations increases the competition among the die manufacturers. Presently tool and die manufacturer's faces so many problems at the time of because of the discreet nature of manufacturing. Several elements of any die are made individually, takes much time and that becomes crucial to manufacture tools and dies timely and sustain the business.

The tool and die manufacturing activities start from the tool cost estimation, selection of feasible manufacturing process, sequence of operation and technology followed to meet the delivery time of a tool and die. Thus, the Key resultant areas are the correct tool cost estimation, product quality, used technology and to meet the lead-time to deliver a tool and die to the customer. Due to its discreet nature of manufacturing a tool and die, making industry faces so many challenges every day to get the correct shape, dimension, material properties, and desired quality standard of a component to satisfy the need and expectation of a customer with taking care of market competitors. Thus, Tool and die manufacturing business is continuously forced to reduce the tool cost by adopting the new process and technology. These adversely affect the profitability margin and business prospects and survival of a tool and die making company worldwide.

Key words: Moulds, Tool and die manufacturing, tool cost, competitiveness, Lean – 5S, CAD/CAM, tool room, framework,

1 INTRODUCTION

To supply the cost effective quality product delivery within the time is the demand of the business organization. Challenges in today's global competition have forced continuously to find out the appropriate manufacturing strategies in order to enhance the efficiency and competitiveness to meet the challenges of offering high standard of quality, cost and delivery to the large companies by MSME sector. Hence MSME sector need to implement the effective approaches like Lean manufacturing for continuous and systematic improvement in their operation production capabilities, productivity quality, and scalability. Implementation of Lean manufacturing has become inevitable to survive in the fast competitive business market.

of Robust Framework to increase firm competitiveness

Organizational background and procedures are two associated modalities for applying envisioned business-level strategic decisions and finding out the solution. A robust framework model is prepared that systematize of these two modalities for the execution of low cost productivity, minimizes lead time and tool and die manufacturing process bottlenecks and operational discrepancies strategic decisions. The Framework establishes a roadmap for solution of organizational problems, strategies, priorities; practices and procedures need to be implemented. The framework consists well-defined, retuned set of organizational activities needed to get a solution to increase competitiveness. Framework presents the solution in simplified form of existing or future state problem situation. A robust framework is an entity between a 'model' and a 'method' that contains a structure or system for the achieving the defined results.

1.1 Robustness: Meaning and concept

The concept of robustness is concerned with the framework development was originated by Taguchi to reduce the process inconsistency of troubles occurring in product manufacturing system. Disturbance of process is an event that hampers, disrupts or effects on going production system in a way contrary to the actual intention of the initiator [1].While addressing robustness in context to MSME Tool Room Jamshedpur, achieved results are very optimistic.

1.2 Framework: Meaning and Concept

A framework deliberated more comprehensive than a procedure and more prescriptive than a structure. It involves a set of ideas or facts that provide support to develop a structured solution. Theories of framework involve the key strategies of manufacturing processes, having enough flexibility to take the change. Although there are many theories about competitiveness and related interdisciplinary strategic fields, operations and resources and economies of scales are referred [2].

1.3 Competitiveness: Meaning and Concept

The term Competitiveness is considered as a part of business rivalry for market. In simple terms, it is the ability to compete with similar manufacturers. It is important to clarify that economic strength at industry or a firm with its competitors in the market. It refers the firm's economy in terms of goods, services, people, skills and ideas that move freely across geographical borders [3].

Concept of competitiveness emphasizes the significance and actual capabilities of core processes. Competitiveness enhanced the performance of organization to compete more effectively in the market. Firm economic outcomes obtained through the competitive framework similar to the Asset-Process-Performance (APP framework) [4].

The powerful lean manufacturing approaches that has proved successful as an operation model in developing economics by the some large Indian companies and increasingly being recognized by MSMEs. In last 10 years the manufacturers located in developing countries such as China and India are also working to transform their manufacturing businesses from traditional to low cost manufacturing , non labor intensive, more manufacturing flexible and more higher value productivity. In India government has already been taken an initiative to create an environment for Lean implementation (LMP)in MSME Sector and

the expenditure associated in implementation in terms of Lean system development and consultants charges will be borne by Govt. of India, this is to foster the rapid industrial growth to the all MSMEs.

2 LITERATURE REVIEW

Tool and die making is a traditional technology used in manufacturing process of components supplied in automobiles, locomotives, and aviation sectors [5].To manufacture complex geometries and increase high production rate in manufacturing process plays an important role[6].Use of lightweight components has increased for the transportation purposes [7].To reduce energy consumption and overall weight, lightweight metal components are good alternative [8]. Parts manufactured from High Pressure Die Casting of lightweight materials i.e., zinc, aluminum, and magnesium alloys are widely used [9].High temperature melt poured into die under high pressure in the production process [10]. As compared with other process, casting is its potential of high-speed filling process [11].

In modern manufacturing methods, the different stages are classified as melting-alloying process, molding process, pouring process, solidification process, fettling process, machining process and finishing process[12]. Common defects occurred in casting process is hot tearing, formed in semi solid phase called mushy zone [13]. Due to shrinkage of the casting and geometric constraints of the mould thermal and mechanical strain occurred which results hot tearing [14].To increase high production rate, high dimensional and low cost component produced for automobile sector, aerospace and other industries[15]. High quality aluminum castings produced by pressure die-casting or using permanent metallic moulds in gravity die-casting. [16].Materials used in the production of high temperature applications are exposed to brisk temperature deviation which effects thermal stress and risk for damage [17].

Common producer of failure for high cost dies are fatigue related issues used in aerospace and automobile industries [18]. Fundamental and quick changes in critical factors like market, product and technologies are the critical factors in tool and die industry [19]. For high volume and mass production of uniform product provides with accurate dimensional tolerance, better surface finish and enhanced mechanical properties with comparison of low cost [20].

The tool and die making industry is one of the major industries in the manufacturing sector by reason of its position in the value chain between product development and progressive production of manufacturing goods [21]. There is wide use of processing technique of die production in the industry [22]. Maximum contribution to the economic performance of major economies in the industries is by the tool and dies making industry [23].

In the modern industry, quality of tools and dies cover direct influence in the component features, cost and its production efficiency [24]. For the mass production in the manufacturing systems high quality die and mold, are best suitable for the production [25]. To produce non ferrous parts in the mass production pressure die casting process is the most economical and effective process [26]. The tool and die making industry influence the production for its suitability in manufacturing of products and product development [27].

The problem of tool and die making process inadequacies are discussed and suitable

productivity enhancement lean tools are studied and conceptual approaches offered to the field of study [Kerzner, 2006] [28]. Robust framework model for MSME Tool Room Jamshedpur consistnumber of tools and techniques e.g. 5S, Product and Process standardization, quotation generation process. These tools are introducedto increase the competitiveness of MSME Tool Room Jamshedpur.

Complexity, inadequate in followed process sequences and tasks are barriers for the product manufacturing strategies [29]. Product development affects the process robustness and organizational competitiveness [30].

Many researchers have endorsed the suitable framework for increased the firm level competitiveness. It is the firms not nations, which compete in markets [31].Environmental factors are otherwise uniform for all rival companies. Many researchesexplain that profit margin directly related with strategically decision making of the companies [32]. Other pro-firm views (Bartlett and Ghoshal 1989 [33]; Prahalad and Doz. 1987 [34]; Prahalad and Hamel, 1990 [35]) focus on specific firms and their global product methodologies, resource positions.

Some authors view competitiveness as strategy, structures, skills, innovation capabilities and other physical and intellectual resources for their competitive success This perspective belongs especially to the resource-based approach for competitiveness [36], [37].

It is necessary to deploy skills and talents more efficiently than competing companies to achieve competitiveness of world class (Smith, 1995 [38]).Productivity isa proxy of competitiveness and a strong predictor of a firm's long-term competitiveness. At the organizational level, Porter's generic strategies stresses on competitiveness criteria (Porter, 1990 [39]). Highest productivity business, industry, or nation considered as the most competitive (McKee and Sessions-Robinson, 1989 [40]). Dynamic capability, flexibility, agility, speed and adaptability are becoming major components for competitiveness in today's turbulent business environment (Barney, 2001 [41]; Sushil, 2000 [42]).

Drawbacks such as losing consumer attention, market positioning and concentrating on large corporations (Barney, 2001 [28], Mathur, 1999 [43]).Due attention is given for the future professionals provide the best tool for integrating robust framework competitiveness with strategies of profitability (Shee, 2002 [44], Momaya, 1998 [45]).

Lean tools are primarily concerned with the elimination of wastes to streamline the processes and in cost reduction [46]. Lean operations eliminate seven wastes namely referred as ‘TIMWOOD’. This is likewise transportation, inventories, signal, waiting, overproduction, over treating, and faults [47]. In the recent days, underutilization of workers has measured as the eighth waste [48].

3 OBJECTIVE OF RESEARCH

To make the MSME Tool Room self financially stable and meet the expenditures more revenue is to be generated. MSME Tool Rooms will be made competitive in terms of cost, quality and delivery at par with the at renowned players of tools and dies manufacturing field. This issue is addressed here elaborately to find the feasible solution.

This research will be focused to identify and eliminate waste and streamline tool and die manufacturing system of MSME Tool Rooms. The aim is to make the improvement in entire manufacturing process flow.

4 LEAN IMPLEMENTATION PROGRAMME

Tools-based approach II

- Select a Pilot Project to implement – 5S is a good place to start
- Run the pilot for 2–3 months - evaluate, review and learn from your mistakes
- Roll out pilot to other factory areas
- Evaluate results, encourage feedback
- Stabilize the positive results by teaching supervisors how to train the new standards you've developed with TWI methodology (Training Within Industry)
- Once you are satisfied that you have a habitual program, consider introducing the

To increase the competitiveness for sustainable growth of MSME Tool Room Jamshedpur (IDTR) followings are the key issues –

i. **Quality**:

Quality of Tools and Dies made in MSME Tool Rooms is to be improved at the same price or lowering down the same. To make the quality tools more analysis is required through which tools design and machining can be improved and desired quality can be made in the same price, rather producing the tools over or under quality. This may need improvement in selection of tool and die parts material, their specific manufacturing processes e.g. machining, heat treatment, assembling and other sequence of operations involved in die manufacturing.

ii. **Cost**:

Cost estimation of received ordered job is a prime factor and according to cost making the tools by way of selecting the adequate processes is also equally important. Tool sand dies build up cost should be made more exact and cost competitive with respect to other prestigious tool and dies manufacturers costing. To find out the actual cost help of some relevant IT tools is very essential. Quotations should be given after development of design and manufacturing of processes and this will help in finding out the correct lead time, also.

iii. **Lead Time** (Delivery time) :

Lead Time is an element which usually increases in most of cases rather decreasing to it. This is just because selection of improper processes- selection of faulty sequence of operations, takes more time and in-between if process is observed inappropriate, corrective measures for process change should taken immediately he existing Tools and Dies Manufacturing Lead time should be reduced. This will save the time and directly reduce the die manufacturing cost.

iv. **Technology up gradation:**

The most formidable problem faced by the SMEs in India has been in up gradation of technology and maintaining competitiveness. The reasons are:

- Poor financial situation
- Low levels of RandD activities
- Poor adaptability to changing technological trends
- Desire to avoid risk
- Non-availability of qualified and technically trained man power
- Lack of management skills
- Lack of access to technological information

- Isolation from technology hubs and private players of the field

Though above all points are playing the role but the most important barrier is the adoption of improved technology going around worldwide. In several instances, the cost of technology also makes it difficult to be adopted. To increase the efficiency of tool and die manufacturing business, following latest trends of technology will be implemented in MSME Tool Rooms. These are Rapid Proto typing, E-Manufacturing and Standardization etc.

v. **Business expansion:**

The Tool Rooms, so called Technology Centers (TCs) need to do a lot in expanding and shifting the their arena of business activities in the most demanding area of robotics, PLC, A Customer centered approach is needed to get the more business nexus. Voice of customer approach is adopted. To get the business in long term, after sales and services will be well taken care.
To overcome with the rivals Lean-5S practices can be tested in this discrete nature of product manufacturing. Through this approach a lot of saving is expected in the organization.

Overview of factors affects the Tool and Die making business:

The factors impacts the tool and dies making business globally is due to its unorganized way of manufacturing. These are usually manufactured by SMEs and MSMEs - a sector that is already unexplored and in developing phase, considered in second priority in compare with the production units. Though, the activities of tool room are vital for manufacturing of tools and dies, in R and D and innovation work, supports for smooth functioning of plant and machines utility services. Acts as an Engineering service department. for maintenance, to maximize the production.

Govt. of India, Ministry of MSME has taken several initiatives to foster the industrial growth of MSME sector under Make in India plan. The factors that affect the tool room profitability in tool and Die manufacturing area are –

- Improper cost estimation of Tools and Dies
- Unrealistic decision of tools and dies manufacturing lead time/delivery
- Low cost and easier manufacturing tool design
- Effective and proper utilization of machine and man power.
- Application of new technology or mixed-up of technology
- Checks and measure to improve upon the QCD.
- Customer centered business approach

Tools and dies are the devices required for production of industrial goods. Tools and dies are made with assembling the several parts made individually as discreet manufacturing. Trial run is conducted to test the functionality and product quality of produced part and matched with the customer requirement. If needed necessary modification is done to meet the desired product quality. The unrealistic cost estimation and decision of delivering the tool are the main key factors that affect the business profitability. Use of IT tool/ software is to developed that will enough capable in tool manufacturing cost calculation, help in accurate process planning in consideration of tool delivery date. Other associated tasks are also included in delivery time e.g. lead time of purchase of die steel for manufacture the different die parts,

BOIs, die trails, modifications thereupon if required. Process planning to sequence of operation, preparation of Master Schedule planner for follow up and note the completion time of different activities and the time difference in between planned and actual operation. This activity will help to reschedule the remaining activities within the time framed schedule. The process may be modified if found any operation critical, the part can be simplified and changed and that will be altered in the original tool design, also. For part machining best possible tool path can be generated in combination of cutting speed, feed , depth cut to save the individual parts manufacturing time.

Tool rooms can use the purchased readymade standard tool parts to control the tool cost and avoid delay associated with the in house parts machining. This is depends upon the die life calculation and the no. of parts to be produced through the die manufacturing delay

Applying the technology mixes to Improvement the tool and die manufacturing process:

Technology plays a vital role in improving the tools and dies quality, cost, lead time. Hence tool and die makers are forced to adopt the latest ways of useful mixed technologies in entire manufacturing process chain in tools design process modeling, proto manufacturing, tool path optimization of generated tool path to make the die parts at high speed with using the best combination of machining parameters, cutting tools to the machining of hard steels. CVD and PVD Surface coating is applied to increase the die life.

The e- manufacturing commonly adopted for effective utilization of man, machine and material. It means the technique which eliminates manufacturing errors, develops an effective work system, set priorities, efforts and avoids too many layers of communication, multiple channels of instructions of tools and dies manufacturing. In e-Manufacturing web or network based information technology system is used for automated, data-driven productivity optimization.[1]

There is always scope for improvement in existing process of manufacturing; it has scope to start it from e-marketing, e-tendering, e-designing-process planning, e-fabrication, e-quality checks, e-invoicing and e-payment etc. Means all operations and activities used in the plant for converting the raw material in to finished goods can be automated and optimized. By collaborating the electronic embedded system in the existing practice the plant efficiency can be improved and customer's expectations can be achieved easily.

5 PROCEDURES FOR TESTING THE E-MANUFACTURING SYSTEM:

I. Adaptation of using web enabled interface and services:

To Test:

i. Whether the tool rooms are using web enabled technology for e-Manufacturing system**?**
ii. Whether any bottle-neck sexist between the production shop and business system of the MSME Tool Rooms? if any, can it be minimized by converting the raw data and process capability data into useful information for quick and accurate decision making**?**

[1] http://www.businessdictionary.com/definition/manufacturing.html

iii. Whether MSME tool rooms have adopted web enabled tenders, online process follow up, product or dies models, e-payment and invoicing etc**?**

II. Storage and handling of data management system:

To know:

- Is the data management system of the tool rooms gather all data from various machines and processes stations using internet and manages this data accordingly**?**

III. Electronically supported process:

To know:

- Whether the e-manufacturing system of the tool room, electronically supported**?**
- Are the mechanical and computer based applications collaborated with electronics application for making the system agile and fast responsive**?**

IV. Utilizing cad and cam technology in workshop floors:

- Has the soft copy of die or product design sent directly to the machines workstation?
- Does the workstation automatically generate the die part's machining programmed, and do the operations according to instructions given?

V. Utilizing computer aided process planning and control system rather than manual process planning in tools and dies manufacturing:

- Has the process planning and machine scheduling done manually, if so whether help of related computer based soft tools can be applied?
- How does the nature of job according to its machining profile similar machine assigned?
- How does the process of job card, route sheet and its follow up done?

VI. Application of soft tools for estimating the time of parts finishing on the machine:

- Has the manual and experience based process planning feasible for proper time calculation required for parts finishing.
- Whether the entire parts machining operations goes normally without time constrains is a right approach.
- Whether Manual process planning is correct for elimination of process errors or some dedicated soft ware may be used to make the process plan proper, realistic, with the time calculation of job finishing.
- Whether the parts machining and delivery time calculation can be done accurately.

Expected Benefits:

It is expected that by adopting e-manufacturing system the MSME tool rooms may get tremendous benefits in terms of saving the man and machine time, cost, ease in manufacturing process, also help in almost exact delivery time calculation of tools and dies. The e-manufacturing concept will be applied in any of the MSME Tool Rooms and its different cost benefits analysis will be made with the earlier practice. The concept of e-Manufacturing is not applicable only on the machines but in the entire plant and depts. activities. The e-manufacturing study shall be

involved from beginning from customers order getting, raw material and items procurement to till finishing and supply of tools and dies to the customers. During the entire process of implementation each every minute process activity will be recorded and its affect will be analyzed and result will be made.

Application of standardization and modular dies:

Modular Dies:

The economic downturn in manufacturing sector looking for ways to do more with less, pushing the limits of optimization, efficiency, and cost effectiveness. The tool and mold making process notoriously adds time to pre-production and can be very costly, especially for shorter production runs. Modular molds and dies shorten the time to production, decrease the cost associated with number of tools and dies making, and compress the die changeover time.

Modular dies provides a proprietary line of standard round interchangeable insert molding systems (called Round Mate) that offer cost- and time-saving solutions. Modular molds and dies are commonly produced as round and rectangular interchangeable systems to compress the overall mold design and mold build process. Modular dies are provided in a range of round interchangeable systems that feature a variety of standard sizes and include Micro Systems, multi-position systems, and machining and loading fixtures with many available options, such as hot manifold, parting line runner, parting line interlocks, and unscrewing molds. Rectangular interchangeable systems also come in standard sizes and feature interchangeable inserts that lock and remove from the parting line, built-in water cooling lines, stepped pocket inserts, and guided ejection, stainless steel plates and protective coating in water jackets, and full-size leader pins and bushings. Applying a modular dies philosophy benefit the tool design and fabrication process, because simply orders off-the-shelf components; however, modular dies can provide much more than simple open and shut tooling. Modular dies are designed with unscrewing, slides, heated, hot manifolds, and cavity pressure sensors, to mention a few. These reduces design and fabrication time because the concept portion of traditional tool design encompasses all aspects of base, cavity, ejection, and machine, there are significant time and financial savings when the parameters of the program line up within the boundaries of a modular mold. You can realize additional savings when standard components can be produced, on demand, from pre-designed and pre-programmed machine setups. The unique benefit occurs when your product mix is married up within a standardized modular molding application – and the savings are realized after just a few tools.

Module system combines the advantages of a standardized tool with the necessary flexibility for parts production. It comprises a standardized basic design and individual tool modules that are interchangeable, which ensures that your production remains extremely flexible and that retrofitting is quick and cost-effective

Feature of above Mould:

Through above Injection Mould by changing its Core and cavity different size of component - 50 mm, 60 mm, 70 mm, 80 mm 90 mm and 100 mm can be manufactured (6 types of component).

Standardization in Tools and Dies manufacturing and evaluation method to be used:

About the applied Technique[2]:

In most of the tools and dies parts similarity in structural build elements are common and it also helps in designing. The suitable form of standardization can be adopted in both single piece and in mass production of similar dies manufacturing. This can reduce the tool cost and die manufacturing time. Commercial the die sets are available in the market in those much of machining is already completed. These are the common parts consist many cylindrical parts like pins and flat plates in desired size. The complete mould and die bases are readily available in the market without containing its core and cavity or punch and die impression. The standard mould and die bases nave the verity like simple and master die set. These are common and preferred by most of manufacturers in present industrial practice; this practice can be adopted holistically in all the MSME tool rooms. In mould core and cavity plate, complete ejector system, guide pillars and bushes and in sheet metal dies Top and Bottom bolsters, springs, knought out rods, different intermediate plates, similarly in jigs and fixtures jig buttons , base plates, toggle clamps and in pressure die casting plate items, ejector system , Sprue spreader, diffusers, cylindrical Pins, register ring etc. is easily and readily available in the market.

Level of standardization globally followed[3]:

- Plate and Plate items
- Standard die Assemblies
- Unit Die set
- Master Die set/ Master Kit

[2]Pye R.G.W, Injection Mould Design Book, Fourth Edition, pp225, pp228
[3]Herman E.A., Die Casting Dies : Designing Book-E506, Chapter 19,pp191

The level of standardization possible in MSME Tool Rooms is to be experimented and viability to be judged.

Test Technique Followed:

To test:

- Whether the MSME tool rooms ready to follow the standardization practice in tools and dies manufacturing?
- Which level of above mentioned standardization is suitable at what instance in tool room?
- Whether structural build elements and die sets are divided in different category, for better selection?
- Whether the MSME tool rooms have any policy and strategy regarding standardization and application in tools and dies manufacturing?
- Whether the MSME tool rooms evaluate the impact of standardization process on cost, quality customer satisfaction?
- How do the MSME tool rooms standardize the products-criteria they use?
- Whether standardization can be applied in categorization of machines parts their accessories management?
- Whether standardization can be applied in machines cutting tools arrangement?

Expected Benefits:

- Mould and die construction lead time may get reduced drastically.
- The cost of tool or mould can be assessed realistically or in much better way.
- Pre-tooling operations like Turning, milling, grinding etc. can be avoided greatly way, which are time consuming

and non profitable work.

- Core-cavity or Punch and die manufacturing can be started immediately just component profile out line and housing planning.
- Individual part can be replaced quickly in case of damage, as they are standard and available.
- Tool and die delivery time may be reduced.
- Highly paid tool makers can be employed on important finishing work rather than relative bolster type plate manufacturing or deploying in rough and unimportant nature of work.

VI. Conclusion

The tool and die manufacturing operations continue with the tool cost estimation, selection of conceivable manufacturing method, sequence of operation and technology followed to meet the delivery time of the toolmaker. The main areas that result are therefore the right projected cost of the tool, the quality of the product, the technology used and the lead time to deliver the tool and die to the buyer. Due to its discrete nature of tool and die manufacturing, the industry is faced with so many challenges every day in order to achieve the correct shape, scale, material properties and the desired quality level of a product that meets the needs and demands of the customer while taking care of market competitors. Tool and die manufacturing company is therefore increasingly pushed to reduce the cost of the tool by introducing a new method and technology.

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