

## LOGISTICS MANAGEMENT

## General Comments

This year the results were much better than usual in terms of the number of passes although there were only two "As", one of which was in the 80s. As in recent years, the case and the theory were done well while the quantitative questions were not done as well apart from the simulation. Once again I will focus on these aspects in this report.

The quantitative sections contain relatively predictable applications that follow set rules. The linear programming question caused the most problems.

The way this course and exam is structured requires one to really get into the theory, the techniques and how to apply the ideas in practice. This follows a learning cycle. Ideally people should look at the cases early on to get an idea of the types of problems that occur. These are mixtures of marketing, logistics, mathematics and strategy. Subsequently one should get into the theory, but not spend the year learning it off. This year it was done well. Students showed a clear understanding of what is in the text and some practical illustrations from outside, including from Irish applications. The middle part of the year should be spent on the quantitative techniques, hopefully linking them into the cases and the theory, and anecdotes about Irish companies where possible.

Some people got through by getting full marks for one of the quantitative questions and getting by on the others. People who failed invariably did one or two sections poorly and were not able to compensate from another section. It is safer to prepare all the sections.

The case questions are geared at bringing one through a process of analysis, evaluation, diagnosis and prognosis. Most people tried all parts of the case section, and attempted all the sections. Consequently there were fewer than ever failures due to not attempting one or more sections. In the past this was the most common cause of failure and the reason for the high average failure rate. One of the problems with the case seems to be that it was done last, which is justifiable, but without being given enough time. It does account for $40 \%$, i.e. it is equivalent to two of the other questions. It should be understood that Logistics is important not just of itself but also because it requires one to put on one's quantitative thinking cap when addressing marketing problems. Some people did no quantitative evaluation in the case, which was regrettable. Generally most people seemed to have been better prepared for the case than previously.

## QUANTITATIVE QUESTIONS

Firstly, before I get into specifics, I would like to emphasise that there is no need to do rough work and then write your answer out neatly. It wastes your precious time. Do the question as best you can. If you think you are making a mistake say so, and try to correct the mistake. If you blank out, just leave two pages so that you can move onto other questions. Maybe later you will be able to do the rest of that question. Do not waste your time doing restarts. The idea of having two different quantitative sections is to separate the less standard from the standard, the unstructured from the straightforward application of algorithms.

Section C contained question on stock (inventory) control. This is a long section in the text and likely to occur every year. Most people got the economic order quantity of 400 units, and 800 for the case of parallel production and sales, but some did not know the modification to the formula for the latter. Generally the key to my seeing if inventory is understood is to put in something unusual and to require a calculation of total costs. Keeping one's head is critical. People are used to annual inventory costs. These were daily costs. Some people tried to convert to the year basis and ended up with economic order quantities, which were obviously unrealistic. The figures were set up to correspond to either one day's baking or two, and the possibility of baking in-house at a higher production set-up cost but benefiting from the extra 10p profit. Being able to produce 800 rolls per day did not mean that you had to produce all 800 if you decided to make fresh bread each day!
The most common error was to assume that there was no storage needed if the rolls were all used in one day. When they are baked they must be put somewhere before they are sold.

Section C also contained a simulation question. I include this kind of question occasionally because, whenever there is no obvious model, the rule is that you simulate.
Many got it fully right or close enough. The following is the answer.
The interarrival-time probability distribution is given below. The third line contains the corresponding intervals that are used for the simulation of inter-arrival times.

| IAT (seconds) | $\mathbf{2 0}$ | $\mathbf{3 0}$ | $\mathbf{4 0}$ | $\mathbf{5 0}$ | $\mathbf{6 0}$ | $\mathbf{7 0}$ | $\mathbf{8 0}$ |
| :--- | :---: | :---: | :---: | :---: | :--- | :--- | :---: |
| Probability | 0.07 | 0.14 | 0.26 | 0.22 | 0.16 | 0.10 | 0.05 |
| Intervals | $00-06$ | $07-20$ | $21-46$ | $47-68$ | $69-84$ | $85-94$ | $95-99$ |

You were required to simulate 11 inter-arrival times between 12 customers.
The catch here was that the first arrival time was zero.

$$
\begin{array}{llllllllllll}
0 & 30 & 70 & 60 & 40 & 80 & 30 & 70 & 40 & 60 & 30 & 50
\end{array}
$$

The probability distribution of the time it takes to be served is given below. The third line contains the corresponding intervals that are used for the simulation of service times.

| Service Time (seconds) | $\mathbf{2 0}$ | $\mathbf{3 0}$ | $\mathbf{4 0}$ | $\mathbf{5 0}$ | $\mathbf{6 0}$ | $\mathbf{7 0}$ | $\mathbf{8 0}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| PROBABILITY | 0.08 | 0.17 | 0.28 | 0.20 | 0.14 | 0.09 | 0.04 |
| INTERVALS | $00-07$ | $08-24$ | $25-52$ | $53-72$ | $73-86$ | $87-95$ | $96-99$ |

We next simulate 12 customers' service times.

The most important thing is to organise your table well. The easiest way is by customer.

| Cust. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | ---: |
| Arrive | 0 | 30 | 100 | 160 | 200 | 280 | 310 | 380 | 420 | 480 | 510 | 560 |
| Service | 0 | 30 | 100 | 160 | $\mathbf{2 1 0}$ | 280 | $\mathbf{3 2 0}$ | 380 | 420 | 480 | $\mathbf{5 3 0}$ | $\mathbf{6 0 0}$ |
| Delay | 0 | 0 | 0 | 0 | 10 | 0 | 10 | 0 | 0 | 0 | 20 | 40 |

Here Service stands for total service start times.
The first delay occurs when the fourth customer takes 50 seconds and the fifth customer arrives after 40 seconds.
The time in service is 600 seconds plus 80 queueing, averaged over 12 customers gives 50 and 6.7 seconds respectively.
The main mistake was to not use the total times to track what was happening.

## Section D: Standard Quantitative questions

The idea of having two different quantitative sections is to separate the less standard from the standard, the unstructured from the straightforward application of algorithms. The transport question is an example of a standard application of an algorithm, which many people got mainly right. I put in a note indicating that shipments were prohibited from Dublin to Holland, the cheapest route. This caused problems with people who tried to apply the steps of the algorithm without understanding what it was about. There were some of the usual catches here, the need for a dummy destination and probably also a dummy route because of degeneracy.

The other such question in Section D was an application of graphical linear programming with sensitivity analysis. It is not a simple method; one must develop an understanding of the technique. In this case there was a small practical addition. Preferably the answers should be integers, as one cannot have a fraction of an airplane. In fact the best point is consistent with this. The basics are straightforward. 1. Develop the constraints. 2. Draw the graph. 3. Find the corners most likely to be best. 4. Put these into the objective function to get the best one. Generally this was done quite well. The best solution was 2 medium and 6 small planes giving a profit of $£ 248,000$.

Part (b) of the question was a sensitivity analysis on the resources. (i) An extra $£ 1 \mathrm{~m}$ in the purchasing fund was useless because the fund was not fully used up: 2 by $£ 24$ m plus 6 by $£ 10 \mathrm{~m}$ equals $£ 108$ m leaving $£ 12 \mathrm{~m}$ unspent. (ii) Hiring an extra pilot allowed you go fully over to 9 small planes, which would be better because they use less maintenance. (iii) An extra 3 hours maintenance a month could allow you to go to 3 medium and 5 small planes, the maximum use of your pilots and monthly maintenance, except that it would require an extra $£ 2 \mathrm{~m}$ in your purchasing fund also, which you do not have.

The main mistake was to divide the constraint of 8 pilots into two constraints, one for small and the other for medium planes. A good idea is to say what the constraint means. The total of both kinds of planes, small and medium, was limited by having only 8 pilots.

