B. MATERIALS AND METHODS
B. Materials and Method

B. 1. Growth parameter:

For the purpose of growth studies the method of counting of individual papers from the primary journals was adopted in this research work as the most suitable growth parameter. To avoid the biasness in the results due to the great variation in the length of a particular paper, the total number of pages produced by these papers were also added simultaneously to the growth calculations.

B. 1.2. Nature of journals:

In this present investigation certain criteria were adopted for the selection of journals. Mainly scope of the investigation is fixed with the particular space. Only those journals which are published in India and a period limitation of 1970 to 1985 were also taken into consideration.

Some journals which already ceased its publication before 1970 or in the middle of the said decade were also excluded because they would not produce sufficient data for this investigation.
Again, some journals those started their publication in the middle of the 70's decade were considered here due to their contribution of data as well as new subjective thoughts. Another important criteria is that most of those journals which published articles mainly in English language were considered. Due to language barrier of the scholar, the journals published in various Indian languages were simply omitted. Yet the journals considered for this investigation sufficiently produced the raw data for undergoing into the various investigations.

B. 1.3 List of the journals:

A number of journals has taken into consideration for this investigation depending upon the above limitations. The names of the selected journals is enumerated below and an alphabetical list of all the journals published in India is given in the appendix C.A.

1. Herald of Library Science
2. IASLIC Bulletin
3. Annals of Library Science and Documentation
4. Library Science with a Slant to Documentation
5. Indian Library Association Bulletin
6. Indian Librarian
7. Granthagar
8. Library Herald
9. Granthagar Sarvasmanu
10. International Library Movement
11. Granthagar vijnana
12. Lucknow Librarian
13. National Librarian
14. DRTC Annual Seminar
15. Library History Review
16. Journal of Library and Information Science
17. ALIS Bulletin
18. Libra
19. Modern Library Review
21. DRTC Refresher Seminar Annual
22. Librarian
23. Progress of Library and Information Science
24. RILISAR Bulletin
25. Library Progress (International)
B. 1.4. Citation Studies:

B. 1.4.1. Nature of Citations:

In this investigation the total number of citations is considered as the total number of times the particular documents were cited in the reference given below the article and also the total number of individual documents. Therefore, there is no distinction in meaning and usage of terms 'reference' and 'citation'. Both the terms are identical in meaning.

B. 1.4.2. Selection of materials for citational Studies.

There are so many instances which clearly signify the great variation in the selection of materials for citational studies. The different authors studied the citational studies in a different way. As for example, in 1971, Kanasy collected 2,073 citations extracted from six journals of 1967 issues of microbiology by random sampling techniques. Generally, citation study is made on the citation appended to the journal articles in a particular subject. Hafner studied in physiology in 1974 taking eight scholarly journals which contained large number of full length reports of original research. He collected 31,669 citations from the journals from 1970
to 1972. In 1975, Bolles made a citational study on American studies taking 21 volumes of 1949-1969 of American Quarterly which amounted to 14,978 citations. Cline in 1979 made a bibliometric study of two selected journals in library science viz., 1) College and Research Libraries, and 2) Special libraries with time limitation of two decades. In this research project 15 productive journals out of 25 journals published in India were selected for citational study.

B. 1.4.3. Time limitations:

The total study year is fixed from 1970-1985. And for citational study 4 sample period range i.e. 1970-73, 1974-1977, 1978-81, 1982-85 for determination of relative growth rate and doubling time for both pages and articles in growth study. A period range of two consecutive years were taken into consideration as 1970-71, 1972-73, 1974-75 ..... 1984-1985. Again in the determination of age of literature a period range of four years were taken into consideration as 0-4, 5-8 etc. for systematic study.

B. 2. METHODS

B. 2.1. Growth Studies:

For this research project the growth of library and information science has been studied through two angles,
i.e. relative growth rates between specific time intervals and total growth trend during the whole period of observation.

B. 2.1.1. Determination of relative growth rate (RGR):

The relative growth rate can be defined as the increase in number of articles or pages per unit of articles or pages per unit of time. In 1979, Blackman originally made a study of rate of interest in the financial investment. And afterwards many scientist used that definition in their study of growth rate determination. In 1978, Hunt also applied that definition in the study of growth analysis of individual plants in the field of botany. From the following equation the mean relative growth rate ($\bar{R}$) over a specific period of interval was calculated:

\[
1 - 2 \bar{R} = \frac{\log_e 2^W - \log_e 1^W}{2^T - 1^T}
\]

Where

\[
1 - 2 \bar{R} = \text{Mean relative growth rate over the specific period of interval.}
\]

\[
\log_e 1^W = \log_{x} \text{initial number of articles or pages}
\]
\[ \log_e 2^W = \log \text{of final number of articles or pages} \]
\[ \text{after a specific period of interval.} \]

\[ 2^T - 1^T = \text{The unit time difference between the initial time and final time.} \]

Here, the year was considered as the unit of time. And in this investigation the relative growth rate was calculated both for articles and pages separately.

The mean relative growth rate per unit of time of articles per unit of year over a specific period of interval was measured by the following formula:

\[ 1 - 2^{\bar{R}} \text{ (aa}^{-1} \text{year}^{-1}) \]

and the mean relative growth rate per unit of time of articles per unit of year over a specific period of interval was measured by the following formula:

\[ 1 - 2^{\bar{R}} \text{ (pp}^{-1} \text{year}^{-1}) \]

B. 2.2.2. Determination of Doubling time (Dt)

Doubling time means the time required to double in number of articles or pages. In this investigation growth of the periodical literature was measured not only through
measuring the growth from the increase in the number of articles or pages with the specific time interval but also from the time taken to double in number of articles or pages. Therefore, it can be concluded that the shorter the 'doubling time', the faster the growth of literature. There exists a direct proportional relation between the relative growth rate and the doubling time. It can be easily proved that if the number of articles or pages of a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and the end of this period must be the logarithm of number of 2 (two). The value of log 2 in natural logarithms is 0.693. And for this reason the corresponding doubling time for each specific period of interval and for articles as well as pages were calculated by the formula

$$\text{Doubling time (Dt)} = \frac{0.693}{-R}$$

Thus

$$\text{Doubling time for articles} = \frac{0.693}{1-2^R \ (pp^{-1} \text{year}^{-1})}$$

$$\text{Doubling time for pages} = \frac{0.693}{1-2^R \ (pp^{-1} \text{year}^{-1})}$$
B. 2.1.3. Determination of growth curve

In the form which is of primary concern to us, the Gompertz curve describes a trend in which the growth increments of the logarithms are declining by a constant percentage. Thus, the natural values of the trend would show a declining ratio of increase, but the ratio does not decrease by either a constant amount or a constant percentage. Therefore, in this present investigation the Gompertz growth curve (Croxton & Cowden, 1988) can be applied safely to determine the growth of literature. The equation for the Gompertz curve is

\[ Y_c = Ka^b^x \]

which may be put in logarithmic form

\[ \log Y_c = \log K + (\log a)b^x \]

This curve has an lower and upper asymptote, the lower asymptote being zero. The fitting of the Gompertz curve is to the logarithms of the observed data and may be accomplished in a manner exactly paralleling the fit of the modified exponential. The expressions are

\[ b^n = \frac{\Sigma_3 \log Y - \Sigma_2 \log Y}{\Sigma_2 \log Y - \Sigma_1 \log Y} \]
\[
\log a = \left( \sum_2 \log Y - \sum_1 \log Y \right) \frac{b - 1}{(b^n - 1)^2}
\]

\[
\log K = \frac{1}{n} \left[ \sum_1 \log Y - \frac{(b^n - 1)}{b - 1} \log a \right]
\]

If it is desired to obtain the value of \(K\) without first computing \(\log a\) and \(\log b\), then the following formula can be used:

\[
\log K = \frac{1}{n} \left[ \frac{(\sum_1 \log Y)(\sum_3 \log Y) - (\sum_2 \log Y)^2}{(\sum_1 \log Y) + \sum_3 \log Y - 2 \sum_2 \log Y} \right]
\]

Using this expression first enables one quickly to ascertain if the upward trend has an upper asymptote, whether or not there is an upper asymptote for an increasing series. It may also be ascertained by noting if \((\sum_3 \log Y - \sum_2 \log Y)\) is greater than or less than \((\sum_2 \log Y - \sum_1 \log Y)\).

If the first difference exceeds the second difference, \(b^n\) (and therefore, \(b\)) is greater than one and there is no upper asymptote for the increasing series.

Trend equation is:

\[
\log Yc = \log K + (\log a)b^x
\]

Thus \(Yc\) will be the antilog of \(\log Yc\).

Again following methods were applied for computation of the value of \(Yc\).
a. The observed years were arranged gradually with the corresponding number of articles collected from each year.

b. The years were grouped into three equal numbers.

c. After year column, X column is arranged giving each year a digit starting 0 to onwards.

d. Third column is fixed for article production denoted by Y.

e. Fourth column is meant for the log values of Y.

f. And other four columns fixed respectively for $b^x$, $(\log a)b^x$, Log Yc and Yc.

Thus $\Sigma_1 \log Y = \text{First subtotal of } \frac{1}{3} \log Y$ column

$\Sigma_2 \log Y = \text{Second subtotal of } \frac{1}{3} \log Y$ column

and $\Sigma_3 \log Y = \text{3rd subtotal of } \frac{1}{3} \log Y$ column

$n = \text{number of observations within a subtotal (In this investigation the number of years).}$
B. 2.2. Self citation studies:

B. 2.2.1. Significance of the sample means:

In case of self citation studies four categories of self citations were observed. For determining the statistical significance in their differences, the 't' test was performed to their means of samples whether their appearance were justified or not. The following formula was applied:

\[
\text{Standard deviation} = \sqrt{\frac{x_1^2 + x_2^2}{N_1 - 1 + N_2 - 1}}
\]

So,
\[
t = \frac{x_1 - x_2}{\text{SD} \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}
\]

Where
- \(x_1\) = Sample mean of the 1st category
- \(x_2\) = Sample mean of the 2nd category
- \(N_1\) = Number of observations in the 1st category
- \(N_2\) = Number of observation in the 2nd category
- \(\text{SD}\) = Standard Deviation
B. 2.2.2. Determination of correlation and correlation coefficient of two variables:

Graphic method was used where individual values of the two variables were plotted on the graph paper. We thus obtained two curves, one for X variables and another for Y variables. Those curves determined the direction as well as closeness of the two curves, and thus they disclosed whether or not variables were correlated. But one limitation was that it was not possible to get a numerical value which might describe the extent to which the variables were related. Therefore, Karl Pearson's coefficient of correlation (Sardana & Seghai, 1982) helped to study the numerical expression and described the extent to which the variables were related. That method of calculating coefficient of correlation (r) was based on covariance of the concerned variables. Thus, the formula for computing pearsonian coefficient (r) was:

\[ r = \frac{\sum xy}{\sqrt{\sum x^2 \cdot \sum y^2}} \]

Where \( X = (X - \bar{X}) \) and \( Y = (Y - \bar{Y}) \)

The various steps involved are as follows:
1) Calculation of means of the two series i.e. \( \bar{X} \) and \( \bar{Y} \).
ii) Taking of the deviation of X series from the mean of X and also deviation of Y series from the mean of Y, indicated as $X$ and $Y$.

iii) Squaring of the deviations, and obtain the sum of the respective squares of deviation i.e. $\Sigma x^2$ and $\Sigma y^2$.

iv) Multiplying the deviation of X and Y series and obtain the table i.e. $xy$.

v) Substituting the values of $\Sigma xy$, $\Sigma x^2$ and $\Sigma y^2$ in the formula.

B. 2.2.3. Application of 'Chi-square' ($X^2$) test.

To determine the qualitative significance the 'Chi-square' test was applied. The data obtained for this investigation was fitted in 4 fold table (Croxton & Cowden, 1988) as given below:

<table>
<thead>
<tr>
<th>a_1</th>
<th>b_1</th>
<th>N_1</th>
</tr>
</thead>
<tbody>
<tr>
<td>a_2</td>
<td>b_2</td>
<td>N_2</td>
</tr>
<tr>
<td>$N_a$</td>
<td>$N_b$</td>
<td>$N$</td>
</tr>
</tbody>
</table>
The value of \( X^2 \) was calculated as follows:

\[
X^2 = \frac{(a_1 b_2 - a_2 b_1)^2 N}{N_1 N_2 N_a N_b}
\]

The nature of the association was determined by comparison with the statistically significance of \( X^2 \).

B. 2.3. Specific method.

The individual chapters were investigated and arranged and analysed systematically through the application of specific steps and methods and a paragraph named 'methodology' is provided in each chapter.