CHAPTER - 6

FINDINGS, AREAS FOR RESEARCH AND CONCLUSION
6 Introduction

The culmination of the study, resulted in the formulation of certain number of findings. The findings correlating to each objective are furnished below :-

6.1 Findings

Objective - i - To assess the growth and development of Toxicology literature

1. Toxicology is one of the oldest field in Medicine.

2. Toxicology borrowed ideas freely from the principles of Chemistry, Biochemistry, Physiology, Pathology, Pharmacology, Forensic Medicine, and Veterinary Science for its growth and development.

3. Toxicology is recognized as a transdisciplinary subject.

4. Today Toxicology became an important field of research all around the world.

5. Ebers papyrus (Circa 1500 B.C.) was the earliest medical record contains information about toxin. The founder of Toxicology is Matieu Joseph Bonaventura Orfila, a Spanish Physician.

6. Rapid development in Toxicology occurred during 20th century.
7. The first journal in Toxicology, "Archiv fur Toxicologie, was published in 1930's from Europe.

8. The multidisciplinary nature of Toxicology has led to the publication of many journals books, reviews, reports, patents etc.

9. The publication of conference proceedings increased every year.

10. Number of scholarly textbooks and reference books were available in Toxicology as referred in page 144 to 147.

11. Subject dictionaries, handbooks, thesauri, indexing and abstracting services, monographs, treatises, bibliographies, review of progresses were available as secondary sources (page 147 to 158).

12. Eminent scientists, organisations, institutions were authoritative sources in gathering information in Toxicology.

13. Filmstrips, microforms, slides, transparencies, videotapes were available in subjects of public interest in toxicology as well as on traditional topics. The recent developments on Toxicology can be viewed through the above sources.

14. New letters contribute a major role in the development of toxicology literature as seen in page no.165 to 168.

15. Rank high among the scientific discipline, popular books constitute a major literature aimed at common man listed as in page 168 to 171.

16. The field of Toxicology has witnessed unprecedented growth with the past 25 years. The explosion in subject matter is large from social concerns as well as by rapid technology innovation.
17. Out of fourteen online databases only four were having international coverage. Most of them were published from U.S. Online databanks include three.

18. More than 100 journals publish articles related to Toxicology. About 110 U.S. Schools offer courses or programmes in Toxicology.

19. The vendors such as BRS, DIALOG and SDC provided an array of information resources that cover the entire spectrum of the published scientific and technical information in Toxicology.

20. Major areas of toxicology are environmental, economic and medical toxicology.

21. The rate of citation per article varied from 6.65 to 0.83.

22. An increasing trend among the number of citing articles and simultaneous decreasing trend among the number of non-citing articles.

23. The value of relative growth rate and doubling time of citations pointed out a logistic pattern of growth of citations in Toxicology literature.

24. The saturation in the number of publications had almost been attained. Within a few years the growth of publications would follow the logistic pattern of growth.

**Objective - ii - To analyse the literature scatter employing standard variables in informetrics.**

25. Regarding the subject dispersion in citations, out of the 20 subject divisions, as in page no.236 maximum number of citations were from Toxicology (21.94%) and minimum citations were reported from the area of Marine Sciences (0.23%).
The second position was occupied by the subject Environmental Sciences (15.72%).

General aspects of Toxicology and Environmental Sciences are the thrust areas of study. Scientists and researchers are utmost alert in the toxicological aspects of environmental issues, the literature of this area occupied a prominent place in toxicology study. Besides the traditional subject areas, newly emerging fields like Food toxicology, Biotechnology, Marine Science found keen positions i.e. along with the growth of traditional components of Toxicology, other specialised areas are also getting popularity.

26. The subject dispersion of book citations showed that books on general aspects of Toxicology came in the first position (33.82%) followed by Environmental Science (18.91%) etc.

Besides the books on their basic subject, toxicologists also refer to a great extent book of other allied subjects due to the transdisciplinary nature Toxicology.

27. Subject dispersion of journals showed that core journals are in the field of 'Toxicology (30.51%) and 'Environmental Science' (18.64%). Scientists all over the world are more alert in the environmental and toxicological effects that not only affect our planet but also the human beings, plants and animals. As Toxicology is an interdisciplinary subject articles of general interest are published in journals having broad coverage in subjects like Biology, Pathology and Pharmacology.

Objective - iii - To identify prominent areas of research in Toxicology

28. Minimum citations were reported from the areas of Marine Sciences, Medical Sciences, Drug Medicine, Analytical

Besides the traditional subjects areas, newly emerging areas like Food Toxicology, Marine Sciences, Biotechnology found keen positions. This is a clear indication that along with the growth of traditional components of the subject, other specialised areas are also getting popularity.

29. The books coming under the category of general aspects of Toxicology came in the first position (33.82%) followed by books dealing with Environmental Sciences. Next positions were occupied by Medical Sciences, Chemistry, Ecology, Pharmacology, Biology, Pathology, Food Sciences, General Sciences, and Human Anatomy.

Besides the books on their basic subject, toxicologists also refer to a great extent book of other allied subjects. This revealed the transdisciplinary nature of Toxicology.

30. Most of the core journals are in the field of Toxicology (30.5%) and Environmental Science (18.64%) other subjects which came in order are Chemistry, Medical Sciences, Ecology, Biology, Pathology, Food Sciences and Anatomy.

The subject scatter showed the value of journals in the interdisciplinary subjects like Environmental Sciences, Medical Sciences, Chemistry, Ecology, Biology etc in the field of Toxicology.

31. The distribution of citation by subject of most cited 50 core journals, the subject 'Toxicology' came in the first position with 24 journals and maximum citation (49.36%) followed by
Environmental Sciences with 9 journals and with 8.55% of citations. Other subjects which got a position in the list are Medical Sciences, Chemistry, Ecology, Pharmacology, Biology, Pathology, Food Sciences and Anatomy.

The prominent areas of research in Toxicology were general Toxicology and Environmental Sciences. The newly emerging research areas were in Marine Sciences, Drug Medicines, Analytical and Applied Chemistry, Human Ecology, Fresh water Ecology, Pharmacology, Pathology, Food Toxicology, Biotechnology and Agriculture.

The citations from the 59 core journals were on subjects closely related to Toxicology.

Objective - iv - To study the authorship pattern

32. The personal author works predominate in toxicology literature. The publications by corporate bodies and anonymous works were less when compared to personal authors. The extent of collaboration was much less.

33. The value of group co-efficient for publications (g_p) was 0.73. The degree of collaboration among co-authors was maximum in articles written by more than three persons and minimum in two author publications.

34. The value of group co-efficient for citations (g_c) was 0.75. The degree of collaboration was maximum in more than three authored citations and minimum in two authored citations. Research in the field of Toxicology was predominant by team research. As a multidisciplinary field scientists and researchers from other fields contribute their knowledge and prefer more to teamwork than solo.
35. The year-wise analysis of value of group co-efficient for citation (gc) for single author works showed maximum (0.48) in the year 2002. In the case of three authored citations, the maximum value of gc (0.49) was observed in the year 2002 and in more than three authored citations, the maximum value of ‘gc’ (0.61) was also observed in the year 2002.

The year 2002 and 2003 witnessed the emergence of citations which were have collaborative nature.

36. The rate of citation of single and collaborated authors showed two authored articles had maximum citation rate (1.84) and more than three authored articles had got minimum citation rate (1.4).

As the number of persons increases in a work, the rate of C/A decreases i.e. the joint authors will have a lesser number of citation rate.

**Objective-v -To analyse the type of language and documents cited**

37. English was observed to be the most dependable language. The majority of the citations were form the documents published in English language. This trend has been observed in other science subjects also. Authors from non-english speaking countries especially from developing countries are writing in English to get a vast spectrum of readership. The dominant use of English language in Toxicology literature may be due to the fact that English is still the common language of communication among toxicologists and to the problem in accessibility of literature written in regional languages and ignorance of regional languages.
38. Among the types of documents cited, journal articles contributed maximum, books and conference proceedings occupied next positions.

The years 1998 to 2003 marked the emergence of conference literature in Toxicology. More than 10% of total literature comprises of conference/symposia documents. The proceedings of conferences are becoming very important today. Such a communication channel is more effective and speedier, though restricted only to research by conference participants, than publication of ideas in primary journals. Thus the journal articles, books and conference proceedings constitute 94.72% of the total toxicology literature.

**Objective - vi - To examine how far the literature scatter satisfy the existing laws of informetrics**

39. The core books in Toxicology were placed in 28 different ranks. Within the first 12 ranks, only 12 books were available which covered 25.89% of the total book citations. More than 60% of the citations were referred by about 213 books. The Casarett and Doull's Toxicology: The basic science of poisons, edited by Dull, J. topped the first rank. When the cumulative number of citations were plotted against the number of books on a semi-log graph, it is seen that the typical Bradford's curve initially rising and then became linear.

The first 20 books described against the serial number 1 to 20 may be the core books in Toxicology. There is only a small number of books in Toxicology literature was covered within the core group and there still remained quite a large amount of book literature was scattered over a huge number of books. Hence the core book phenomena is not fully satisfied.
40. The scientific productivity of core authors showed that in lower ranks more number of authors were available than in the upper rank. The first five positions in the rank were occupied by C.J. Price (3.48%), R.W. Chadwick (1.78%), J. Ashby (1.00%), J.D. George (0.92%), J.R. Reel (0.83%).

41. The citations of authors almost followed the typical Bradford's hyperbolic curve. The analysis revealed that the 11 core authors contributed only 11.57% of the total author citations which is a clear indication that core concept was not fully applied to these authors.

42. The Lotka's Law is applied to author productivity and found that the observed percentage of authors varied from the expected percentage of authors as predicted by the law when chi-square test was applied, the calculated Chi-square value (228.54) was more than the table Chi-square value i.e. 18.3 at a degree of freedom 10, level of significance $\alpha = 0.05$. The Chi-square value was highly significant and Lotka's law cannot be applied to this data.

43. The core journal data tested by Bradford's theory found 2308 (1/3) citations were contained in 5 journals, 4616 citations in 15 journals and 6922 citations in 59 journals. The value of $n^2$ is found to be 4 whereas it comes to 8.8. Bradford law does not confirm to the study.

**Objective - vii - To examine the literature scatter in Toxicology in the light of laws of informetrics and suggests deviation if any.**

44. In the case of number of paper of the authors, the expected values were not close to the observed values, hence Lotka’s law does not fit for the study.
The law can be extended as

\[ f(y^2) \approx \frac{A}{y^2 + (y-1)} = \beta \]

Where 'A' and '\beta' are constants and 'y' is a number of papers.

When Bradford's law is applied to core journals, the value of 'n^2' is found to be 8.8.

Hence the law can be extended as \(1 : n : 4n\)

6.1.1 Other findings

Bibliographic Coupling

45. The journal "Toxicology" had highest percentage of articles (15.3%) which had common citations, i.e. 10 pairs.

The journals 'Toxicology, Environmental Toxicology', 'Journal of Applied Toxicology', 'Chemosphere', 'Ecotoxicology' and 'Chemical Research in Toxicology' had published articles whose basic subjects were mostly similar nature in individual volumes, because of high rate of common bibliographic entries. But the rest of the journals 'Toxicon', 'International Journal of Toxicology' and 'Neurotoxicology' had published articles whose subject coverage were mostly different in nature in individual volumes, because of their low rate of common bibliographic entries which gave us an indication that the articles published in individual volumes were mostly distantly related.

46. Every year some of the articles published in the different journals of Toxicology had little similarities in relation to their subject content. There was no fixed trend in the development of number of bibliographically coupled articles in different journals in Toxicology.
47. The maximum pair of articles (33) were reported when the bibliographic coupling strength was 1. The number of coupled articles decreased as the coupling strength increased. Only one pair of article was available when there were five common citation entries.

Few of the articles had perhaps some similarities and the rest of the articles were not related to their original subject content. The strength of bibliographic coupling was very weak because only few articles were having more than 5 common citations i.e. each of the volumes of the journals, published articles are of trans-disciplinary nature which belong to different areas of research. Hence the diversity and transdisciplinary nature of Toxicology can be evident from this analysis.

**Self-citation**

48. Maximum number of self-cited articles were published in journals (121) followed by books(51). The number of conference proceedings self-cited were 42 which came almost nearer to the percentage of total citations when compared with unpublished dissertations/theses.

49. In comparison to other subjects such as Physics, Life Sciences and Botany, the rate of self-citation in Toxicology is not very low (7.87%). The authors in the field of Toxicology conduct researches based on their previous work or continuation of the first work.

50. The growth in the number of self-citations showed a steady increase. This increase in self-citation during the last 6 years revealed the development of Toxicology as a transdisciplinary subject.
51. Repetitiveness of self-citations were observed to be very less (10.18) in Toxicology journals. Out of the 13 documents repeatedly self-cited, 10 (76.92%) had been cited two times and 3 (23.08%) had been cited 3 times each.

Most of the self-cited articles were not so much similar in their content to the citing article. This trend can be observed only in subjects having tremendous multi-disciplinary growth. Like in Toxicology, active R & D results new and new discoveries and as a by product nascent literature are producing every year.

52. Regarding the age of self-citations, maximum number of self-citations were found within two years (17.74%) and minimum after ten years (2.64%).

As the age of self-citation increase, the number of self-citation decrease. Maximum number of self-citations were made within 5 years of the publications or occurrence. The age of self-citations was an important factor which highlighted the probable reason of self citations. Scientists, researchers of high scientific productivity came under this category. If the self-citations are of recent origin it usually points of to the fact that the work is an extension of the author's previous work, which he is presently doing. As maximum number of self-citations were found within two years, it can be concluded that most of the works in the field of Toxicology doing presently are extension of previous works.

53. Recently self-citation with five major categories of authors, maximum number of reference belonged to very recent group. Recent articles had more chances to be self-cited then the older ones.

54. Indian toxicologists had more self-citations (6.7%) than foreign authors (1.1.%). More number of Indian authors like to self-cited
than by foreign authors i.e. self-citation is more among Indian authors than foreign authors.

55. The number of multiple authors articles published were less when compared with single author cases, the self-citing articles in multiple authors cases were more in number. In three author cases, the rate of self-citation per article was more than that in the case of two authors and more than three authors. When the number of authors were more, the number of individual works became more and there were more chances to cite their earlier works. Co-author works contained more number of self-citations than single author. As there are more number of authors in an article, there are more chances of self-citations.

56. Among different categories of self-citations single author works were self-cited in maximum number.

57. Year-wise analysis of self-citing articles revealed that maximum number of self-citing articles (25.93%) appeared in the year 2003 and minimum (8.64%) in the year 1998. The self-citing tendency is increasing among authors as years pass.

58. The third author did not have any self-cited articles. The absence of third author citations may be due to the fact that while giving citations, authors had given priority in selecting articles of first and second citing author only or all the authors but not the article of third author alone. The works of the third authors were generally not considered for the extensive study and hence did not get any citations. Thus the authors are senior, authentic and experienced have got a large number of publications to their credit.
Core Journals

The rank list of 59 journals most cited, have an international coverage and based their study the following findings were done.

59. The librarians and information managers working in libraries specialising Toxicology can effectively use the core list for acquisition of journals. Along with the growth of Science and Technology and increase in the number of scientific journals and cost no library is self sufficient in the procurement of journals.

60. Scientists and researches working in the field of Toxicology can be made aware of the core journals. So that they can publish their research results in these journals and can get a wider exposition.

61. In certain areas of Toxicology only a few journals were available. Publishers can be informed of the core journal list so that they can assess the weaker areas and can start new journals.

62. There was a wide variation in the number of citations received by top ranking journals. Journals receiving more than 100 citations are 19 in number, which have a total of 5040 citations i.e. 72.81% of the citations received by the core journals.

The relevant articles in the field of Toxicology are concentrated in a few journals while increasing number of less related journals are in circulation.

63. The percentage of cumulative journals and citations showed that it does not conform the 80/20 rule. The 20% (11 Nos.) of journals from 2% (149 Nos.) of citations or 80% (47 Nos.) of journals contain 40% (2790 Nos.) of citations.
In Toxicology the relevant articles are scattered in a variety of journals which are cited frequently by researchers.

64. The journal “Toxicology” with 33 issues per year is ranked first while ‘Toxicon’ with monthly periodicity stood second. The journal, 'International Journal of Toxicology’ with bi-monthly periodicity was ranked in the third position. Ranking of most cited journals by year of origin found that from 1970’s a total of 20 titles were started, 1980’s witnessed the origin of same number of titles.

The increase in the number of journals during this period indicated the emergence of new branches of toxicology i.e. medical, environmental and economic toxicology. The core journals in Toxicology originated in the 20th century which showed the rapid development of the subject during the period.

65. U.S. was found to be the most productive country with 28 journals (47.45%) and U.K. in the second position with 12 journals (20.34%). Only one journal from India was seen in the rank list.

The vast and quick progress of research and development in the field of Science and Technology in U.S. and U.K. led to an increase in the number of journals published from the above two countries. The developed countries stood forefront in publishing journals of international reputation because they have all facilities for research, communications, education etc. than the developing countries like India, Japan, China etc.

66. Age of journals cited was calculated as 5.7 years The journals became obsolete after this period. The low age may be due to increased research and development in the field of toxicology which results in the discovery and publication of new research
out put. Median citation age plotted in graph showed the low age which is an indication that this is a growing subject. Rapid obsolescence is directly proportional to high popularity of the subject.

6.2 Tenability of Hypothesis

The data collected form TOXLINE were analysed with appropriate statistical tools and the results derived were drawn out and summarized as the findings of the study. In the light of the major findings, tenability of the hypothesis was tested. The following statements are the outcome of the testing of the hypothesis.

1. Bradford's Law was applied to core journals, the value of $n^2$ was found to be 4, whereas it came to 8.8. Bradford Law did not fit for the study.

The expected values were not close to the observed values, hence Lotka's Law did not confirm for the study. Thus Toxicology literature will not satisfy the existing laws of informetrics.

2. The age of journals in Toxicology is calculated as 5.7 years. Increased research and development in this field account for this low age. After this period the journal article became obsolete. Hence the obsolescence or aging of journals in Toxicology is quick. In Biochemistry the age of journals is calculated as 8.3 years.

3. According to 80/20 rule, 20% of the journals must contain 80% of citations. Whereas in the present study 20% of journals form only 2% of citation. But the percentage of cumulative journals and citations does not conform the rule. 80/20 rule is not applicable to Toxicology.

4. U.S. and U.K. account for the publication of 40 international journals in Toxicology. Online databases on Toxicology are mostly
published from U.S. Thus input of literature in Toxicology is mostly produced from developed countries.

6.3 Areas for Research

1. Hypertext Links

Citation concepts have been applied to hypertext systems. Citation analysis methods have recently been applied to the Web environment. The term 'citation' has been used by Rousseau to represent a hypertext linkage between Web sites, to distinguish between citations received by published works and hypertext linkages between two documents. The domain names and links between Toxicology web sites may be adequately modelled with a Lotka's distribution.

2. Web impact factor

The concept of Web impact factor proposed by Ingwersen can be applied to Toxicology literature, where the Web site and its individual pages correspond to journals and articles. The impact factor is calculated as the number of link pages pointing to a given site/domain, both the external and internal link, divided by the number of pages on a given Web site. The Toxicology Web impact factor may serve as an indicator of a Toxicology Web site's significance.

3. Co-word studies

Co-word analysis has been used to determine the strength of relationship among textual-containers, i.e. full-text documents, their surrogates, fields within documents, or queries submitted to Toxicology information retrieved systems. Co-occurrence analysis of document content is usually performed on substantive keywords appearing in a Toxicology bibliographic database record field such as the title, description, or abstract. The results of co-word analysis can be mixed depending on the application.
4. **Electronic Resource Usage**

Now-a-days electronic resource usage extend to records accessed within databases, or hits on Web sites. Many issues associated with usage of electronic resources, particularly on the Internet, remain to be explored. In the same way Toxicology Websites can be analysed to study their use.

5. **Literature growth of Toxicology Information Retrieval systems**

Like growth studies applied to literature, the same methods may be applied to the growth of indexes in Toxicology information retrieval systems. Growth investigations may focus on different components of an information retrieval system i.e. rate of document growth, growth of terms to the index, growth in the number of Web servers etc. Document growth is measured by the number documents indexed over time i.e. monthly, yearly. Index growth can continue at higher rates in distributed environments as in Web. Internal growth studies on Toxicology Web sites help to assess number of Toxicology Web sites, pages and search services available in the field.

6. **Science Indicators Policy Development**

The results of this informetric study can lead to recommendations for science policy of a country. Informetric measures such as citations, publication productivity, author productivity are core scientific indicators. The policy development can extend to more regional or local applications.

7. **Generalized Distribution for Informetric Modelling**

A simple visual inspection of equations used in informetrics reveal that many of the ‘reverse J-shaped’ models used in different areas of informetrics are very similar to one another. The models developed for specific data measures may be generalized so that a unified approach may be adopted when undertaking informetric research. In future by taking commonalities between different informetric phenomena, relatively simple models developed for specific data types evolve into more
sophisticated models with additional parameters to make models more flexible for a broader range of data.

Most of the univariate informetric models have taken into account the influence of important contributing factors such as time on the resulting distribution. But multivariate models, in which one variable is dependent on one or more other variables, can deal with changes in distribution shapes over time. This will form a milestone in the future of informetrics. The comparative newness and broad usage of information environments such as the web and communication tools informetric models can be applied.

6.4 Conclusion

In recent years Library and Information Science field has witnessed a large number of informetric studies where data was collected from particular subject area. Invariably the studies attempted to analyse the data using certain number of parameters and concluded whether the fundamental laws in informetrics are in conformity with the existing data. Very rarely some researchers have seriously taken the problem to the extend of extending the existing laws. Whatever extensions suggested by the researchers were not very popularly known to the profession. Because of the IT developments sufficient data can be derived for informetric analysis from the Web. As a result of wide scale interest in electronic information access and use facilitated by the Internet, informetric analysis can legitimately hope to derive new fundamental laws in the field in future. The present study could derive formulae for the extension of the Bradford and Lokta's laws, how far they can be applied to other fields collecting data form the Web, is a matter for future research. This study has ample scope for research in this direction.