3E10 OPERATIONS MANAGEMENT FOR ENGINEERS, 2013

QUESTION

1 (a) The product-process matrix helps organisations identify the type of production approach they should use for a product.

(i) Describe the product-process matrix for manufacturing organisations, and identify the key advantages and disadvantages of each process type [25%]

(ii) Mass Customisation combines the flexibility and personalisation of "custom-made" with the low unit costs associated with mass production. How can this concept be reconciled with the Product-Process Matrix?

[10%]

(b) How do the basic characteristics of service operations differ from manufacturing operations? [25%]

(c) Most manufacturing operations have three categories of inventory: Raw Materials (RM), Work-in-Process (WIP), and Finished Goods Stock (FGS). Describe how the inventory might be split between the three categories for the following manufacturers:

- making high-volume, Make-to-Stock (MTS) items such as fast-moving-consumer goods
- making low-volume, Make-to-Order (MTO) products such as luxury automobiles

[15%]

(d) You are an operations consultant at a firm. You have been called in to help the Accounting department. They receive an average of 1,000 payments per week. There is an average of 500 cheques waiting to be deposited. The cheques coming in are classed as being either small or large. Small cheques have an average value of £500 and large cheques have an average value of £5,000. 20% of the cheques coming in are large and the rest are small. Currently there is no distinction between the processing times of the large and small cheques. As a result, 20% of the cheques waiting to be processed are large. As operations consultant, you have been asked whether it is worthwhile to reallocate resources (at no additional cost to the company) so that large cheques wait an average of 0.3 weeks, while small cheques wait an average of 0.8 weeks, before being processed.

(i) What is the average time spent by each cheque waiting to be deposited?[10%]

(ii) What is the current inventory in terms of monetary value? [10%]

(iii) Is it worthwhile to reallocate resources as described above? Justify your answer with a brief explanation. [5%]

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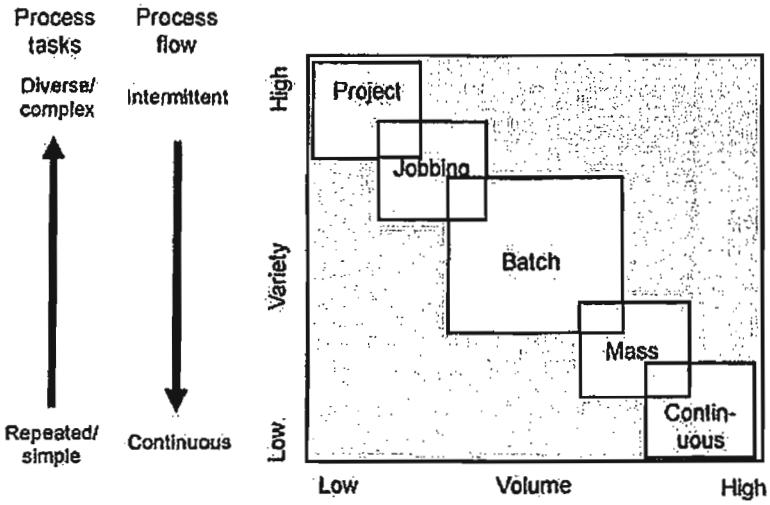
ANSWER:

(a) (i) Two key variables for manufacturing operations are volume and variety. These determine the layout, dedication of equipment and level of training of the workforce.

- defines types of job design required
- defines necessary tools and technology
- defines cost structure
- defines relationship with suppliers
- established customer expectations – cheap or customised

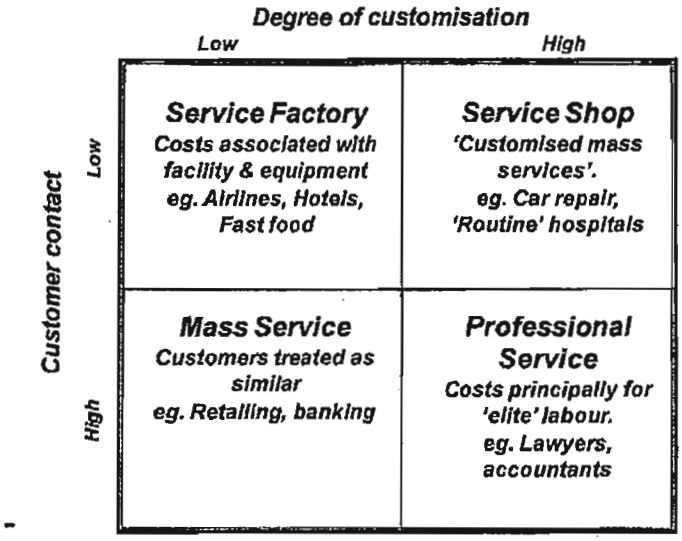


Here a good answer should comment on the product, process, and workforce implications:

- project: specialist workers, one-off, resources brought to location often, general purpose machinery
- job-shop: specialist workers, few of a kind, general purpose machinery, complex routing
- batch: higher volume, so setup times justify batch production, dedicated equipment but no rigid automation, variable speed, similar products
- line: dedicated and rigid equipment, high volume with clear line speeds, low skill requirements, high repetition, very similar products
- continuous: no clear distinction between products, very rigid and automated equipment, low labour requirements (only as control engineers)

(ii) Mass customisation implies a position off the optimal position, as producing high volume, but also high variety. This is reconciled by firms making investments in flexibility (Flexible Manufacturing Systems) and responsiveness, which allow it to operate off the fit implied by the PPM.

(b) The nature of manufacturing and service tasks differ considerably between firms. Service operations follow a similar setup in terms of Volume-Variety, proxied by degree of customisation, degree of customer contact. The service process matrix could be used to illustrate these different types:



Manufacturing and serve tasks also differ on the basis of their:

- Tangibility (service is intangible)
- Quality (service is subjective)
- Heterogeneous (service has variation due to heterogeneous customer needs)
- Storage (service cannot be stored)
- Simultaneous consumption and production

(c) High-volume MTS. These companies tend to have high FGS as make to stock; medium RM as although produce to forecast (stock plan), they will want to have enough RM so that if there is a rush on products can make immediately; WIP tends to be low as throughput time low – examples: food items, simple consumer items.

Low-volume customised MTO. RM will be low as order items in against specific work plan; FGS will be almost zero as made-to-order so finished items go straight to customer; WIP will be high as expensive parts and in work a long time.

(d) (i) Using Little's Law:
R = 1,000 per week. I = 500.
Thus average flow time T = I/R = 500/1000 = 0.5 weeks.

(ii) Currently the department carries an inventory of 500 cheques worth:
(500)(0.2)(5000) + (500)(0.8)(500) = 700,000 pounds waiting to be sold.

(iii) Yes, reallocate resources, because T = 0.3 is less than the current average, hence average inventory (=amount of cheques not deposited) will decrease on average, and we are told that reallocation can be done at no additional cost.

(2) (a) Consider the problem of minimising average tardiness on one machine with the processing times and due dates shown in Table 1:

Job	1	2	3	4
p_j	7	6	8	4
d_j	8	9	10	14

Table 1

Find the schedule with which you can obtain minimum average tardiness. Is this solution optimal? [20%]

(b) Cambridge Leafy Houses Ltd. is a local residential property development company. The owner of the company, Mr. Alcock, is considering to outsource the kitchen and bathroom tile fitting and wall painting work to another local company, HomeWorks. One of the main requirements in obtaining this contract is rapid delivery time. Mr. Alcock says that if HomeWorks can fit and paint five newly completed small studio flats in 24 hours or less, the contract will be theirs. Table 2 shows the time (in hours) required in the tile fitting and painting for each of the five flats.

Flats	Tile fitting Time (hours)	Painting Time (hours)
A	6	3
B	0	4
C	5	2
D	8	6
E	2	1

Table 2

Assuming that flats go through the tile fitting operation before they are painted, can HomeWorks meet the time requirements and get the contact? [40%]

(c) (i) What is the difference between outsourcing and offshoring? [10%]

(ii) Discuss the key advantages and disadvantages that a company should consider when deciding whether to outsource their manufacturing activities [30%]

ANSWER:

(a) Recall that the MDD Rule is a good *heuristic* for minimising average tardiness, although it is not guaranteed to be optimal. Since we are asked to find the *optimal* sequence, and the problem is small, one approach is to started with the given sequence and try to improve via pair wise interchanges. There is one optimal sequence: 1, 2, 4, 3, where the total tardiness is $\sum T_j = 0 + 4 + 3 + 15 = 22$, so the average tardiness is $22/4 = 5.5$.

(b) The problem can be viewed as a two-machine flow shop and solved using Johnson's rule. The final schedule is B – D – A – C – E, with 22 hours flowtime. Contract can be fulfilled.

Manually, the problem is solved as:

Flat	Order of Selection	Position in Sequence
A	4	3
B	1	1
C	3	4
D	5	2
E	2	5

(c) (i) outsourcing refers to the obtainment of goods or services from an external supplier company, whereas offshoring refers to the practice of basing some of a company's processes overseas to take advantage of lower costs. The two concepts are not mutually exclusive or inclusive.

(ii) Students need to highlight the key benefits and disadvantages of outsourcing a process.

Pros:

- focus on core competences
- harness lower labour cost at supplier
- access to technology at provider
- stable and predictable financial planning in fee-for transaction services
- less investment risk

Cons:

- loss of control over process
- limited ability to improve processes
- risk of opportunistic behaviour of supplier
- loss of human capital and tacit knowledge

3 (a) Explain the key features of Total Quality Management framework. [25%]

(b) (i) Provide a definition of bottleneck in the context of operations management [10%]

(ii) What are the differences between a floating bottleneck and a fixed bottleneck in a manufacturing system? [10%]

(iii) Describe two negative effects of a non-bottleneck operation running faster than the bottleneck in a manufacturing environment [10%]

(c) According to the Theory of Constraints, what steps would you follow to increase throughput? [20%]

(d) Taichi Ohno outlined seven "deadly" wastes. Define these seven wastes, and describe which waste you consider to be the 'worst' and why. [20%]

ANSWER

(a) Three essential elements of TQM:

1- Know the customer: link knowledge of the customer to the day-to-day activities of the organisation
2- Mould the organisation's culture: largely through the deeds of leaders. Foster pride, joy, collaboration, and scientific thinking.
3- Continuously increase knowledge: of control over variation in the processes of work through the widespread use of the scientific methods of collection, analysis, and action upon data.

(b)

(i) A bottleneck is any resource whose capacity is less than the demand placed upon it. Bottlenecks are important because they control the rate of output for the organisation

(ii) Floating bottlenecks change through the process depending on mix of products and machines, permanent bottlenecks are always at the same resource.

(iii) (1) non bottlenecks running faster than the bottlenecks create excess inventory, and (2) They also reduce capacity that could otherwise be redirected.

(c) The following 5 steps should be followed in implementation of TOC:
1) identify the constraint (e.g. bottleneck workstation)
2) decide how to exploit that constraint (e.g. add extra worker)

3) subordinate all other processes to above decision (e.g. make sure the bottleneck is always running at 100% capacity by adding a buffer in front of it)
4) elevate the constraint (e.g. reorganise the workstations)
5) if the constraint has been removed return to step 1

(d) The seven wastes are: Overproduction, waiting time, movement, transportation, defects, inventory, over processing. The waste of overproduction (supplying the process with more than is needed and/or sooner than is needed to meet order requirements) is viewed as the worse. Why? Overproduction helps cause all the other wastes (e.g. excess inventory, unneeded transportation, waiting).