Decision Making for Time and Profit Optimization as Applicable to Job –Type Production Company

[1]Ogundola J, [1, 2] Yakubu A.M*,

[1] Prototype Engineering Development Institute, Ilesa, Osun State, Nigeria
[2] Federal University of Technology Akure, Nigeria
*Email of Corresponding Author: yakmoji@gmail.com

Abstract
Computational analyses that enable the selection of appropriate job selection based on the time allocated to each job for an optimum profit.
This paper work proposes a computational analyses framework for deciding which job to venture into on the account of the resources available viz: Machines, Time and other logistics. Cost optimization aims at reducing the cost attached directly to the realization of a product, this will certainly assist in increasing the profit margin, which is one of the objectives of any manufacturing company or organization. Organization could determine to embark on a project or not if the available hour and cost of material are known from the onset. A respective unit order of component, A, B, C, D, E, and F, were made and the cost of production, profit margin and operation time per unit job were estimated as presented in this paper. To decide which product and at what quantity could yield maximum profit, a computational software called Excel solver was used. It was discovered that 20 units of Component, C and 10 units of Component, F yielded an optimum profit of Six Hundred and Ten Thousand Naira (₦610,000:00) only with the mind-set of avoiding other non-profitable components in the subsequent order. For Optimal profit, it is advisable for the company to engage in the production of component C and component Fand for any other one would result to big loss for the company.

Index Terms— Optimization, Optimal profit, Cost, Computational analyses, Job selection

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1.0 Introduction

With global economic factors and competition, manufacturers encounter strategic challenges of right pricing and rising costs. Products are becoming more and more complex with frequent feature enhancements; while target price- points are falling progressively. Moreover, global demand is continuously shifting to rapidly growing emerging markets, where competition is largely based on price. Against this backdrop, companies must continue to create and bring new and highly differentiated products to the market cost- effectively, and within compressed time frames.

To address these challenges; companies try to reduce their product prices and optimize costs.

To reduce prices, companies adopt several techniques such as innovative pricing methods (e.g. smaller unit of sale) and optimizing their delivery network. For cost reduction, they build an organizational foundation that promotes a culture of cost containment and productivity improvement. However, both initiatives require careful balancing to avoid any compromise with positioning in the marketplace, and the ability to capitalize on future growth opportunities.

To achieve their strategic goals, companies need to assess their product realization value chain from a total cost optimization perspective. Best- in- class companies adopt several initiatives that focus on opportunities in product engineering, manufacturing engineering and industrial engineering to optimize their product costs.

2.0 Need and scope for cost optimization

Manufacturing organizations face a strategic dilemma between increasing revenue and decreasing cost to enhance profitability. In this context, cost optimization is often thought to be a purely cost reduction exercise. However, if carefully balanced, cost optimization can help in increasing both profits as well as revenue.

Cost optimization aims at reducing the costs 'built- in' the product; this will ultimately help in increasing the profit margin of the product by lowering the price- points, and expand the footprint of the product in virgin markets as also in existing markets.

Most cost optimization initiatives are carried out when products are successfully implemented on the manufacturing product line. Whenever firms undergo a profit- maximization drive, they undertake a cost optimization program focused on post- development functions like production, sales, and other operational overheads. The choice is based on the fact that materials and manufacturing expenses constitute a major part of costs. However, most of the cost structure for the product is locked into place because of the product specifications and decisions made during the development stage. Therefore, it is necessary to focus on cost optimization right from the beginning of the product development lifecycle, i.e. at the conceptualization stage of a new product. Companies can create significant cost optimization through better understanding and evaluation of cost drivers across the entire product realization value chain.

2.1 Mechanisms for early product cost estimation

The ability to achieve full cost optimization depends on correct cost evaluation capabilities during the product development stage. Organizations use various techniques such as parametric costing and function/feature based costing, to estimate costs during the early stages of product development. However, accurately evaluating the costs of products, in the detailed design and engineering stage continues to be a challenge. They need 'On Demand' access to multifaceted skills for correct cost evaluation.

Should costing provide a framework to systematically evaluate costs right from the Conceptualization stage to production? It is a cost estimating methodology, whereby one can determine the costs of the part or product, based on the raw materials used, manufacturing Costs, and overhead production costs. This can be achieved by analyzing the engineering models to understand the raw material required, defining the manufacturing processes required to deliver the required form features, and calculating the total costs through the use of rate data related to material costs and processing costs.

It is, therefore, very important to have a fairly thorough knowledge of the product, its build up in terms of material, the manufacturing processes that are used, and associated costs in the very early stages of product development. Component costing provide every gate, from the conceptualization stage to the launch of the products a platform to track cost at every gate, from the conceptualization stage to the launch of the product.

2.2 Product cost optimization elements

To minimize the total cost of a product, it is important to focus on individual cost elements.

Companies need more insight into what drives costs of their products and ensure that Optimization is targeted at the right places. Once the costs elements are defined, it becomes easier to take appropriate decisions to channelize suitable actions towards each cost element of the product.

3.0 Optimize manufacturing processes

Manufacturing cost is made- up of elements like raw material cost, tools and equipment cost,

Tooling cost required for manufacturing, and the cost of human effort. There are various ways to optimize manufacturing costs.

3.1 Improve material utilization

Since, raw materials can account for up to 70% of total manufacturing costs, reducing scrap and inventory costs can significantly reduce the total raw material cost. Sourcing the right- sized material stock or adjusting the component placement (i.e. strip- layout) helps in reducing scrap. In a scenario of varying manufacturing mix and variance in shape and quality of input material (e.g. leather), adaptive processes of component placements are used. Utilization can also be increased by switching to near net- shape manufacturing processes.

3.2 Reduce manufacturing operations

Low volume manufacturers prefer fabrication operations for flexibility in product variance. This often duplicates the manufacturing operations (e.g. cut and join) and increases cost. Use of programmable manufacturing systems can eliminate duplication, and retain the flexibility of one- piece manufacturing.

3.3 Flexible equipment/ tooling

Manufacturing systems (i.e. machinery and tooling) requirement up-front investment to start production. Moving from special purpose systems to flexible systems reduces the investments required for each product revision. This can be achieved by using programmable or adaptive machines, and design tooling with variability considerations.

3.4 Increase manufacturing throughput

To increase manufacturing capacity, companies must be able to capture and reduce idle- time and eliminate bottlenecks in the systems.

Techniques such as Single Minute Exchange of Die (SMED) can be used to minimize machine Idle- time and maximize utilization. Bottle-necks can be eliminated by appropriate

line- balancing techniques. Manufacturing simulation and dis-creet- event simulation techniques can also be used to maximize throughput by analyzing various what- if scenarios.

Methodology

Some components were machined based on the demand of the custom-er (Company). Various machining operations were done to achieve these components. The operations required are cutting, Drilling, mill-ing, Turning and Bending.

The kind of component to produce will determine the type of operation that will be involved in its realisation.

The constraint considered in this work is the available hour for an operation to be carried out. The reason for this is that a single machine can perform more than one operation hence; available hour becomes a constraint that must be considered since other jobs are coming for machining on the same machine. Available hour for each operation must not be exceeded.

During production the following components were produced based on the hour available.

See the table below:

Table1: Production process duration in hours per component

Component	**Turning**	**Cutting**	**Drilling**	**Bending**	**Milling**	**Testing**	**Delivery Time**	**Assembling**
A (C-Spanner) 60-90	0	0.3	0.5	0	1	0.5	1	0.75
B(Damper)	0	0.16	0.3	0	1.5	0.5	1	0.5
C (C-Spanner) 95 - 155	0	0.3	0.5	0	1	0.5	1.083	0.75
D(Reducer Shaft)	1	0.5	0.75	0	0.75	0.75	1	1
E (Collector Shaft Cover)	0	0.75	0	0.5	0	0.75	1	0.3
F(Collector Plate)	0	0.75	1	0.5	0	0.75	1	0.16
Available Hour/ Week	5	15	20	5	20	20	35	20

The cost of production for different components is shown in table 2 below:

Component	Cost of materials	Bending	Cutting	Turning	Drilling	Milling
A (C-Spanner) 60 - 90	2000	0	1000	0	700	1500
B (Damper)	5000	0	2000	0	1000	1400
C(C – Spanner) 95 - 155	3000	0	1000	0	700	1500
D (Reducer Shaft)	1000	0	300	1500	1000	1200
E (Conveyor Shaft Cover)	2500	500	1000	0	0	0
F (Collector Plate)	3500	500	1000	0	1500	0

Table 3: The cost/unit, selling price/unit and profit margin for each component produced after numerous operations.

	Specification	**Material**	**Operation involved**	**Cost/ Unit**	**Selling Price/Unit**	**Profit Margin**
A (C-Spanner) 60 - 90	300mm x 80mm x 8mmth	Mild Steel	Cutting, Drilling & Milling	5200	7000	1800
B (Damper)	500mm x 40mm x 40mm	Teflon Material	(i) Cutting (ii)Drilling (iii)Milling	7600	9500	1900
C(C – Spanner) 95 - 155	300mm x 60mm x 8mmth	Mild Steel	(i) Cutting (ii)Drilling (iii)Milling	6200	8200	2000

D (Reducer Shaft)	Φ32mm x140mm	Mild Steel	Cutting,Turning, Milling & Drilling	5000	6600	1600
E (Con- (Conveyor Shaft Cover)	3080mm x 185mm x 3mmth	Mild Steel	(i)Cutting (ii)Bending	4000	5500	1500
F (Collector Plate)	1000mm x 130mm x 3mmth	Stainless Steel	(i)Cutting (ii)Bending	6500	8600	2100

The equations generated from above can be itemised as follows:

P = 18A + 19B +20C +16D + 15E +21F

Subject to

1D ≤ 5

0.3A + 0.16B +0.3C+ 0.5D + 0.75E +0.75F ≤ 15

0.5A + 0.3B + 0.5C + 0.75D +1F ≤ 20

0.5E + 0.5F ≤ 5

1A + 1.5B + 1C + 0.75D ≤ 20

0.5A + 0.5B + 0.5C + 0.75D + 0.75E +0.75F ≤ 20

1A + 1B + 1.083C + 1D + 1E + 1F ≤ 35

0.75A + 0.5B + 0.75C + 1D + 0.3E + 0.16F ≤ 20

A, B, C, D, E, F ≥ 0

Table 4: Integrated Coefficients Extract of production processes from objective functions

Operation	A	B	C	D	E	F
Turning	0	0	0	1	0	0
Cutting	0.3	0.16	0.3	0.5	0.75	0.75
Drilling	0.5	0.3	0.5	0.75	0	1
Bending	0	0	0	0	0.5	0.5
Milling	1	1.5	1	0.75	0	0
Testing	0.5	0.5	0.5	0.75	0.75	0.75
Delivery	1	1	1.083	1	1	1
Assembling	0.75	0.5	0.75	1	0.3	0.16

Table 5: Objective function Results from Excel solver Computational Analysis

	A	B	C	D	E	F
Coefficient	18	19	20	16	15	21
SOLUTION	0	0	20	0	0	10
Profit (Optimal)	610					

Table 6: Constraints Coefficient.

	A	B	C	D	E	F	Condition	Value
Constraint 1	0	0	0	1	0	0	≤	5
Constraint 2	0.3	0.16	0.3	0.5	0.75	0.75	≤	15
Constraint 3	0.5	0.3	0.5	0.75	0	1	≤	20
Constraint 4	0	0	0	0	0.5	0.5	≤	5
Constraint 5	1	1.5	1	0.75	0	0	≤	20
Constraint 6	0.5	0.5	0.5	0.75	0.75	0.75	≤	20
Constraint 7	1	1	1.083	1	1	1	≤	35
Constraint 8	0.75	0.5	0.75	1	0.3	0.16	≤	20

	LHS	RHS
Constraint 1	0	5
Constraint 2	13.5	15
Constraint 3	20	20
Constraint 4	5	5
Constraint 5	20	20
Constraint 6	17.5	20
Constraint 7	31.66	35
Constraint 8	16.6	20

4.0 RESULT AND DISCUSSION

As seen in the analyses above, the maximum time for turning operation was not exceeded which means there is still ample time for turning operation to be done. In the case of cutting operation, the time allotted has not been exhausted more can still be done to gain more profit.

In Drilling operation, the time allocated for it was the same as the time used for drilling. This is application to Bending and milling operations as the time available was exhausted.

For others like Testing, Delivery and Assembly more can still be done for the time available was not exhausted.

5.0 CONCLUSION

Based on the result of the optimization from above is advisable for the organization (Company) to engage only in the production of component C and component F as components that can bring optimal profit. Engaging in production of any other component would result to big loss to the company.

In other words, organization could determine to embark on a project or not if the available hour and cost of material is known from the onset.

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