**THE BORROWERS**

**Background**

The librarian at the University of Central Garstang (UCG), John Samuels, has recently carried out a survey among users of the library. This consisted of asking those entering the library to write down the titles of books they wish to borrow. On leaving the library they were asked whether they had been successful in borrowing the titles. A similar online questionnaire had also been carried out, which was activated by users browsing the online catalogue. Both surveys indicated that users were only successful about 60% of the time in borrowing the book that they want. The survey also showed that a large proportion of the attempted borrowings were key course textbooks that were popular throughout the year. John was disappointed with these results as the library has a target of a 75% success rate for borrowers. Ideally, he would actually like to achieve a success rate of 85%.

**Current system**

The library is open 7 days a week and the current loan period is 21 days. The University has 3 terms each of 10 weeks duration and the Christmas and Easter vacations do not count in the loan period (for example, a book borrowed on the last day of the Michaelmas term would be due back on day 21 of the Lent term). For book loans the University year can therefore be considered simply as 210 consecutive days (30 weeks). All books must be returned by the end of the summer vacation and the library therefore has all books in stock on the first day of the academic year. Any lost or stolen books will be replaced before the start of the new academic year from a special budget set aside for this purpose.

In order to start to investigate this problem John has collected some data from the library’s records. The records show that most users return their books near the end of the loan period. In fact, about L% of books are returned late (see note below). The library has a system of fines whereby users returning books up to 5 days late are fined £0.50 and users returning books after that are fined £3. The effect of this is that most overdue books are returned 5 days late.

For the purpose of the analysis John thinks that a reasonable assumption is that all books are returned after exactly 21 days (for example, a book borrowed on day 10 is returned on day 31), except for overdue books which are returned after a further 5 days (for example, a book borrowed on day 10 that is overdue is returned on day 36).

**Options**

Increasing the number of copies of the books would certainly improve the success rate. However, UCG is currently under financial pressure and the library has a strict budget which it must keep to. Additional spending on books may require reductions in other services which John does not want to make.

The other option that John is considering is reducing the loan period to 14 days. One likely effect of this is that it will increase the proportion of books returned late – John estimates that the late proportion will increase to 30%.

John feels sure that it must be possible to build a model of book loans and use this to experiment with the different options. He has got some data on one popular textbook and thinks that if a method can be found for analysing the situation for this book then this could also be applied to other books. The particular textbook is one that is used on courses all year round and John has found that demand is constant throughout the year. Based on past data, the probabilities for the number of users wanting to borrow this book on a particular day is:

|  |  |
| --- | --- |
| No. users wanting to borrow the book | Probability |
| 0 | 0.45 |
| 1 | 0.40 |
| 2 | 0.15 |

John would like to know how many copies of the textbook the library would need with the current system and with the reduced loan period in order to achieve a success rate of 75% and how many copies to achieve a success rate of 85%.

Another option that has been suggested is to increase the fines for late books so as to reduce the proportion of books that are late. John would also like to know how much effect this would have on the success rate.

**Note:** The proportion of books returned late, L = (0.1N + 10) %, where N is the last two digits of your library card number. For example, if your library card ends 12 then L = 11.2%.