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**IMPACT OF INFORMATION ON RESEARCH AND DEVELOPMENT  
ACTIVITIES OF NUCLEAR SCIENTISTS IN GHANA**

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**Abstract.** This paper considers the relationship between nuclear information use and the professional development of nuclear scientists in Ghana with reference to some identified productivity and achievement indicators. The assumption is that, frequent use of library and information services results in higher productivity and achievement. A national survey of nuclear scientists was conducted resulting in a response rate of 92 percent. The analytical framework proposed by the International Development Research Centre (IDRC) for impact studies served as an appropriate guide for the study. The results indicate that information use leads to increase in the volume and quality of work output of nuclear scientists. Evidence is also found to support the claim that information use enhances contributions of scientists to their organisations. The study concludes with recommendations aimed at improving information delivery to nuclear scientists.

### 1. Introduction

It is generally accepted that scientific and technological information play a vital role in the socio-economic development of all nations, especially those of the third world. Extensive work has been done on the impact of information in different parts of the world and most of the studies have shown a positive correlation between information use and the professional development of scientists and other professionals. However, most of these studies were undertaken in the corporate [1,2], energy [3,4] and health [5,6,7,8,9,10] sectors of industrialized countries, mainly in the United States of America and the United Kingdom.

In the field of nuclear science and technology, there is a dearth of literature on the impact of nuclear information on research and development. Past work on nuclear information use have generally focused on the establishment, development and the operation of the International Nuclear Information System (INIS) in various countries [11, 12,13,14,15,16,17]. However, the few empirical studies undertaken have been limited to information use by nuclear scientists as well as user satisfaction with INIS output products and services [18,19,20]. The only previous impact study in the nuclear sector is that of Amoral [21] who evaluated the impact of document delivery and selective dissemination services derived from the INIS Database in Brazil. Therefore, it will be worthwhile investigating the impact of information on the research and development activities of nuclear scientists from an African perspective.

The objectives of this study are, first, to explore the use of library and information services by nuclear scientists in Ghana. Secondly, to investigate the relationship between information use and the productivity and achievements of the nuclear scientists and finally, make recommendations for an efficient and effective provision and use of nuclear information based on the findings. The rationale for this investigation is the need to provide policy and decision-makers, whose task it is to allocate scarce resources, with empirical evidence that information is crucial to the work of nuclear scientists. Such evidence should ensure adequate and sustained funding for library and information services in the nuclear sector. Furthermore, such an investigation will definitely enhance the body of literature in this area of research.

## 2. Methodology

The survey population were scientists and engineers, university lecturers and post-graduate students involved in nuclear research and using nuclear information in Ghana. The total population was 100 nuclear scientists. In view of the relatively small size of the population, there was no sampling. The entire population was studied. Data were collected using a semi-structured questionnaire. Responses were obtained from 92 out of the 100 questionnaires distributed.

The impact of information may be positive or negative. For the purpose of this work, impact of information is defined simply as the “beneficial consequences” of information use. The analytical framework proposed by Griffiths and King [22] and later by the International Development Research Centre (IDRC) [23,24] guided this study. Applied to this study, impact of information related the following factors: "Usage", "Outcomes", and "Characteristics". Usage was determined in terms of reasons for use and non-use, frequency of use, awareness of services, nuclear information sources and preferred document type. Outcomes of information use was determined in terms of time saved by having information, improved quality of work, increased user productivity and achievements of scientists. Since productivity and achievements are difficult to determine, indicators were used to measure them. In this work, productivity was assessed in terms of the number of publications, formal oral presentations and number of consultations. Achievement was assessed in terms of promotions earned, awards, and membership of special committees or projects. Such a technique was used by [22].

## 3. Results

### 3.1 Use of Library and Information Service

One objective of this study is to examine the use of library and information services by nuclear scientists. Therefore, it is pertinent to look at respondents' personal characteristics, their reasons for use and non-use of library resources, preferred sources of information and awareness of existing services.

#### 3.1.1 *Characteristics of Respondents*

Analysis of the data on the background characteristics of respondents revealed that, in Ghana, the bulk of nuclear scientists are research scientists (75%) and they are employed mainly in research organisations. Majority of nuclear scientists (85%) are males. The population of nuclear scientists is relatively young, with about 70% below 51 years. The level of education of nuclear information users is generally high, with 90% of them holding a second degree. Over a quarter of the nuclear scientists (26%) are currently engaged in the agricultural sector of the economy.

#### 3.1.2 *Reasons for using nuclear information*

When respondents were asked to recall the reason why they sought information on one occasion recently in relation to their work in nuclear science and technology, it was revealed that, they use information for three main reasons. These are: research (55%), publication (20%) and teaching (12%). The figures reflect the nature of the study population; majority being research scientists and university lecturers whose work involve research, teaching and publication. Infact the latter is crucial to their career advancement. Other reasons given for using information are: professional development (8%), consultancy services (2%), planning, budgeting and management of research (2%), and executing assignments (1%).

#### 3.1.3 *Frequency of Use of Library and Information Service*

The study has further revealed that, majority of nuclear scientists in Ghana (about 90%) use their organisations' libraries. Only about 10% indicated non-use of their organisational libraries. Of the 90% of respondents who use their libraries, 28.3% use the library services at least once a week, while about 43.5% use the library at least once a month. Though majority

of respondents (90%) are library users as indicated above, the rate of use is not too encouraging as less than one-third (28%) indicated that they use the library at least once a week.

#### *3.1.4 Reasons for non-use of Library and Information Services*

As indicated earlier, about 10% of respondents indicated non-use of library facilities during the last twelve months. Reasons given for non-use included dissatisfaction with the library collection; they either found the library lacking in specialised journals and books (approximately 29% of respondents) or not up-to-date (almost 21% of respondents). About 8% of respondents expressed difficulty in using facilities offered by the library, 8% preferred to use their personal information resources and about 4% preferred accessing the Internet. Also, whilst about 4% of respondents did not find the physical conditions in the library conducive to learning, others (26%), expressed dissatisfaction with the standard of service rendered by the library staff. These findings confirmed earlier observations made by Stone [23] and Rorrisa [24]

#### *3.1.5 Sources of Information*

When respondents were asked to indicate information sources they frequently consulted, the most frequently used source mentioned was reference books or handbooks (25%), followed by colleagues (22%) and organisational libraries (22%). Other sources of information mentioned by respondents were their personal resources and departmental files (15%), the Internet (4%) and others (12%) comprising libraries such as the Ghana Medical School Library, the Noguchi Medical Research Institute in Ghana, the International Atomic Energy Agency in Austria, university libraries, the Ghana Atomic Energy Commission Library, the Centre for Agriculture and Biosciences International (CABI) Library Service. With regard to reasons for preference for the afore-mentioned sources of information, 82% indicated that these were readily accessible sources; 15% said information from these sources could be accessed at no cost, while 3% considered the source as being more reliable. From the results, one can deduce that accessibility of information is very important to respondents. This suggests that, perhaps the less frequently used sources such as the Internet would be utilised more if they were made available in the offices or laboratories of nuclear scientists. A look at the infrastructure base of nuclear related institutions and universities in Ghana indicate low accessibility of such facilities.

#### *3.1.6 Preferred document type*

Analysis of the responses to the question on the most frequently used document type, revealed that nuclear scientists are more likely to consult journals (51.6%) than any other type of document when they visit the library. This is consistent with the findings of a previous research [19], that journals are the most popular type of document used by nuclear scientists. Other documents used by respondents are books (about 30.5%), technical reports (8.5%), conference proceedings (8.5%), and theses and dissertations (.8%). The rather low percentage recorded for Technical Reports (8.5%) compared to Books (30.5%) was unexpected. This may be attributed to their inaccessibility as a result of their poor documentation in this part of the world, especially in the case of internal reports.

#### *3.1.7 Awareness of existing library and information services*

Overall, 37% of respondents felt that, they were much aware of library services, 28% were aware of library services and almost 35% were unaware of library services. Based on these statistics, one can conclude that more than one-third of the nuclear scientists are ignorant of most library services. The obvious consequence is under-utilisation of existing library facilities.

### 3.2 Impact of Information Obtained

The main aim of this study is to assess the impact of information on the research and development activities of nuclear scientists. When assessing the impact of information, it is important to know the immediate as well as the long-term impact of using information.

#### 3.2.1 Short Term Impact

The short term or immediate impact of information is described as the “fit between the information provided and the existing knowledge of the user”. Thus, users are “likely to be more satisfied if the information they obtain provides something new...”[8], or result in monetary gain and savings in terms of time or resources. When, respondents were asked to recall or focus on a recent occasion when they needed information specifically for their work in nuclear science and technology and indicate the immediate impact of information on their work, they generally found the information they obtained useful as shown in Table 1 below.

*Table 1. Responses on Immediate Impact of Information Obtained*

Impact Statement	% YES	% NO
Added information to personal collection	82.9	17.1
Refreshed memory on details or facts	82.9	17.1
Immediate usefulness	82.2	17.8
Better quality performance of task	79.7	20.3
New knowledge	73.3	26.7
Shared or hope to share with colleagues	72.0	28.0
Resulted in faster performance of task	68.4	31.6
Confirmed previous knowledge	68.0	32.0
More information on topic needed	60.3	39.7
New activity was initiated	37.0	63.0
Expected to find something else	25.3	74.7
Generally out-of-date	6.8	93.2

Table adapted from [8]

While some respondents (82.9%) indicated that they would add the information to their personal collection, others (82.2%) reported they found immediate use for the information they obtained. Also, 79.7% reported that the information resulted in better quality performance of the work for which they sought information and 68.4% of respondents indicated that the information obtained led to timely performance of the task. Significantly, 72% of respondents reported they either shared or hoped to share the information with colleagues.

#### 3.2.1.1 Savings Made from Information Obtained

In this study, savings was considered in terms of working time or resources. The reason for this approach is that, in this part of the world, library and information services are generally free, so most respondents would find it hard to place a monetary value on the use of information. Consequently, respondents were simply asked whether the information found enabled them make some time savings. About 71% responded in the affirmative, while 15% responded negatively. The remaining 14% could not tell if the information resulted in any savings. Examples of the type of savings made by respondents are as follows: modification of the research approach (32%), confirmation of research work (22.6%), avoidance of duplication of research (20%), stopped an unproductive line of research (16%). Other comments (representing 9.4%, of responses) were: “helped reduce period of search”; “helped explain theoretical concepts”; “helped categorize previous findings”.

#### 3.2.2 Long Term Impact

The long-term benefits of information use can be described as information output activities that result in higher productivity and achievement.

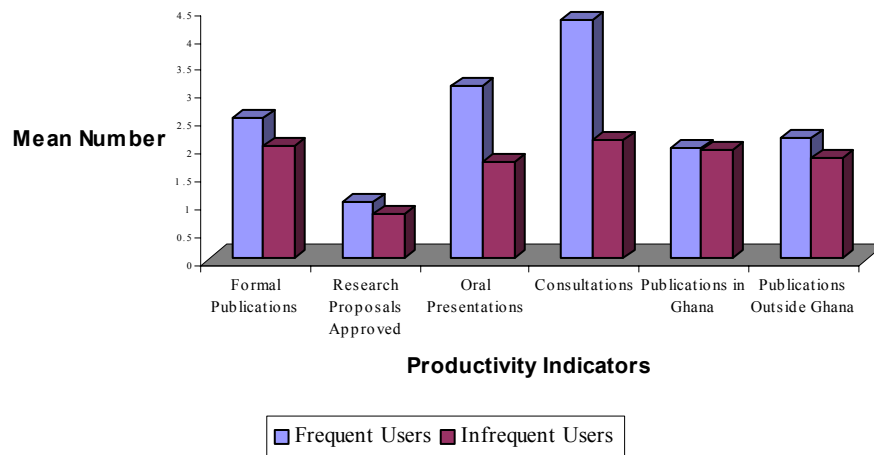
### 3.2.2.1 Relationship Between Frequency of Library Use and the Productivity of Respondents

To assess the relationship between information use and the productivity of respondents, frequency of library use was quantified and used as a proxy of the time spent in performing the information related activities. Thus, frequency of library use served as input, which was cross-tabulated with the identified productivity indicators that served as the output of the respondents, on the assumption that, those who use the library frequently gain more in terms of their professional development than less frequent library users. Here productivity indicators are divided into two. The first set of indicators comprises mainly written or paper-based outputs (number of formal publications such as technical reports written, research proposals approved, journal articles published within and outside Ghana). The second set is related to some form of expression or oral presentation (Oral presentations and advice/consultations given). Table 2 and Fig.1 show the relationship between frequency of use of library and information services and some productivity indicators.

*Table 2. Relationship Between Frequency of Library Use and the Productivity of Respondents*

2.0.	Frequent Library Users N=65		Infrequent Library Users N=27		
	2.1. Indicators	Mean	Standard Deviation	Mean	Standard Deviation
PRODUCTIVITY					
		2.000	1.987	1.951	1.975
	Journal Articles in Ghana	2.190	2.861	1.817	3.076
	Journal Articles Outside Ghana	2.542	2.836	2.042	2.458
	Formal Publications	1.034	1.189	0.792	0.833
	Research Proposals Approved	3.119	3.922	1.750	1.359
	Oral Presentations Consultations / Advice	4.288	9.248	2.125	2.740

FIG. 1. Relationship Between Frequency of Library Use and the Productivity of Respondents



No doubt, frequency of library use has effect on almost all the productivity indicators of users. The mean values recorded for frequent library users were higher, compared to the infrequent library users. The highest mean value was recorded for consultations or advice (4.288 for frequent library users against 2.125 for infrequent library users), followed by oral presentations (3.119 for frequent users against 1.750 for frequent users), Formal publications (2.542 for frequent users and 2.042 for infrequent users). The least mean value was observed for research proposals approved (1.034 for frequent against 0.792 for infrequent users). Thus, frequency of library and information services use has profound effects on almost all the productivity indicators especially the oral productivity indicators. It is, therefore, apparent that the most direct impact of library use has to do with some form of expression or oral presentation, perhaps with written or paper-based productivity impacts becoming more visible in the medium or long-term. It can generally be concluded that frequent library and information services users are more likely to be productive than infrequent users, as was also observed by [22]

### 3.2.2.2 Relationship Between Frequency of Library and Information Services Use and Achievement

The achievements of professionals may either be measured at a personal level in the form of benefits to the individual or the ultimate benefit to the parent organization. The following achievement indicators were used to assess impact: committees served on within and outside the parent organisation; computer codes or programmes written; patents and technical awards received; and promotions earned within the last ten years. The impact of library use on achievements of respondents was less apparent (see Fig. 2), compared to its impact on productivity (See Fig.1).

Table 3. Relationship Between Frequency of Library Use and the Achievements of Respondents

2.2.	Frequent Library Users		Infrequent Library Users	
	Mean	Standard Deviation	Mean	Standard Deviation
2.3.				
2.4. Indicators				

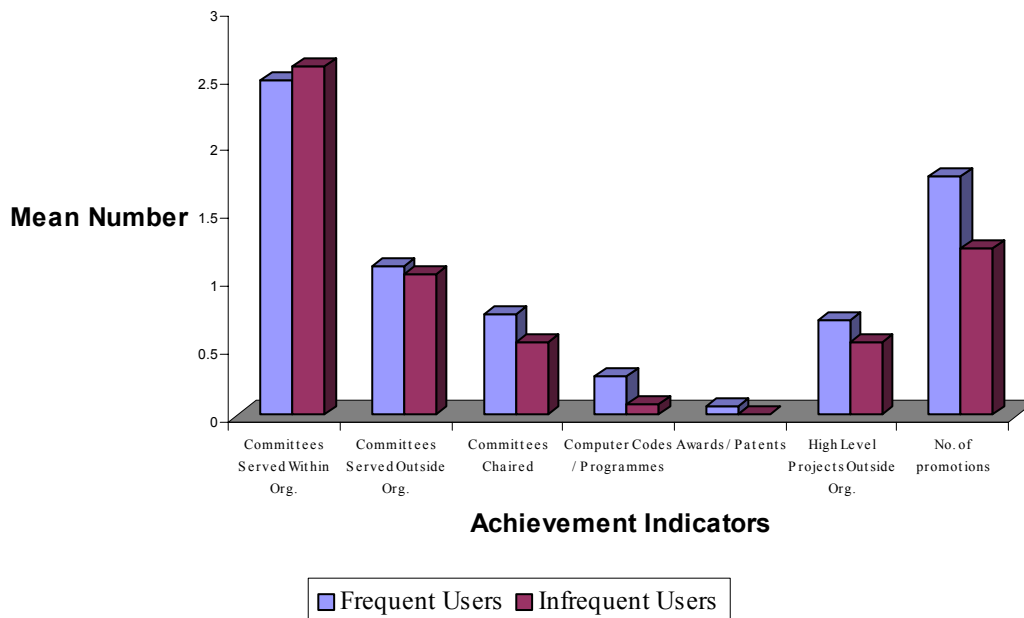
## ACHIEVEMENTS

	2.4	2.43	2.5	1.76
Committees Served in Organisations	75	8	83	7
Committees served Outside Organisations	1.1	1.43	1.0	1.54
Committees Chaired	02	5	42	6
Computer Codes / Programmes Written	0.7	1.39	0.5	0.72
Awards / Patents	46	7	42	1
High Level Committees / Projects Outside	0.2	0.87	0.0	0.40
Org.	88	2	83	8
Promotions	0.0	0.32	0.0	0.00
	70	0	00	0
	0.6	1.00	0.5	0.93
	95	4	42	2
	1.7	1.45	1.2	1.12
	6	6	4	3

However, frequency of library use also affected the achievement indicators considered in this work, such as the number of promotions obtained within the last 10 years, number of high-level projects that respondents have participated in outside their organisation and the number of committees chaired.

The mean number of awards/patents produced for frequent and infrequent library users are 0.07 and 0.00 respectively. The trend was similar for the number of computer codes/programmes written, where frequent and infrequent users produced 0.288 and 0.083 codes/programmes respectively. Though there are clear differences between the achievements of frequent and infrequent library users with respect to number of awards/patents and computer codes/programmes, the mean number per respondent is very low. Therefore, any attempt to attribute these achievements exclusively to library use may not be appropriate.

FIG. 2. Relationship between frequency of library use and some achievement indicators



### 3.3 Problems encountered by respondents in accessing information.

Regarding the problem of access to nuclear information, 78% of respondents reported that they faced problems. Only 22% reported they did not face any problem. The foremost problem mentioned was lack of access to the Internet, followed by lack of current journals

and lack of relevant books and journals. Other critical comments in the respondents own words were “poorly equipped libraries”, “delays in obtaining full texts of references”, “lack of computers”, and “outdated teaching facilities”.

#### 4. Conclusion

This study focuses on the impact or beneficial consequences of information use on the work of nuclear scientists in Ghana. Before tackling the actual benefits of information, the study addressed among others, the following issues that are all related to the subject: personal characteristics of respondents, their reasons for using information, their sources of information and their use of library and information services.

The results show that in Ghana, nuclear scientists seek information mainly for research, publication and teaching. Most of the nuclear scientists seem to prefer information sources that are readily available and free of charge such as reference materials and handbooks, colleagues, organisational libraries, personal resources and departmental files.

Though most nuclear scientists in Ghana use their organisational libraries, frequency of use is not encouraging as less than one-third of them indicated using the library on a weekly basis. Some nuclear scientists do not utilise library services mainly because the libraries lack current, specialised journals and books. Also, more than one-third of nuclear scientists are ignorant of most library services.

The main problems nuclear scientists face with regard to information are lack of access to the Internet, lack of current journals and books and poorly equipped libraries.

Among the benefits of information use, to the nuclear scientists are faster performance of work, time savings and quality performance of work. An important finding of this survey is that frequent library use has effects on the productivity as well as the achievement of nuclear scientists in terms of their research output and their contribution to the work of their organisation.

It is hoped that, the results of this study will convince policy and decision makers in the nuclear sector that library and information services play a significant role in the research process, hence the need to pay more attention to information, if we are to fully enjoy the benefits of nuclear science and technology in this part of the world.

#### 5. Recommendations

A major complaint that ran through this study is the lack of up-to-date journals and relevant books as well as lack of easy access to the Internet. Acquisition of current print and electronic journals and relevant books must be given priority through sufficient budgetary allocations at the institutional level. Relevant institutions should develop adequate and reliable infrastructure that will enable all nuclear scientists fully maximise the benefits of the new information technologies, particularly the Internet. This will go a long way to supplement inadequate library resources.

The study revealed that apart from scientific journals, nuclear scientists prefer information sources that are readily available such as handbooks, reference books and colleagues. Nuclear scientists should be supported financially to maintain their private collections through personal journal subscriptions and acquisition of materials for individual use by the library. For effective information transfer and resource sharing, formal and informal information networks among institutional libraries with nuclear programmes should be strengthened. Telephone facilities and computer systems should be provided to improve electronic networking and fast document delivery.

It may be recalled from the results that, more than one-third of nuclear information users indicted lack of awareness of existing library services that could help them with their research, teaching, and publication needs. There is an urgent need for information professionals to create awareness of available nuclear information sources and services. This

should be done on a regular basis through current awareness services such as issue of bulletins, circulation of content pages of current journals and selective dissemination of information (SDI) based on the INIS Database, as well as user education programmes. The success of such programmes however depends very much on adequate financial and human resources, support, and interest shown by policy and decision makers in the nuclear sector.

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