Chapter Two

Literature Review

2.1 Introduction

This is a descriptive study based on the research trends of postgraduate scholars in the sciences. The present study will concentrate on the research trends in the sciences by examining the doctoral theses submitted by the postgraduate science researchers to the University of Malaya between 1970-1995.

The literature review for this study will be divided into two parts: the information-seeking behaviour of scientists and citations (references used/cited). An overview is given for each of the two parts followed by a more focused look in each, to meet the needs of the present study. It is hoped that with such an overview a better understanding of each of the sub-sections will be achieved.

Most of the materials used in this study are taken from articles in journals as it was felt that the journals give wider coverage not only with regard to length of time but also with regard to the variety of viewpoints related to the present study. References from as early as the late 1960s to the latter half of the 1990s are used in this review. This is mainly because the data used are taken from theses from as early as the 1970s.

A conclusion is given for each of the sub sections as it not only relates the various studies to the present study but it also indicates, how and if, the present

study fits in with the existing knowledge. It is felt that with such a conclusion, emphasis is placed not only on the different studies but also on how these studies have a bearing on the needs and requirements of the present study.

While the literature surveyed includes references to the information-seeking behaviour of the science researcher, in particular, and scholarly communication among members of the scientific community, in general, the focus of the present study is on the research trends. These would form the foundation on which this study will be based.

2.2 Information- seeking behaviour: Studies on information-seeking behaviour - an overview

A number of studies have been carried out on the information-seeking behaviour of scholars. The "information-gathering" or "information-seeking" habits or behaviour of scholars for the purpose of this study would refer to the information needs and practices of the scientists and scholars focusing mainly on the channels and sources by which scholars acquire the information used in their work. The term 'scientists' and 'scholars' in this study will be used interchangeably.

Information-seeking behaviour has been described as how people "go about finding answers to solve a problem". The way people behave is influenced by culture and their values influence their way of communication. The different

cultural backgrounds, different cultural experiences, education, language, socio-economic status, level of literacy and social networks, play a vital role in the information-seeking process (Liu, 1995).

What actually determines the researcher's requirements for information are the needs that he considers pertinent to the type of search. According to Voight (1959) there are three categories of approaches to information amongst scholars. They are: (a) "current approach" which deals with the need to be up-to-date with current progress in the researcher's field; (b) the "everyday approach" which deals with the need for specific information that is essential to the researcher's work; and; (c) the "exhaustive approach" which deals with the need to find and examine all the relevant information on a given subject (cited by Shoham, 1998). Menzel (1964) adds another two functions, that is to familiarise on fields that are included in the researcher's "attention area" and to seek information "outside of the researcher's predefined areas of attention". In his study of academic scientists, Premsmit (1990) found that "identifying up-to-date information, receiving relevant studies and data and finding a research topic", are among the most important information- seeking needs of the researcher (cited by Shoham, 1998).

For a scholar to recognise the desired information, he must already have a purpose in mind and be at some level of informed state. Scientific information, being as diverse as it is, is treated differently in different research situations.

An information search begins with the user's problem. The gap between

the user's knowledge about the problem and what the user needs to know to solve the problem, is the information need. The user's state of knowledge is dynamic. It changes as the user proceeds with his investigation. There are no definite boundaries. As users move through levels of information need in an information problem, their judgements of relevance also are likely to change reflecting their personal knowledge of the topic and their understanding of the problem (Saracevic, 1975).

In her article, Kuhlthau (1991) describes the information search process (ISP) as an activity where the user finds meaning from information in order to extend the user's knowledge on a particular problem. Kuhlthau's view on information-seeking is similar to Saracevic (1975) in the sense that the process of sense making involves forming a personal viewpoint. A person moves from the "state of information need to the goal state of resolution by a sense of choices." These choices are affected by environmental constraints such as prior experience, interest, knowledge, available information, time and by the relevancy of the content of the information retrieved (Kuhlthau, 1991). An information search, therefore, is a process of construction involving the experience, feeling, thoughts and actions of a person. Hence, what may have been relevant at the beginning of a search may not be so at the end, and vice versa.

Chen and Hernon (1982) in their study on information-seeking activities of four hundred residents of six New England States concluded that information

needs "arise whenever individuals find themselves in a situation requiring ... knowledge to deal with the situation as they see fit" and that "information needs arise in all aspects of everyday life" (cited by Renekar, 1993). Reneker's study, based on the information-seeking activities of thirty-one members of the Stanford University academic community during the 1990-91 academic year, showed similar results. It shows information-seeking to be embedded in the day-to-day tasks and relationships.

In a study conducted by Leckie, Pettigrew and Sylvain (1996), it was found that an information need arises out of situations related to a particular task. Their study on information-seeking by professionals shows that the nature of a particular profession, age, career stage, areas of specialisation and geographical location can influence information need. This would be true in the case of the postgraduate researchers in the present study, as factors, such as profession and areas of specialisation mentioned above, would affect their study. The range of information that the earth science engineers require in their work varies with career stage. Lawyers' information-seeking behaviour, on the other hand, depends on the legal jurisdiction in which they practice. Engineers show that oral communication is as important as reliance on colleagues and internal sources of information. Scholarly journals, books, and conference papers are not as important. With the physicians, nurses and health professionals, informal conversation and journal articles are channels most frequently consulted. Their

study also shows that professionals generally consult a source of information if "they are familiar with it and have had prior success using that source for an earlier problem or similar need". This characteristic is seen in engineers who prefer a source based on authors they know and have used. Lawyers use notes from other cases. The level and degree of complexity and importance will affect the information-seeking activity undertaken.

In her study on biochemists, entomologists and statisticians, Palmer (1991) showed that information behaviour is affected by discipline, and the rate of change in that particular discipline. The length of time the respondent's tenure with the organisation, the research area and the extent to which other subjects impinged upon the central research interest also affected their information behaviour.

To a science researcher, scientific information is dynamic, the blood of science, a prerequisite of any research project. It is necessary to solve problems or to make decisions and to keep abreast with the latest development in the field. New information, obtained through research, stimulates further research. This has led to a growth in scientific information resulting in a multitude of literature. The information gained from published literature forms the base for new and further research. In the academic and research environment, researchers need this stimulus to enable them to form new ideas and concepts. The consistency and regularity of research trends is thus motivated.

2.2.1 Scientific Communication

While the focus of the study is on research trends amongst postgraduate researchers in the University of Malaya, it is inevitable that the literature that is drawn upon would include the scientific and scholarly communication of science researchers. A comparison with the scholarly communication of other researchers in the various other disciplines would give a clearer, more vivid insight into the information-seeking habits of the science scholar.

Scientific communication refers to the "process by which scientists and scholars communicate with one another, create knowledge through their research and disseminate that knowledge by means of scholarly publication" (Hart, 1993).

The scientific communication system, through which information is sought and used, enables scientists to share information. This helps determine scientific priority and intellectual property rights. It confers peer recognition. It also offers "opportunities for enhancing the institution's status, continuing research activities through competitive grants and achieving economic and job security" (Doty, 1992: cited by Senggern, 1995). The peer review of work submitted maintains high standards and establishes a medium of record and dissemination. This medium ensures priority and fast dissemination of research results.

How scientists find and use information have been of great interest to the information scholar. In early studies about scientists and the practice of science,

(Price, 1963; Crawford, 1971) researchers showed that rather than "being remote, impersonal and rigid, scientific research was actually communal, reflecting a strong interpersonal network of interconnected scientists" (cited by Leckie, Pettigrew and Sylvain, 1996). In these networks, there have been both formal and informal exchanges. For researchers to progress or even to get started, on a research project, the review of literature and communication with other researchers are fundamental.

Studies that focus on the information-gathering behaviour of scholars evaluated the channels by which scholars acquired the information used in their work. The channels of communication commonly focused on are the formal and informal (Hart, 1993). The formal channels of communication or organised methods of communication, are the scientific literature and its abstracting-indexing services as well as papers read at formally established meetings. It would also refer to the book and the scholarly journal, be it in the library or in the scholar's office. The informal elements of the system of scientific communication include personal interaction through phone calls, letters, conversations at social meetings and the informal distribution of pre-prints (Crane, 1972). Crane found that in fields of study where research productivity was high, the informal channels of communication were used heavily by scientists. Crane used the term 'invisible college' to describe the situation where intense informal communication characterised a discipline or area of specialisation (cited by Seggern, 1995).

2.2.2 Formal Sources of Communication

It would be interesting to note that the science scholars' habits differ from those of other professions. Studies by Chen (1974), Olaison (1985) and Guest (1987) have shown that scientists (science scholars) rely much more heavily on formal channels - books and periodical literature - than on the informal channels - the informal discussions at professional meetings and contact with colleagues (cited by Hart, 1993).

The studies of information-gathering habits of scholars have established that formal sources of communication are most heavily relied upon (Bebout, Davis and Oehlerts, 1975-76; Stone, 1982). In a study on historians (Stieg, 1981), it was found that when distinguishing between the importance of books and journals, books were the most heavily used format. Periodicals were a close second. This dependence is largely due to the absence of a well-developed invisible college. Historians also rarely consult librarians. This also holds true in a survey conducted on social science researchers in Bath and Illinois. The Bath survey (Evans & Line, 1973) also concluded that researchers use fewer bibliographical tools. They do not make systematic and frequent use of abstracting tools to ensure good coverage, which would indirectly minimise the possibility of missing important relevant material. A study on English humanists at the Illinois social science faculty, also reached a similar conclusion. They prefer bibliographies and footnotes in journals and books to find references (Stieg,

1981). Goi's (1997) study shows a heavier reliance, that is 52%, of documents used by the postgraduate humanities researchers at the University of Malaya were monographs and single authored papers. Hart (1993) in his study, finds that in the humanities, scholars show a preference for books which "continue to be dominant in the number of pages printed and read". In Hart's study (1993) he noted that scientists relied more on journals and less on books and the humanists relied more on books and less on journals. Social scientists fell in between these two groups. It must be noted here that the humanists' reliance on books is 21% as compared to that of journals, which is 8%. The difference is minimal. In Shoham's study (1998) on the use of professional journals by Israeli academic researchers, it was found that scientists used them the most with 94.9%. The percentage use for the social scientists and humanists were 92.4% and 91.9%, respectively. The difference between disciplines is also minimal. Similar results were observed in Margaret Stieg's (1981) findings that historians' preference of books over journals was slight. These findings support Oliasen's study (1985) which was based on the faculty members of eleven campuses of a Norwegian State. Olaisen's findings show that humanists rank books and journals as equally important to their work (cited by Hart, 1993). This comparison is relevant to the present study as it shows that journals are the more preferred source of formal communication compared to monographs. Whether the postgraduate researchers' preference in the present study concurs with the views of studies presented here,

will depend on the study to be carried out, although hypothetically their preference is for journals.

A number of studies have revealed the importance that the scholar places on the professional meetings. Scholars in higher education have indicated that activity in the professional association is of the utmost importance for stimulating involvement in inquiry and as a means of gaining information through other scholars (Hart, 1993).

The article in journals is often reported first as a paper at a professional meeting, where criticisms and comments from participants are welcomed. Social scientists are much more active information seekers at their society meetings than are scientists at theirs; this is due to the lag time that they are required to wait for new research to appear in print, or to the fact that the scientists' information channels seem to be more effective in distributing information prior to the meeting (Garvey, Lin and Nelson, 1971: cited by Hart, 1993).

In another study, Garg and Kumar (1984) found that 69% of scientists scan scientific literature in their search for information as compared to 12 % of scientists who seek information through discussions with colleagues. It also showed that scientists preferred journals compared to other sources of information. This has been substantiated by the studies of Chen (1972), and Flowers (1965). The survey indicated that scientists, on the average, spend about 7 hours per week gathering information and mostly by scanning or reading current

literature. Research professionals spend 20%-80% of their work hours "seeking and manipulating information" (Leckie, Pettigrew and Sylvain, 1996). The suggestion is that there exists a relationship between the number of journals read and the area of specialisation of a scientist. Chemists and mathematicians scan more periodicals than do physicists. The study also proved that no relationship exists between the number of journals read with the qualification and rank of a scientist. Generally, scientists scan secondary periodicals, such as the abstracting and indexing periodicals, to keep themselves up-to-date with current information and to look for specific information. These scientists use their own libraries to gather information. Other libraries are visited occasionally.

In her study, Chen (1972) noted that physicists generally scanned 1-6 journals with an average of three titles and only 4 scientists scanned more than 9 journal titles per week. These figures are lower then those reported by Tornudd (1953) and Bernal (1948) (cited by Chen, 1972). In these studies, academic scientists read seven to ten journals a week. The reasons for the difference according to the study by Chen were: (1) the change in structure of the scientific literature in the last decade; (2) the proliferation and increase in the use of letter journals; (3) the availability of publications such as *Current Contents* and other, SDI services where current publications are made known and; (4) the trend towards specialisation among scientists. The study also found that letter journals were among the more popular journals scanned because of the "brevity and up-to-

dateness". Physicists also scan, apart from the few general physics journals, highly specialised journal titles, the selection depending on the areas of research. The study also noted that the difference in the number of physicists who subscribed to journals as compared to the earlier studies by Tornudd and Bernal. The differences may be due to " the rising costs of subscriptions, ready availability in institutional subscriptions, easy accessibility of needed journal titles in the department's reading rooms".

In another study on physicists, Bayer and Kilgour (1996) reveals that physicists use specialised online indexes, distribution networks of preprints, recently published issues of journals and informal contacts with colleagues as the first sources of information.

On the use of the library, the study by Chen (1972), found, that the library was used primarily to locate specific information and for browsing. It also noted that physicists do not seek librarians' assistance, as their help do not have much impact in locating the required information.

In a study by Liu (1992) based on the utility level of information sources, it was found that 79.8% of the respondents located information sources from the institutional library where they were doing their research. A correlation analysis shows a significant relationship between the use of the institutional library and the author's citation output. This indicates that the institutional library has an effect on the number of references a physicist cites in his research paper. This finding

would definitely be in line with the present study, for as postgraduate researchers, a personal collection of journals would be beyond their financial scope and many of them would definitely have to depend on the institutional libraries. Moreover as young researchers, they would not have made enough contact to have a social network for informal communication of research findings.

Although the scientists prefer informal communication with their colleagues, formal publications continue to be considered their primary source of information. Hart (1993) also reported similar findings.

The science and humanities researchers' information needs vary. In the science disciplines, most research are in precisely defined areas, so information needs are highly focused. As such, general browsing is less appropriate than in the humanities. The humanities researcher relies heavily on browsing particularly among older monograph literature. As science research concentrates closely on prior work, scientists need to have continuous access to concurrent research literature, that is, journal literature research reports rather than books and monographs. Social science researchers share similar characteristics with scientists except that they rely almost equally on serial literature and monograph. The humanities researcher is not dependent on the latest publications in his field nor does he rely heavily on electronically sophisticated information services. Like the theologian researcher the humanities researcher in uninterested in sophisticated library services (Gorman, 1990). Hart (1993) and Garfield (1972)

had similar findings.

It can therefore be said that in science, information is recorded in well-established journals. Monographs and reports are of minor significance (Line, 1973; Hurych, 1986). Aims (1965) found that abstracts and original papers in the sciences are important sources for specific information, and current information is best obtained from conferences. Line (1973) showed that abstracting and indexing journals and personal contact were the best ways to stay abreast with current information and research.

The present study, based on the above review, hopes to prove the hypothesis that journals are indeed the main source of information postgraduate students in the sciences used in writing their postgraduate research paper.

2.2.3 Informal Sources Of Communication

Surveys on groups of scientists (Chen, 1974) and social scientists (Line, 1971) indicate that informal communication ranks behind the formal channel in importance. Informal sharing of research results, namely, the verbal and written communication and discussions at seminars and professional meetings, constitutes the informal channel of communication. The informal communication allows researchers to "dispense as well as absorb new information, connect with experts in their field and float ideas and hypotheses" (Seggern, 1995).

In an earlier study, Menzel (1964) noted that informal channels of

communication played an important role in the "communication experience of scientists". The exchange of information takes place through "correspondence, visits, seminars, workshops, corridor conversations, professional meetings and conferences and via electronic mail". Menzel regards this "accidental" means of communication as a "reliable mechanism" that brings to the scientist's attention "information whose significance for his work he had not anticipated". In another study, Garvey and Griffith (1972) define informal channels of communication as "information that is for a restricted audience and whose storage is relatively temporary" (cited by Shoham, 1998).

Informal channels allow researchers to "obtain information easily, to direct a communication and select for himself the specific information he needs" (Britain, 1970). Scientists would also be able to express an opinion, a point of view, a possible doubt through such channels (cited by Frost).

In a study by Garvey, Lin and Nelson (1970), it was found that authors distributed their reprinted papers to colleagues. The dissemination of information in this form appears to be more effective in the physical science rather than the social science (cited by Shoham, 1998).

In a review article, Adam (1971) summarises that social scientists' information use is better served by the informal means of communication than the formal. Humanities scholars' research is likely to be characterised by an individual approach (Stone, 1982). Collaboration among humanities researches is

therefore not prominent as in the sciences.

Based on a 1989 survey of Adelaide theologians, Gorman found that as information seekers and library users, theologians rely to a significant degree on informal network of colleagues for information. They prefer to seek information independently of librarians and their main method of seeking information is by browsing in libraries and scanning in journals. Philosophers prefer informal contact with other researchers, scanning journals and noting current library accessions as ways of keeping up-to-date (Gorman, 1990).

De Solla Price (1963) voiced the existence of the 'invisible college' where current means of communication is used in contact with and between colleagues (cited by Seggern, 1995). The invisible college as used by De Solla Price in the 1960s is applicable to the 1990s. Cronin (1982) and Hurych (1986) both believe that there is a strong preference for informal systems of communication by scientists and social scientists. The humanists as shown by Stone (1982) prefer to work alone. In her study on Israeli academic researchers, Shoham (1998) found that the informal means of communication played a more prominent role. Her study showed that 51.9% consulted colleagues in the department, 50.1% consulted colleagues outside the department, and 55.3% got their information from conferences. This is evident in other faculties, namely, the social sciences and the humanities, although stronger amongst the scientists and engineers. The study shows that informal channels of communication are important both with

colleagues within and outside the department. Informal meetings at conferences and lectures play an 'essential role'. Her study also shows that, in spite of the technological innovations, the method of obtaining information is very 'conservative' and has not undergone transformations. With regard to the use of databases, the social scientists use them the most.

Studies on formal and informal information retrieval channels among scientists indicate that the latter is more predominant. Studies on the 'invisible college' by Paisley (1965), Crane (1972), Cronin (1982) and Chubin (1983) show that it is a reality, for it provides a mechanism for scientists in specialised areas of research to continue routine communication. Informal information retrieval is obtained through personal contacts at conferences and symposium and the exchange of conference papers, technical reports, reprints that precede the appearance of the research results in a refereed journal (cited by Stoan, 1991).

Informal channels, as the study by Garvey, Lin and Nelson (1970) show, satisfy the practical needs of scientists as they allow for works to be made available before publication. They also allow scientists to make adjustments to their research based on feedback, from others (cited by Stoan, 1991).

In a recent study, Hallmark (1994) found that scientists in all disciplines except chemistry and physics, depended most heavily on informal sources. They felt that it was important to know personally the important contributors to the field to stay current with their work. The study also shows that browsing in the

library and personal journal issues are also important and this is especially so amongst the geologists and biologists.

Informal channels of communication are present in the social sciences but they are not as well structured as in the sciences. In the humanities, although there is little collaboration, they do consult with others a great deal.

The introduction of the electronic mail and discussion group have led to greater informal communication and networking. Studies by Stoller (1992), Lubans (1987) and King (1977) show that the state of informal communication amongst scientists and scholars is growing. However, studies by earlier researchers like Rowland (1982), Bayer and Jahoda (1981) and Knightly (1979), all show that the electronic media has no significant impact on the use of traditional information retrieval strategies. Horner and Thirlwall (1988) studied the use of online retrieval systems and showed that it is of limited use to the humanist scholars as they rely heavily on old books.

The number of academics using the Internet to date, is relatively small (Lazinger, Barllan and Peritz, 1997). In their study, Bane and Milheim (1995) found that many academics were not aware of the resources available (cited by Lazinger, Barllan and Peritz, 1997). This finding complements an earlier study by Adams and Bonk (1995). The study concludes that the obstacle to the use of electronic information resources by faculty is the lack of knowledge about what is available. In their study on Internet use by faculty members in the various

disciplines, Lazinger, BarIlan and Peritz (1997) concluded that although computer and Internet use was apparent, it was used more in the sciences. All Internet users were also E-mail users and they used it primarily for research. The study by Abels, Liebscher and Denman (1996), shows similar findings. In the study by Bukhari and Meadows (1992) and Shanbari and Meadows (1995), it was found that computer capabilities in the United Kingdom have become more sophisticated over the past few years resulting in more opportunities for their application in research. Electronic data exchange amongst scientists has increased and so has the growth of electronic mail and online search databases. In Saudi Arabia, scientists have already made substantial use of the computer. Universities in Saudi Arabia however, are still in the early stages of implementing networks although the study has shown an increase in the use of CD-ROMS and e-mail. Zainab and Meadows (1999) found that there is a correlation between publication productivity and the frequency of computer use of academic scientists in Malaysia.

Youngen (1998) in his study shows that the electronically available preprints in physics and astronomy, have increased in recent years. Internet accessible preprint servers provide unrestricted access to citations and full text of many physics and astronomy papers before they appear in print. Physicists and astronomers cite preprints in their research articles. The results of his study indicate that electronic preprints are becoming an increasingly important tool in

the dissemination of primary research information.

Meadows (1983) in his review, mentioned that most scholars would benefit from formal communication as it is a "permanent, easily accessible form" and it enables "dissemination internationally". Although many scholars and librarians alike would agree to the above, the rising costs of journals makes such a practice difficult to continue. Many hope to see a migration of scholarly reporting from the print form to the electronic media.

Future generations of the Internet and the World Wide Web will not be able to ignore the web as a centre for resources. In spite of obstacles like legitimacy, ephemerality, integrity and the problem of version control where documents available on the Web change regularly without corresponding references, the scholars of tomorrow would indeed find the web an indispensable source of information. Laying the groundwork for a smooth transition from traditional paper-based format to the complete electronic storage and retrieval of scientific reporting will help everyone cope with the changes that are inevitable.

Based on the above studies, the present study will examine 'acknowledgements' found in the theses to see if the postgraduate researchers at the University of Malaya between 1970 and 1995 were more dependent on their lecturers and supervisors for their informal source of information. An in-depth study on the extent of informal communication carried out by this sample of postgraduate researchers from the University of Malaya would merit its own

attention and hence would be beyond the scope of this paper. The emphasis of the present study for this section, would be to examine the trend in information seeking based on formal sources such as journals/monographs and computers. Through the 'acknowledgements' printed in the theses the study hopes to obtain a general view of the informal sources. The study also hopes to determine if the information seeking habits of this sample of researchers relates with the habits of earlier researchers.

2.3 Studies on citations - an overview

A citation is an acknowledgement given by one researcher to another. Garfield describes it as the "formal, explicit linkages between papers that have particular points in common" (Garfield, 1979). Martyn (1975) pointed out that citations are "... the record of a number events which have the same external appearance but which are members of different families..." The study by Price (1965) discussed the cumulation of papers where previous papers form the foundation on which each new paper in built on. These, in turn, become one of several points of departure for the next. Soper (1976) regards citations as "signposts left behind after information has been utilised. Their presence indicates that the works to which the citation refer were judged to be important enough to record."

Most researchers would agree that citation is an essential part of a

research paper and is particularly so in the sciences. The role of citation, has been studied extensively, by scientists and information professionals and the general consensus from their studies is that the citation process is a central aspect of the use of information by scientists in their communication.

It is the norm that scholarly work requires authors to cite documents they have used or found useful in their own work. Most researchers and authors cite in order to: (1) connect the present work to previous work relevant to their study; (2) give credit and to acknowledge ideas used; and (3) provide evidence and clarification to support the material used (Tagliacozzo, 1977).

Merton's (1973) work on the structure of science confirms the cumulative nature of science. A scientist makes his contribution by publishing his findings and ideas and in so doing lay claim to it. The cumulative nature of science and the acknowledgement of contribution through citations have become a key practice in science. His study also infers that the frequency of citation could be a measure of relative importance on quality (cited by Liu, 1990). Swanson (1977) in his study, observed that the "relevance bridge" constructed between the citing and cited documents is not always "topic or subject oriented".

King (1987) in her review, notes that citation analysis acts as an intellectual link between citing sources and reference articles. Citing is subjective and is governed by a combination of the normative (i.e. adhering to a set of universal norms) and particularistic (inconsistent, personal considerations).

Citation practices vary between fields and over time. Biochemistry papers contain about 30 references whereas mathematics papers usually have less than 10. Citing depends on the field of study. A relatively isolated study will have fewer citations than a general field. The decay rate of citation frequency will also vary with each field. A less cited document will become obsolete faster than a highly cited one.

Bertram (1972) suggests that the amount of information cited varies with the section of scientific paper in which the citation is made. Bertram's findings show that the introductory section of the paper is likely to refer to the "whole of the cited articles", in the experimental section, the citations are likely to refer to the "small bits of material, words from cited articles" and in the results and discussion sections, citations tend to cite sentences or paragraphs of the cited articles (cited by Martyn, 1975).

Weinstock (1971) explains that "scientific tradition requires that when a reputable scientist or technologist publishes an article, he should refer to earlier articles which relate to his theme" (cited by Frost, 1979). Frost (1979) in her study, discusses the use of citations in literary research. Citations provide a means for the "interested reader to test the conclusions of the writer and to verify the source of a challengeable statement". However, the acknowledgement of previous research and the expression of intellectual indebtedness are still the major reasons for citing. Other reasons are "personal allegiances" and organisational ambitions, which may lead the researcher to cite works of colleagues or superiors.

Myers (1970) in his study found that citation frequency was a strong indication of the scientist's esteem (cited by Liu, 1990). Cole and Cole (1971) (cited by Liu, 1990), concluded that the research that scientists cite in their own papers represents roughly valid indication of influence of their work. Narin (1976) in his study of the use of publication and citation analysis in the evaluation of scientific activities, showed that citation counts correlate well with various rankings of eminence (cited by Liu, 1990). Garfield (1979) summarises that "since authors refer to previous material to support, illustrate, or elaborate on a particular point the act of citing is an expression of the importance of the material."

A survey undertaken by McAllister, Anderson and Narin (1979) to ascertain the extent of agreement between scientists' subjective assessment of the average influence per article in different scientific journal compared with corresponding citation ratings influence for articles in the same journals. It is found that a strong positive relationship exists. These findings provide evidence for the validity of citation-based measures.

Martyn (1975) surveyed the use of citation analysis. He contends that most difficulties with regards to this type of study are with regard to the word 'use'. "Use is often taken to mean 'readership' or 'borrowing frequency' and there is no clear evidence that citation frequency correlates highly with either of these".

Scales (1976), in a similar study, examined the validity of citations as

indicators of actual use. Although citation analysis has often been used to rank journals from a given literature according to the number of citations received, it has often been implied that the list forms a valid guide for library selection. Based on Scales' study, there is an indication that there is only a small degree of correlation between citation ranking and actual use, suggesting that citation ranking are not reliable guides. Journals in high use (those scanned to keep abreast of current knowledge) are unlikely to be those frequently cited and journals that are highly ranked may be due partly to self-citation.

Smith (1981), in her paper, enumerates the assumptions and limitations of citation analysis. Her studies indicate that some documents are "underrated because not all items cited are used" because citation does not necessarily reflect usage. Citation analysis is used to evaluate citation counts, which have high face validity. However, Thorne (1977) argues that citation counts have "spurious" validity because "documents can be cited for reasons irrelevant to their merit" (cited by Smith, 1981). Until more is understood about the reasons for citing, citation counts can best be viewed as a rough indicator.

Studies have shown that 'accessibility' is as important as 'quality' in the selection of information source. Soper (1976), in her study, confirms this. She found that the largest proportion of documents cited in the authors' recent papers, were located in personal collections followed by those in libraries in departments and institutions. Also, an author is likely to be most aware of the work of his

colleagues. Just as in the case of research articles, those researchers who are cited are not exactly representative of the best or the most outstanding in a particular field. In short, anything that enhances the researchers' visibility is likely to increase his citation rate irrespective of the intrinsic quality of his work (Smith, 1981).

MacRoberts and MacRoberts (1989), in their review on problems of citation analysis, mentioned that the normative theory maintains that authors cite so as to give credit when the work of another is cited. This reason to cite is in accordance with the norms of science which require authors to cite documents they have found useful in their own research. However, in their study, they found that only 30% references were cited. In the sample studied, the most thorough scholar cited only 64% of his references. They found no correlation between the frequency of use and the frequency of citation. Another problem is the frequency of self-citations. Approximately 10%-30% of all citations is self-citations.

Tagliacozzo (1977), in her study of self-citations, indicates the similarity of subject matter between the citing and cited article. Her study shows that self-citations occupy a prominent position when compared to other citations. Authors tend to stress in their writings the contributions between their present work and their previous work. In many cases, self-citation will be determined by the fact that the cited paper is an antecedent of the citing paper. Since the citing work is often the offspring of a cited work, the two are very close in time. Areas in which

self-citation rates are high would have a larger proportion of recent citations than areas in which the self-citation rates are lower.

Oppenheim and Renn (1978) studied the reasons why old papers are still highly cited. It is universally acknowledged that recent papers are cited more than older ones - a decline of citation with age. This is because: (1) the growth of science resulting in more recent literature available; (2) older papers get superseded by the more recent ones; (3) the authors have become so well known that it is considered unnecessary to cite the original sources or; (4) a subject field may have recently come of interest. The study also notes that about 40% of the citations are based on the old papers. The reasons for the citations are purely historical and that therefore "the main reason why these old articles are still highly cited is that they are relevant and valuable even to this day".

Studies have been carried out to investigate the validity of the Science Citation Index (SCI) as a data source for indicators of the international science activity. The conclusion arrived at by one such study by Carpenter and Narin (1979) is that the SCI is representative of science publishing activity for most countries and most fields. The coverage of scientific journals of major fields in the US and UK is excellent but are generally fair for West Germany and French journals. It is, however, deficient in its coverage of the Russian journals. With regards to coverage by fields, large and important journals such as physics and chemistry are well represented and vice versa for small journals. Although the

SCI is not completely balanced and representative of all of the world's science, it shows considerable bias and favour periodicals published in the US and other English language periodicals as against periodicals with non-Roman alphabets (Liu,1993; Zhang & Zhang,1996).

Rochester (1996) in her study on professional communication through journals noted that citation analysis does not differentiate between affirmative or negative citations, hence, the quality of the material cited cannot be accounted for. Nevertheless, it is widely used, as data is easily collected and it also allows for comparisons over time.

Kochen (1987) reports that the acknowledgement of an intellectual debt is not the only function of a paper's bibliography. It gives the author's actual source of ideas "which may not be the true origin of the idea." Indirectly, it directs the reader to "further information." To him, a paper that conforms to the norms of scholarly perfection should "cite every past publication to which it owes an intellectual debt." The reason is that it becomes a part of the archival record and as such is regarded as an "authoritative source for further bibliographic work." Further "recognition of priority" through citation is a "powerful incentive" for those engaged in research. This view is also shared by Arunachalam and Singh (1984). As noted by Garfield (1972), the citation frequency of a journal "reflects the value" of that journal and the scientist.

These reasons function as tools for librarians concerned with the cost

effectiveness of their journal and in library collection building. They also act as tools to analyse journal citation counts of research activities for scientists doing research on one aspect or another.

2.3.1 Obsolescence

Science writings age. Documents, issues or volumes of scientific journals become less valued and are used less often with the passage of time. Long periods of time eventually render certain sections of literature obsolete and ageing becomes evident (Griffith et al., 1979).

Knowledge is commonly recorded in documents. A decline in document use can occur even though the information recorded is "still valid and potentially useful" (Line & Sandison, 1974). A document less used could be due to less accessibility. Changes in 'use', therefore, do not necessarily correspond with changes in validity.

Line and Sandison (1974) in their review indicate that obsolescence of information could concern either the documents as a whole or with the information they contain that represents knowledge. When documents are considered, it would be of practical use to librarians as it would concern weeding and storage. Absolescence of knowledge, on the other hand, would mean the "decline over time in validity and utility of information".

Most studies on patterns of document use show heavy use of the most

recent literature and a lower use of items more than two or three years old. Readers keep up-to-date with recent/current literature by directly scanning recent accessions to a library or through current awareness services. Others read materials of all dates through references, bibliographical tools or computer searches in a general search of literature for a different aspect to their work. The pattern of use over time would therefore be different.

Fussler and Simon (1961) found that "past use was the best indicator of future use and that the decline with time differed substantially between subjects". The impression given by reference density studies is that there are some evidences for lower citations of older items. Fussler and Simon also cite the 'replacement theory' that previously published books decrease in use because new books have come in implicating that old books would still be in use if no new books had come in. Hence, obsolescence is in a certain situation and not in content (cited by Line & Sandison, 1974).

In their review, Line and Sandison cite Garfield's views that scientists read some journals to keep up-to-date with findings in general and as such rarely cite such journals in their published work. Such being the case, then, it does not necessarily mean that journals that are ranked relatively low are less important or less used than those that are frequently cited. Neither does it mean that their use decays more rapidly.

The fall-off in use with earlier publication is likely because the non -cited

items are usually older ones. They contain no relevant information not already repeated in later items such as review articles, which provide sufficient access to them. It is also quite probable that literature that grows rapidly ages faster because in a field where much research is done. Older work tend to be "superseded or incorporated more quickly" and an average item can have a short life. Scientists in a fast growing research field may also not have the time to plough through the mass of literature and therefore confine their sources to current material. It can be summarised that Line and Sandison, through their various studies, quite strongly oppose the view that obsolescence of an article is primarily due to age and therefore used less.

Chen (1972) studied 220 physics journals at the MIT science library over a three-and-a-half month period. Her findings show that the frequency-of-use shows a gradual decline for older volumes. Chen adopts the conventional approach that raw frequency of use is a measure of heaviness of use, capable of distinguishing the core journal and those less in demand that are suitable for weeding. Her study also showed that foreign language journals were little used. This was confirmed by Sandison (1974).

Sandison (1974) reanalysed Chen's data by converting it to density-of-use by shelf-space occupied by the journal volume. Sandison found that there was an increase in density of use with age. Few journals, like the letter journals, decreased density of use with age. For all physics journals taken as a whole,

density of use is constant, and therefore, show no obsolescence.

Cawkell (1976) points out that a subject will consist of "enduring" literature of earlier years and the recent literature, some of which will endure and some will "die". There will be more citations from literature that is recent and growing because there are more of it.

Griffith et al. (1979) indicates that there are a variety of ways in which the value of scientific literature can be assessed to determine if its value is changing with time. Journals age at different rates. A journal, if used intensively by a specialised audience, would age faster. A journal with a diversified audience results in diffused use, and thus, ages slowly. A journal that ages quickly receives most citations in the first few years after publication. However, a journal volume that ages slowly, is cited evenly each year after publication. The articles in a published journal volume age as they are cited. The citing literature makes them old by exhausting portions of their total usefulness as cited documents. Ageing depends on the content and its user. A journal ages differently by different user communities. In his study, Griffith et al., (1979) shows that citation data conforms with Brookes' model (1970) which "proposes a systematic exponential ageing process for the corpus of library periodical holdings".

Wallace (1986) regards obsolescence as the tendency for publications to be used with the greatest frequency shortly after publication. This frequency decreases rapidly as the publication ages. Brookes (1970) stated that scatter (or

journal productivity) and obsolescence are related but they are determined by the growth rate. If the growth rate is fast, then the scatter will be less. And obsolescence will be more rapid. This is in agreement with Buckland's study (1972) which suggested that literature that are highly obsolescent tend not to be widely scattered.

Wallace's study also examined the relationship between journal productivity and journal obsolescence for a database of references from articles dealing with desalination. The findings show that there is a systematic relationship between journal productivity and journal obsolescence. This relationship is a negative one, for journals that contribute the most articles tend to contribute articles that, on the average, have short active lives, and vice versa, those that produce articles that have the longest active lives are among the least productive.

Bottle and Gong (1987) indicate that the factors responsible for the ageing of literature are the growth and nature of the literature. They also cite that the many different ways in which a reader utilises the literature may also be a relevant reason. The increase in the number of scientists who generate and use information may also have an effect on the ageing process.

Price, (1965) in an extensive study, found that literature usage as a function of age was heavily dependent upon the disciplines. He cites two types of literature, namely the ephemeral and classical. According to Price, every well-

defined subject area can be classified within those two extreme (cited by Bottle and Gong, 1987).

The study by Bottle and Gong (1987) on biochemical periodical literature has been examined according to their content typologies (describes the major types of use to which information contained in the paper may be put by the researcher). The citation frequency of the sample during 1972-1982 showed negative exponential growth. Based on the results, the discipline is regarded as ephemeral and competitive subject area.

Stinson and Lancaster (1986), in their study, referred to 'obsolescence' as the phenomenon of replacement. There is evidence of obsolescence of publications when the use of the publications, decline with age. This decline may be ascertained through library use studies or citation analysis. In their study of the literature of human and medical genetics, the data collected suggest that the synchronous method give an accurate measure of decline in use with age.

Sandison (1975) in his review maintains that citation density does not necessarily fall with increasing age.

Gupta (1990) conducted a synchronous citation study of 15 leading physics journals to determine the obsolescence of Physical Review articles with age. The results conclusively show an exponential decrease of citation density with age. The results of Gupta's study contradict Sandison's 1974 study. In Gupta's study, the citation densities have been calculated by using the actual

number of articles published as against Sandison's who used shelf-length occupied by journal volumes. Sandison's use of shelf-length can lead to erroneous results as recent journals in general occupy larger shelf-space. As cited by Gupta the increase in average length of a Physical Review article has increased from 7.1 pages in 1963 to 8.3 in 1982 (American Institute of Physics Annual Report 1986). Line performed a diachronous study on all articles published in volume 117 (1950) of the Physics Review from 1961-1972 using data from SCI. The results show that the number of citations to the heavily cited articles increases with time followed by a gradual decline in time. Other groups of articles show a decline. This is probably due to the growth of the source articles with time. This result is consistent with Gupta's study (cited by Gupta, 1990).

An exploratory study was conducted by Glanzel and Schoepflin (1995) on the time behaviour of citations to articles of seven journals representing different scientific fields. It was found that obsolescence of the social science journals in the set is slower than for the medical and chemistry journals. The behaviour of the mathematical journal is similar to the ones in the social sciences. The study suggests that ageing seems to be specific to the field rather than to the individual journal.

Rosseau (1988) in his study stressed that, in the case of pure mathematics journals, the ageing behaviour is slow. The increase in citations in the first two years after the date of publication is small compared to the natural and life science

journals (cited by Glanzel and Schoepflin, 1995).

Vimala and Reddy (1997) examine the obsolescence of literature in zoology by citation analysis. Citations were taken from 128 doctoral theses from 1962-1994. The data show a declining trend in the frequency of citations as the cited literature ages resulting in a negative exponential pattern.

The present study will examine the currency/recency of citations used by the sample of postgraduate science researchers in their theses. The study will be based more in terms of obsolescence of volumes from which the articles are taken. As this is a descriptive study, citations will be placed in two groups: (1)less than 10 years; (2) more than 10 years. It hopes to determine if there are any similarities or differences in the samples and whether they conform to the findings found in the studies mentioned in the review.

2.3.2 Language

The role played by journal literature in science and technology is of prime importance in the advancement of science. Ideally, science should belong to all. Everyone who needs information in science and technology for whatever purpose should be able to procure and use them (Holmstrom, 1962). However, the major barrier to this availability of written and spoken information is the 'foreign' language.

This foreign language barrier occurs when "communication is broken due

to the existence of a language that is unintelligible to all people involved in that process" (Riley, 1992). Where research is concerned, this is detrimental for it renders useless studies published in the foreign language. As English is regarded as the lingua franca in scientific and technical research, all other languages, for the purpose of this study, will be regarded as a foreign language.

Whether a researcher makes the effort to read a paper in a foreign language would depend not only on the competence of the researcher in that language but also on how highly the researcher regards the research done by the author.

Generally, research in non-English speaking countries is ranked less highly than those done in the US and the UK. While this assessment may reflect a true picture, it is possible that it has been influenced by the attitude of researchers who keep abreast with current research in general, which is mainly in English.

There were many studies conducted on the use of foreign language in research. One of the earlier few, was that conducted by Holmstrom in 1962. Holmstrom has indicated that English readers "are losing the potential benefit of the world's literature". This is so because it is evident that English has and still continues to be used widely, but literature in the foreign languages like Japanese and Chinese are making their mark in scientific communication. Until and unless scientists make an attempt to either learn or be current about tools for retrieving abstracts and translations in English, they will be at the losing end as they would

lose the benefit of half the world's literature.

Wood in as early as 1966 predicted that a greater proportion of the world's scientific and technical information, which is now published in foreign languages, will, continue to increase. The depth of this problem of inability to read and understand a foreign language will depend on the linguistic abilities of scientists, the scientific importance of the material and the ease with which translations can be located and made available. In a survey carried out to establish the extent to which scientists and technologists in the UK are deprived of essential knowledge due to the language barrier, it was found that mathematicians had difficulty with Russian literature, engineers with German material and chemists with both Russian and Japanese papers. The scientists could cope with French literature. Few scientists could deal adequately with Russian, Japanese and Chinese literature.

Hutchins, Pargeter and Saunders (1971), in their study on the use of journals in the library, found that nearly 58% read articles in English, 22.1% in French, 12.5% in German and 1.3% in Russian. According to faculties, the Social Science faculty read the most English materials (92.8%), and the Arts faculty read most in French and German (39.2%), and the Pure Science faculty read in German (16.6%). According to the sample surveyed, most (59.6%) considered that all important researches were either published in English or appeared very shortly in English. The study also indicates that the under-utilisation of foreign

language material can be detrimental to research.

Chen (1992) in her study showed that English journals supplied 95.3% of total literature used, German 3.7% and Russian and French titles totalled 1%. She noted that English-speaking countries like the USA, UK, Canada and Australia supplied 78.8 % of total use, 11.9% from non English speaking countries which are published partially or completely in English. Her study also indicates that English journals, which are frequently cited, are also heavily used. However, the foreign journals may be heavily cited but may not be heavily used. This is because these are foreign language journals of which few have cover-to-cover translations. Users who would rather read English journals and find relevant information from these sources, would therefore, hesitate to read journals in foreign languages.

Michel (1982) who analysed the growth of publications in English of scientific and technological materials for the past ten years, shows that English is most used for primary publications in the basic disciplines like Physics, Chemistry and Biology. In the applied sciences such as the earth science, medicine and engineering, to name a few, "authors use much more of their mother tongue".

Japanese science journals have grown resulting in a loss of information for the science community. Michel's study shows that the main losers are the English-speaking people of whom 12% can read French documents and 4% can read

German. In contrast, 97% of French and German scientists can read English. However, in oral communication the language barrier becomes a stumbling block at meetings and seminars. Speakers/ scientists who are not proficient in English do not understand most of what is being said and are therefore not able to participate effectively in discussions. His study further shows that the most cited country is the US followed by UK, West Germany, Japan, France and the former USSR.

Mitra's study in 1972 is based on the use pattern of literature among Indian scientists. The analysis is based on an analysis of citations appended to original articles published by these scientists in 26 Indian periodicals in the year 1966. These are based on language, time and use of foreign language versus domestic language. The comparative use of the three types of literature namely English language, foreign language and Indian literature reveals that English dominates the total literature intake of Indian scientists that is 69.6%, 20.7% Indian literature and 9.7% foreign language literature. Although the dependency of Indian scientists in different subjects is English, the dependence varies from subject to subject. Biochemists make most use of the English language literature with 80% of total citations recorded in the subject, geologists and geophysicists and botanists, 49%, and even less for chemistry, zoology and mathematics. The low count is probably due to the domestic nature of the problem, hence, the reason for the larger use of Indian literature in these areas. The foreign language is little

used. Arunachalan and Singh (1984) in their study found that English to be the lingua franca of superconductivity research.

Chan (1977) in his study shows that researchers do not know or are unaware of the facilities, which already exists. Abstracts in English and full translations are means of overcoming the language barrier. Neglect of foreign language materials by English speaking scientists may sometimes be one aspect of a more general problem involving poor current awareness and failure to use available bibliographical tools. Published English language abstracts may be sufficient to overcome the language barrier.

Arunachalam and Markanday (1981) emphasise that local and national publications have a tendency to "parochialism". Poor access to international publications has resulted in failure to cite relevant literature, duplication and work falling outside the mainstream research. The consequences of these as Moravesik (1975) pointed out is "a preparedness to settle for second best, a retreat into a research backwater or the abandonment of research altogether" (cited by Inman, 1983).

Inman (1983) studied the experiences of scientists working in developing countries. The sample of the survey is from Leicester University. The aim is to gather information on language difficulties experienced by users of scientific literature in English who are not native speakers of the language. The results of the survey emphasise the importance placed on the English language. Few

claimed that they were "usually not" or "never" successful in getting foreign publication and attempts to obtain them is either often long drawn or that there is no guarantee of successfully obtaining the book. Low expectation of success in getting the publication, and a lack of an awareness of what is available were identified by Line (1979) (cited by Inman, 1983) as problems that have resulted from poor library services. Gordon (1979) has shown that among the common reasons for criticism or rejection of papers submitted by scientists from less developed countries are "failure to refer to relevant literature, duplication of research already carried out elsewhere and work falling outside the mainstream of current research interests" (cited by Inman, 1983), an indication of inadequate access to current information. The conclusion arrived at from this study indicates an urgent need to ensure the supply of current publications to less developed countries, if effort and talent are not to be wasted.

Thorp et al. (1987), in his survey, indicates that the number of languages in which scientific research are published is increasing. The study was to survey the awareness of and attitudes to foreign language materials and the means of dealing with them. They found that the foreign language material is underused and that there is a "prevailing lack of enthusiasm for and appreciation of the value of this material." The languages that appear to have created some concern are German, Russian and Japanese. Japanese and Chinese are now perceived as major problems. In a survey of the attitude amongst a group of research workers in the

UK pharmaceutical industry toward the use of non-English material, it was concluded that there was a language barrier. This barrier resulted in the under-use of materials and an overall lack of appreciation of the value of information lost as a result.

The aim of the study by Riley (1992) was to determine the extent to which information transfer within the research community at the University of Tasmania is affected by the foreign language barrier. It was found that 39.9% of the research community felt that they were missing out on valuable information in their subject area because of the language barrier and 63% considered that they had access to all the necessary information.

Khorevin (1995), in his study, analysed the presence of information elements in the publications of Ukranian journals. The name in English is absent in most technical and agrarian journals. Practically, none of these journals have abstracts in English and few use references, indicating that agrarian and technical journals are most oriented to readers in their own industry. The conclusion drawn is that the journals of Ukraine, which are an important vehicle of scientific communication within its science community is insignificant for communication with the world community of scientists. Articles in Ukrainian journals do not make sufficient use of the world literature.

Zhang and Zhang (1996) in their study, show that the number of papers published in foreign periodicals is higher than those in domestic journals.

Although the paper output in foreign periodicals is increasing and that of the domestic journal is decreasing, the overall mean citation rate for Chinese papers is not above 0.65 for any discipline in 1993. This lack of citation is attributed to the language barrier. Papers in languages other than English are less frequently cited (Narin and Frame, 1989; Liu,1993).

The present study will examine to see if articles in English are the most used in all disciplines, in the sample studied. It must be remembered that in Malaysia the national language is Bahasa Melayu which was implemented in the early 1970s, the period during which this study begins. The study hopes to examine: (1) if the titles cited in the bibliography are English or foreign language titles; and (2) if the theses written by the sample of postgraduate are in English.