# UNIVERSITY OF NAIROBI

## AN INVESTIGATION INTO THE DISSEMINATION OF CONSTRUCTION RESEARCH INNOVATION FROM THE UNIVERSITY OF NAIROBI INTO CONSTRUCTION PRACTISE.


BY

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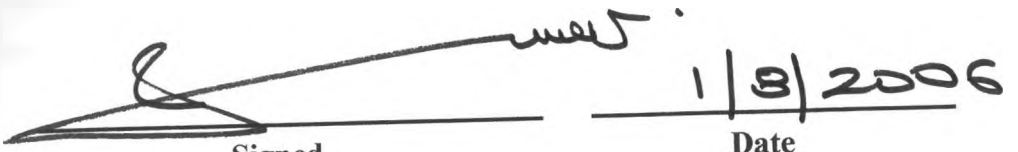
## DECLARATION

I, Joab Awalla, hereby declare that this project is my original work and has not been presented in any other university for any degree,



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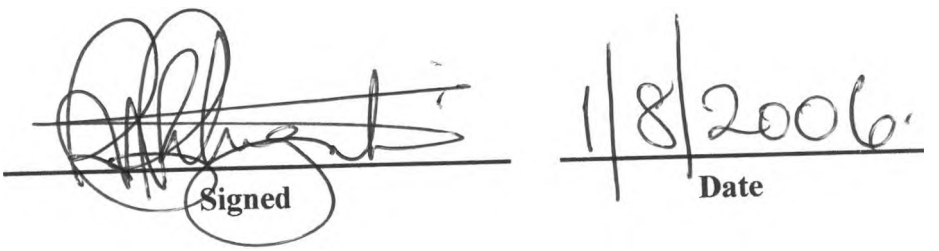

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I feel a deep sense of gratitude for my late father, Jared Awalla, who formed part of my vision and taught me the good things that really matter in life. The memory of my father still provides a persistent inspiration for my journey in this life. To my mother Monicah Awalla; I can never pay you back, but this in a small way will show you that I appreciate. Special gratitude is also due to my brothers and sister for their loving support.

Especially, I would like to thank my wife Nellie whose patient love enabled me to complete this work. To my daughter born, during the completion of this document, just remember that daddy loves you.

Finally, I acknowledge that many readers will take issue with both major and minor points in this report. Indeed, the report will have failed if it does not bring forth other points of view. Its' underlying purpose has been to provide "raw material" that can serve as a launch point for analysis, criticism and suggestions that, in turn, will provide a useful foundation for discussion and further research.

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## ABBREVIATIONS

| | |
|---|---|
| AAK | Architectural Association of Kenya |
| AAU | Association of African Universities |
| AVU | African Virtual University |
| ADD | Architecture, Design and Development |
| CARL | Canadian Association Of Research Libraries |
| CSIR | The Council for Scientific and Industrial Research |
| DATAB | Association of African Universities- Database of African Theses and Dissertations |
| ETD | Electronic Thesis and Dissertations |
| IEK | Institution of Engineers of Kenya |
| IM | Information Management |
| JKUAT | Jomo Kenyatta University of Agriculture and Technology |
| KIPS | Kenya Information Preservation Society |
| Ksh. | Kenya Shillings |
| LAN | Local Area Networks |
| MOPND | Ministry of Planning And National Development |
| MOPW | Ministry of Public Works |
| NCDDR | National Center for the Dissemination of Disability Research (USA) |
| NCST | National Council for Science and Technology |
| PDF | Portable Document File |
| R&D | Research and Development |
| S&T | Science and Technology |
| SBE | School of Built Environment |
| UNECA | United Nations Economic Commission for Africa |
| UNESCO | United Nations Educational, Scientific and Cultural Organisation |
| UON | University of Nairobi |
| WWW | World Wide Web |
| XML | Extensible Markup Language |

## ABSTRACT.

The overall aim of this research project was to investigate the dissemination of, and subsequent absorption of construction research innovation from the School of the Built Environment (UON) to the Kenyan Construction industry. The study investigated why research results are not easily accessible and usable by those who need them most, and are of limited practical use.

The study supposes that there is a direct positive relationship between the dissemination of construction research findings and the absorption of construction innovation in the Kenyan construction industry.

The objectives of the study attempted to answer the questions on the university-industry linkage difficulties. The study proceeded to explore the level of use of research innovation by industry practitioners; the dissemination mediums practitioners used, and determine the factors and barriers affecting efficient dissemination of university research.

A survey research method was adopted based on the construction research innovation currently found at the Department of Real Estate and Construction Management. The questionnaire was administered to randomly sampled construction practitioners (Architects, Engineers, Quantity Surveyors and General contractors) within Nairobi.

Descriptive analysis of data was undertaken to explain phenomena revealed in the literature review. The hypothesis was then tested empirically to affirm the hypothesized relationship. Conclusions drawn confirm the presence a casual relationship between the dependent (innovation absorption) and independent variable (dissemination pathways).

The study also affirmed that decisions about which dissemination channels to be used should be determined based on the resolution of inherent barriers afflicting the source, the medium, the content and the user needs in that order of priority. It finally recommends that the University of Nairobi introduce the now popular electronic thesis and dissertation system (ETD) as the best strategy for efficient dissemination of its research innovation.

# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background of the Problem.

The building industry is highly diverse and fragmented and its participants work in contexts that are unfavourable to good communication and, above all, unfriendly to the systematic acquisition of information. The industry has a low absorption rate of new technologies, improved materials, processes and management methods, even in instances where improved processes and cost effective solutions to long-standing construction problems are known (McDermott, 1998). Solutions to these problems have been documented through numerous research projects undertaken by universities and research institutions worldwide. Whereas research has the potential to help practitioners become mindful of their circumstances and to adapt accordingly, most of it has only been interesting to academics, and hundreds of these papers are resting on bookshelves in academic libraries.

Conceptually, the research, development and adoption process should be viewed as a complete system. Often, however, the information dissemination part of the process is considered as a separate and unrelated activity. Most of researches and studies done are focused on ways to improve the value for money invested in building and construction, that is to say, to improve the quality, processes and procedures by which buildings and infrastructure are initiated, designed, produced and used. Through all these initiatives, there is a common thread: *information*. Without information, the decision-making that supports all building processes and procedures would be poor and building work would grind to a halt.

Information used for decisions on accurate cost estimates, time scheduling and required quality falls into two classes*: project-related information and general information.* The former grows with the project and is 'lost' in the final product. The same has been subject to numerous exhaustive research studies including Nguyo (1998). The latter constitutes an ever-increasing, publicly available stock of knowledge such as information coming

from research institutions which access to and immediate use by practitioners presents difficulties (Davidson, 1998).

Communication of research results to practitioners and within the industry itself has been found to be an impediment to innovation in the construction industry (Davidson, (1998); Zaky et al. (1998)). This suggests that research into this problem and its consequences is urgently needed, since information in its two forms is an essential ingredient of all decision-making and knowledge enrichment. This problem of the information gap between solutions (university research findings) and practitioners requires an understanding of the information flow processes between researchers, professional practitioners, contractors and construction enterprises. By understanding the nature of these relationships, a practical dissemination system can be modelled to trace the application of research information so as to stimulate industry growth and innovation.

## 1.2 Problem Statement

In spite of the growth observed in the construction industry, universities are reported to have remained confined in their ivory towers with unfortunately little or no effort made to bridge the university – industry gap (Zaky et al, 1998). Universities usually account for a significant proportion of national research expenditures. In the financial year 2005-2006, the Kenyan government allocated Ksh. 75 million for research to be shared among its six public universities. This amount of money together with that spent by self sponsored students on basic research may not be optimally utilised if the construction industry fails to apply much-needed innovations undertaken at university by researchers.

A recent ranking of universities worldwide, ranked the local leading University of Nairobi twenty forth in Africa and lower than its counterparts in the region. One of the study parameters examined the extent each university's research outputs changed the lives of people and this shortcoming contributed to the low ranking of Kenyan Universities (Nation, 2005). In developed and industrialised countries, universities are in the process of forsaking their ivory towers and forging strong links with industry, mainly through sponsored research and continuing education (Zaky et al., 1998). The

contribution of public Research and Development (R&D) institutions in developing countries is however negligible. Studies on the role of universities and research institutes in industrial technological change in these countries are also scarce (Mwamadzingo, 1995). There is, thus, a need for a greater understanding of the factors that could lead to improved interactions between scientific research institutions and industry and to the enhancement of Kenya's industrialization process (Odhiambo et al., 1989). Furthermore, Nguyo's (1998) study on information management (IM) for the MOPW commendably tackled the general IM as concerned with both design and construction and recommended that research institutions such as the University of Nairobi pursue ways on how they can facilitate gathering and dissemination of research information.

Mwamandzigo (1995) elaborates that the Kenyan government's recognition of the important relationship between research and innovation was clearly defined in the National Development Plan, 1984–88, that National Council for Science and Technology (NCST) was to coordinate industrial research institutions (including universities) and the transfer of the Science and Technology (S&T) research findings to the productive sector. The mode of coordinating was further fine tuned in the 6$^{th}$ National Development Plan, 1989–93 (Government of Kenya 1989), which specifically associated the establishment of the Kenya National Scientific and Documentation Centre at NCST with the need to implement Kenya's S&T research findings for social and economic development. So far, none of the numerous attempts to streamline research-industry linkages have had any significant effect on industry–research interactions in Kenya (Burke 1973). However, a recent initiative, the Kenya-South Africa Roundtable Discussion on S&T Partnerships Related to Infrastructure, echoed the need for enhancement of links between research and industry so as to support economic growth (MOPND, 2004). Hence, the Government still acknowledges the central role that is played by research and industry collaborations, as the relationship is the backbone of economic growth and development.

Innovation, can be defined as "the application of new knowledge to industry, and includes new products, new processes and social and organisational change" (Kelly, 2005). Waithaka (1988) established that innovations in production processes are the most

promising channels of reducing costs, increasing productivity as well as improving the quality of construction works. However, it is obvious that the Kenyan construction sector has had little if any change over the last few decades. Whereas existing innovations should by now have disseminated into practise, problems that still afflict the industry include:

- Time delays are still common-place in Kenyan construction projects despite solutions suggested by; Talukhaba (1999), Gichunge (2000) and Kivaa (2000).
- Construction projects are still completed at high costs, above projected cost estimates, have relatively high maintenance costs and life-cycle costing is hardly used despite solutions by Miriti (1995), Rukwaro (1990) and Masu (1987).
- Quality of materials and workmanship of construction projects are still questioned while the research results of Oduor (1991) and Dindi (2004) is largely unused.
- Information and communication management (ICT) has not found its rightful place in the industry as envisioned by Nguyo (1988) and Aligula (1994). ICT is expected to impact construction in profound ways. The more obvious ones include e-commerce, integrated design capabilities, improved management and process software, etc.
- Safety issues are still ignored by construction practitioners yet the implications are spelt out in several studies such as Mwangi (1989) and Ndege (2004).
- Disintegrated processes: New contracting practices, including design-build, build-own-operate-transfer, project management, public private and integration of industry internal processes is consciously happening as in developed countries. This is despite solutions offered by Mbatha (1986) and Kithinji (1988).
- Inadequate risk management still plagues the Kenyan construction industry though feasible solutions have been recommended by Gichunge (2000).

Clearly, an item of information only becomes knowledge if it reaches the decision maker who can use it on time and in the desired form. A substantial part of the requirements for the successful completion of a research degree is that the research conducted should be in some way original, and also make a worthwhile contribution to knowledge. Given these requirements, it would be expected that the dissemination of these research results should

be a routine part of the process of postgraduate study and its aftermath. Yet information coming from research unfortunately does not reach practice (Davidson, 2004). Recently, the first Kenya-South Africa Roundtable Discussion observed that research findings have played a minor role in the construction industry innovative process. The discussions concluded that "there is no linkage between research and construction, though most problems in the industry have been researched" (MOPND, 2004 p.1). Poor dissemination and communication strategies of research results were singled out as a major contributor to the quandary.

## 1.3 Research Questions

- What is it then, about a system that encourages research but appears to take no notice of the findings?
- What is the source of the linkage difficulty?
- How should the rules of optimum dissemination of this research information be established?
- What do we need to do to enhance linkage between the research institutions and the construction industry?

The problem under study is the case of low absorption rate of research innovation.

## 1.4 Study Hypothesis

It is the hypothesis of this study that there is a direct positive relationship between the dissemination of construction research findings and the absorption rate of construction innovation in the Kenyan construction industry.

## 1.5 Study Objectives

The primary objective of this study is to investigate the underlying causes of difficulty in construction practitioners applying construction research findings to stimulate innovations that will improve industry efficiency. To attain this aim, this study will attempt to:

i.) Establish the level of use (absorption) of research innovation by industry practitioners.

ii.) Determine which dissemination mediums practitioners use to access research innovation.

iii.) Identify the factors and barriers affecting dissemination of research innovations between research institutions and the Kenyan construction sector.

iv.) Examine optimal dissemination strategies that will enhance linkages between research institutions and the construction industry in Kenya.

v.) Establish the relationship between university construction research findings dissemination and the absorption rate of construction innovation.

## 1.6 Scope of The Study.

Most literature recognises innovation theoretical framework as having three parts: the generation of knowledge, the diffusion of knowledge and the use of knowledge. This study assumes that the knowledge (university research thesis findings) has been created and is stored somewhere and that construction industry practitioners are already using some already existing knowledge in making their decisions. The study is therefore limited to the problem identified, that is, the diffusion/dissemination concept framework.

In Kenya, currently only two institutions, the UON and JKUAT offer graduate programs in construction related studies. The study will further be limited to the relatively larger number of researches undertaken at the UON School of Built Environment (SBE) (formerly ADD) since 1970 as the later institution is relatively new (1994) and as such has not produced significant quantity of post-graduate theses in construction disciplines.

Geographically, the study will be limited to the city of Nairobi due to financial and time constraints. Only building construction professionals and contractors firms based within the city are to be considered to form the study population. Nairobi, the capital city of Kenya, is chosen since it has the highest level of building activities, most professionals practice therein and as such, it would be representative of the entire country.

## 1.7 Justification of The Study

It is generally recognised that, compared to other industry sectors; the construction industry is slow in the adoption of technological innovations and new ways of working. This has often been attributed to the conservative nature of the industry. This conservative nature is largely due to the fact that, unlike other industry sectors such as the manufacturing, automotive and pharmaceutical industries; the construction industry has a very weak culture of research and innovation. Indeed, it is often the case that construction organisations do not have a Research and Development (R & D) Department. This might be due to a lack of appreciation of the added value of research and development activities, and would be tantamount to suicide if such an approach was adopted by a manufacturing or pharmaceutical firm.

There are also growing calls for improvements to be more rapid and sustainable. These improved business processes cannot be achieved and sustained unless there is an established culture of research, innovation and development within the industry. The aim of this project, therefore, is to explore ways of promoting a culture of research, innovation and development within the construction industry. The optimal diffusion of existing innovations in the building construction industry can have substantial social, economic, and environmental benefits to Kenyans.

It is expected that this project will produce a critical overview of factors that underlie a successful research, innovation and development culture. This will benefit construction companies specifically by making practical, recommendations that will improve the dissemination of research information and consequently industry innovativeness.

## 1.8 Study Assumptions

The study assumed that the best way to measure the dissemination of research innovation, if any, would be to measure the construction industry awareness and use of the current existing research at the university library. A further assumption was that the research dissemination into industry would be manifest in the form of how much the construction practitioners put the same into use.

The study also assumed that that although innovative ideas emanate from several sources, research information is the prime vehicle to formal innovation processes occurring in industry. The study also inferred that most of the construction practitioners interviewed had some idea of what a research project involves as they or those under their employment have undergone professional training. By attempting to discover the effects of research dissemination into practise innovation, the study hoped to assist the industry optimise on use of these expensively sort solutions.

## 1.9 Organisation Of The Study

This study is organized in five parts. While chapter one dwells mainly on the research proposal, chapters two to five entail the actual research process.

Chapter one introduces the problem and includes the problem background and statement, study hypothesis, study objectives, study limitations, scope and limitation of the study, study justification, study methodology and organization of the study.

Chapters two deals with the theoretical basis of the study. It explores relevant literature review from publications on the study subject and forms the theoretical framework for the collection and evaluation of the primary data.

Chapter three outlines the study methodology. It will explain the type of research design adopted, the type of sampling used, data collection and sampling tools, and data presentation and analysis techniques.

Chapter four records the actual collected data and findings inherent in their analysis. It provides a clear picture of the actual results of the research survey.

Chapter five basically comprises the research conclusions and recommendations. The reference section concludes the document.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

## 2.1 RESEARCH INFORMATION IN THE CONSTRUCTION INDUSTRY

### 2.1.1 Introduction

The premise that the information generated through research is a critical resource is not new. Scholarly research makes profound contribution to the social, cultural and economic wealth of a country. Ultimately, for research to be relevant it must be linked to practice. The purpose of research is to be of use, to change current practice, or to confirm it. If research results are not easily accessible and usable by those who need them most (i.e., construction practitioners, service providers, clients, other researchers, etc.), they are of limited practical use (NCDDR, 1996). Thus, the dissemination of that knowledge, through an efficient and effective communication system is of enormous importance to the construction industry.

In their study of dissemination of disability research the NCDDR (2005) organisation in Texas, USA confirmed that, for many innovations, the timeline involved in the process of moving new understandings and new products from research to practice took decades or even generations. DATAB, (2003) contend that although theses and dissertations represent a significant proportion of Africa's research activity, access to this research output is not easy, even within the institutions where they are submitted. Likewise, long periods may elapse before papers or other forms of publications describing aspects of the research in these documents can be published. Production of thesis documents is very limited and the only copy available for public access is usually in print and can only be consulted physically in a university library. Zaky et al. (1998) underscore that a gap exists between universities and industry in both developed and developing countries. The task of optimal dissemination is precisely to bridge that gap.

### 2.1.2 Information

The term information has to do with "becoming knowledgeable", with the reduction of ignorance and uncertainty. Although several authors (Braman (1989); Buckland, (1991)) expresses the irony of information in itself being ambiguous and defined in several ways, three principal uses of the word "information" which help conceptualise its' meaning can be derived from an analysis of dictionary definitions characterised as:

a) **Information-as-process:** Considers information as "The act of informing, communication of the knowledge or 'news' of some fact or occurrence; the action of telling or fact of being told of something." (Oxford English Dictionary, 1989).

b) **Information-as-knowledge:** The notion of information as that which reduces uncertainty, that is, the "knowledge communicated concerning some particular fact, subject, or event; that of which one is apprised or told; intelligence, news." (Oxford English Dictionary, 1989).

c) **Information-as-thing/object:** The term is used attributively for objects, such as data and documents, since they have "the quality of imparting knowledge or communicating information; instructive." (Oxford English Dictionary, 1989). This definition has is fundamental in information systems including, computer-based systems, libraries, museums and collections of informative objects which might include people, products and events.

In addition to the above definitions, information in the management realm can also be viewed as a distinction between *explicit* and *tacit* knowledge. Explicit knowledge is formal, systematic and codified rather like *information-as-thing*. Tacit knowledge is highly personal, consisting of technical skills and know-how as well as having cognitive dimensions such as entrenched mental beliefs, which shape perceptions (Kirk, 1999; Nonaka 1991; Moody, 2003). There are similarities between *information-as-knowledge* and tacit knowledge. Tacit knowledge is considered more valuable because knowledge must be made tacit to make decisions or to take action. However because tacit knowledge is intangible, it is much more difficult to manage and is now subject to various Knowledge Management researches.

A large percentage of construction industry information is stored on text documents, such as contracts, specifications, meeting minutes, change orders, field reports, and requests for information, among others. This study will therefore conceptualise information as a tangible object because it is usually easier to *capture, store, retrieve and disseminate*, using the range of communication and information technologies currently available (Nguyo, 1988).

### 2.1.3 Types Of Information (Information Resources)

Most commentators (Kirk, 1999; Buckland, 1991; Nguyo, 1988) regard the following as constituting information resources in organizations including construction industry firms with the concept of *information-as-thing*.

i) Data: This is the plural form of the Latin word "datum", means "things that have been given." It is a term used for information-as-thing that has been processed in some way for use. A construction project consists of a great amount of data such as about labour productivity, materials, equipment, cost estimating, scheduling of activity duration, and so on.

ii) Records: Data are very often associated with records of events, objects and persons. Much of the information in records are textual in character and will consist of files of site reports, material test results, correspondences, etc. Procedures have been evolved to ensure their effective filing, security, storage and eventual disposal under the heading of information management.

iii) Text and Documents: Textual information has long been the province of archives, libraries, and offices. The term *document* is normally used to denote text-bearing objects. The use of text and document extends to include images, and even sounds intended to convey some sort of communication.

iv) Objects: The literature on information science has concentrated narrowly on data and documents as information resources (Buckland, 1991). However, objects, such as experienced practitioners and historic buildings, that are not documents in the normal sense of being texts can nevertheless be information resources,

v) Multimedia: All the above, together with sound recordings, graphics, pictures and video, may now exist together in a single *document*. Examples include various

educational, manufacturers catalogues and reference sources published as CD-ROM packages. While the other information resources referred to above may exist in either paper or electronic form, multimedia records require the application of information technology (IT).

### 2.1.4 Construction Information

Industrial processes are characterised by the intensive use and production of knowledge and information. Building industry processes are unique in that all diverse and complex information is specific to each product that is constructed, and that the information is generated and handled by many participants from several diverse organizations. Information management has therefore become a crucial issue within modern building firms. The construction industry has a myriad of operators including;

- The client community of facility/building operators and management (both public and private /sector);
- The traditional supply chain of building materials suppliers, machinery manufacturers, building product component manufacturers, sub-assemblers (trade specialty and installers), developers and;
- The facilitators and providers of knowledge/information such as evaluators, information services, professional associations, scientists, education and training providers;
- Providers of complementary goods and services such as transportation, distribution, cleaning, demolition and disposal, and
- The major economic business environment drivers such as the Government policy, physical and communication infrastructure, financial institutions, general labour, regulations and standards,

However, the key players in the Kenyan construction sector involved from the concept, feasibility, execution to completion stages of project can be described as:

a) The design community and users of information including architects, quantity surveyors and engineers; and,

b) Facility assemblers (or general contractors)

Most researches and studies done as earlier indicated are focused on ways to improve the quality of buildings and infrastructure. Underlying these initiatives there is the information that forms the basis for the decision-making that supports all building processes and procedures. The implication is that the building design and production process can be described in terms of its decisions. Information used for these decisions falls into two classes: *project-related* and *general* information. The former grows with the project and is 'lost' in the final product, whereas the latter constitutes an ever-increasing, publicly available stock of knowledge which access to and immediate use of by practitioners, presents inherent difficulties (Davidson 1998).

- **General information** –This is information that is not generated for a particular project but which is most often the product of research institutions reports, practice notes, a codes body (codes and standards) and commercial firm (trade catalogues). Information coming from a building research institution, *explicit* information, usually addresses problems that are of current concern in a given region over a given period. To be useful, it must find its way into practice – i.e. it must be disseminated and stocked so that it can be taken up (voluntarily) when needed.

- **Project-specific information** –This is the information that is generated for a particular project, which flows between the participants, receiving additions and undergoing transformations as the project progresses such as; project brief, project design drawings, project technical drawings and specifications, project-related contract documents and change orders.

Information is not a trivial matter. Not only does it impact on the quality and performance of buildings, but information management also represents a considerable cost item – as much as 25 % of total revenue (Lindfors, 2003). Indeed, Leslie et al., (1995), concurs that despite this assertion, "practitioners constrained by lack of time, money and human resources and perhaps unaware of their knowledge gaps, tend to rely on old familiar material for solutions. Rarely, if at all, would a project be delayed while a search is

undertaken for additional, but unknown, information". In other words, under current conditions, better information is sought only where there is a pressing need for it.

### 2.1.5 The Research Information Problem

Several surveys (McDermott, 1998; Davidson, 1998; Zaky et al., 1998 & Bardin, et. al., 1993) carried out on the research information problems afflicting the Construction industry in several developed countries found that problems in most aspects of construction and building products are covered in more or less detail by existing research. However, the fact that practitioners complained about a lack of problem solving information indicated a gap between research and its application. These reports suggest that there is a breakdown in the mechanism for linking the two functions.

The studies also found that a spectrum of situations existed, ranging from researchers researching the wrong problems, being ignorant of, or disinterested in the potential application of their research, leaving the writing of research findings incomplete or publishing only in journals enjoying limited circulation that excluded exposure to a wider and more relevant audience. At the other end of the spectrum are building practitioners who are unaware of or were unwilling to admit to building problems, found their own problems difficult to define, were either ignorant of information sources or were unwilling to pay for them. Most importantly, the studies also found that research reports were not always located at recognised documentation centers, largely due to inadequate indexing and poor retrieval capabilities.

## 2.2 RESEARCH INFORMATION AND PRACTISE INNOVATION

### 2.2.1 Introduction

The word research is considered both as a verb (researching) and a noun (research findings). Research can be defined as an organised, systematic data based critical scientific inquiry to a specific problem undertaken with objectives to find solutions to the same. Although research can be classified in several methods, for example, by data

collection (qualitative and quantitative) or by method of analysis (descriptive, comparative or correlation research), this study will take Zaky et al. (1998) wide-angle view of the purpose of carrying out research to define four categories of research as:

- *Undirected research*: this is the so-called pure or disinterested or "blue sky" research. It is research pursuing exciting new speculative ideas in which no immediate pay-off is perceived.
- *Basic or fundamental research*: this is research directed towards identified gaps in knowledge. It is a major component of the type of research that industry looks to universities to perform.
- *Directed or action research*: this is research having a direct bearing on local conditions and long-range aims connected with economic and/or industrial potential of the country.
- *Applied or ad hoc research*: this is multidisciplinary research. It seeks solutions of identified industrial problems which use the already known facts of science. It is thus strongly associated with the development of technology and usually involves meeting the timescales needed for product development.

### 2.2.2 Innovation

Innovation has been defined as the application of new knowledge to industry, and includes new products, new processes and social and organisational change. Construction is first and foremost a process industry. Innovation is a concept that is sufficiently complex and multi-dimensional that it is impossible to measure directly (Hansen, 2001). It is a bit like measuring the health of a human body which has no single measure. Measurement must therefore rely on a range of indicators, such as body temperature, skin colour, level of pain or discomfort, the levels of various different components of the blood, and so forth. Each of these indicators is based on our fundamental understanding of how the various biological systems in humans work. So it is with innovation. Construction innovation is a process that involves the interaction of many different resources within and among firms. It also results in a wide variety of outputs that cannot be measured along any single-dimensioned scale. As a result, innovation can never be

measured directly. Instead, indicators of innovation provide information on various facets of the innovation process (ibid).

Construction activities/services are also distinct from manufacturing in that they tend to be intangible, lacking physical substance, and as such the consumer is unable to examine the product before purchase. Second, there is a very high degree of consumer participation in the production process such as, design or specification of the service, diagnosis of a problem to be solved and even co-production. These are all aspects of services that distinguish them, at least in some degree, from manufacturing. Finally, for many services, production and consumption are essentially the same activity. All of these suggest that innovation will be slightly different between construction services and manufacturing but that is not necessarily the case. To characterise innovation in construction industry, four main outcomes are generally used (Austin et al., 2004):

i) **Innovative Construction Technologies**: - These address technical innovations that enhance the industry's technical competence and improve understanding and effectiveness of the project delivery process. They include research into innovative materials (e.g. advanced composites), advanced analysis and design of facilities (e.g. finite element modelling of structures), and novel construction technologies (e.g. modular construction).

i) **Innovative Construction Business Processes**: - These focus on innovative business processes and management techniques that will improve quality, reduce cost, shorten project duration, facilitate collaboration, and ensure client satisfaction. These will include research into knowledge management (e.g. organisational learning), innovative procurement practices (e.g. partnering), and collaborative and concurrent engineering (e.g. value engineering).

ii) **Advanced Information and Communications Technologies**: – These emphasis on the development and application of these technologies to facilitate information processing and flow, and collaborative working on construction projects. Key issues include integration of IT systems, and communications infrastructures for virtual construction project teams.

iii) **Sustainable Construction**: – This is a key issue that increasingly will have an influence on the way that construction projects are delivered. Innovations include energy conservation and emissions trading, implications of climate change on construction, and recycling of materials.

### 2.2.3 University Research and Innovation

A central component of public research systems is the university sector. The role of universities and other institutions of higher learning in the innovation process is natural because of their multidisciplinary nature, their competence in undertaking basic research, their reservoirs of knowledge and information, and their ability to recruit young talent. Traditionally, university research has typically been discipline based, focusing mainly on long-term research issues for the advancement of knowledge and the training of new generations of researchers UNECA (1997). However, it is now recognized that for the universities to be effective in stimulating innovation and industrial growth, they must cooperate with industry.

Martin (2000) in a UNESCO report recommends that Universities prioritise linkages with industry to strengthen their traditional responsibility of knowledge generation and dissemination resulting from either basic or applied research. The report also notes that university-industry linkages play a second role especially in traditional universities whose main tasks remain teaching students and carrying out basic research.

Accordingly, a review of the research going on in the faculties and departments of University of Nairobi carried out by Mwamadzingo (1995) showed that the university has the expertise and technological know-how to offer a wide range of services and to generate improved products and processes. He observed that several technologically successful consultancy projects and the generally high inventive activity of the individual members of staff confirmed this capacity. However, he noted that very few linkages with industry existed due to the problem of a lack of awareness by the local industry of what the university has to offer.

University basic research has often been undertaken with an expectation that the results would have some influence on industry practice and on educational policies including curriculum, but numerous obstacles seem to limit that influence. Mwamadzingo (1995) confirmed widespread concern that the research results at universities and scientific institutes in Kenya remain largely unused, and this has limited the effectiveness in Kenya.

To understand the importance of information as a driver to innovation, Mohsini et.al. (1986), describe the flow of information as asymmetrical within the building project team. Having information is a source of power and having difficulty in accessing it easily leads to conflicts, which are reflected in reduced productivity (Ibid.). Indeed, Davidson (2004) emphasizes that the availability and access to information "conflict" is negatively correlated with most of other conflicts observed in the construction industry. Not having the proper information is also identified as a source of rework and/or of delays of construction works (Ibid). This suggests that less availability and access to information leads to more conflict. Quite clearly, then, there is a direct link between the easy availability of adequate information and the improved performance and innovation of the building process.

### 2.2.4 Research Innovations at the SBE.

A thesis simply put, is the acquisition and dissemination of new knowledge. The University of Nairobi requires that the examination for Masters and PhD degree shall consist of a thesis, or of two or more written papers or of a thesis together with a written paper or papers or any other combination of written examination, thesis and project as the faculty may recommend and the Senate may approve. Consequently, all Masters and PhD graduates of the School of The Built Environment (formerly known as ADD) are required to write a research thesis, which must be approved, and copies of the same displayed in the departmental libraries for reference purposes.

In addition, one of the most often stated requirements of any post graduate research is that it should be an original and significant contribution to knowledge in the discipline in which it was conducted. It therefore follows that completed thesis reports stored at the departments' libraries have met that stipulation. A sample of research information on much required innovation to the Kenyan construction industry identified among the thirty-seven (37 no.) completed construction management research projects in the Department of Real Estate and Construction Management library include:

- Construction projects should not be depending on lowest bid tender for procurement of works (Talukhaba, 1988) but rather selective tendering method.
- Kivaa's (2000) objective *mathematical formulae which uses the cost and height of the building for estimation of construction periods*, should by now have been tested in the industry.
- Various methods of procurement suggested by Mbatha, (1999) should by now have permeated the industry, such as:

  i) Design and build ii) Construction management

  iii) Management contracting iv) Partnering

- A *project manager* who is not the project architect should also now be a regular consultant to coordinate all the other consultants in all significant construction projects and manage the construction time. (Talukhaba (1988); Kithinji (1988)).
- Construction projects should now feature some sort of a materials management plan (Ebole, 2005)
- Construction firms should now be aware of the benefits of marketing and employ services of marketing specialists in their firms (Muchungu, (1997).
- Contractors should by now have undergone some form of training before registration by the requisite authorities (Bakuli, 1986)
- Prefabrication and off-site construction should now be a common feature in construction erection activities on site (Waithaka, 1988).
- Construction sites should now feature a safety management plan and employ service of safety experts (Mwangi, (1989); Ndege, 2004)

- Contractors safety records be a factor in the tender analysis stage (Mwangi, (1989)
- There should now have been established a Construction Industry Project Information Center to aid industry practitioners access information (Nguyo, (1988); Talukhaba (1999).
- ICT should be incorporated in construction projects, building maintenance information systems (Aligula, 1994)
- On-job training of craftsmen by field technicians should have been introduced in construction sites to improve building qualities (Okaka, 2004).
- Construction processes should have moved from the day-to-day labour remuneration to bonus incentive work targets by trade gangs to improve labour productivity (Nyaga, 1989)
- Construction professionals should be aware and using Rukwaro's (1990) mathematical model to consider future building maintenance costs at feasibility stage.
- Construction projects should by now have introduced use of risk management strategies, employ services of a risk manager and use an objective predictive mathematical model to predict on cost risk, time risk, cost overrun and time overrun (Gichunge, 2000).

## 2.3 DISSEMINATION OF RESEARCH INFORMATION

### 2.3.1 Introduction

The Oxford (1989) dictionary defines the verb *to disseminate* as 'to scatter or spread widely, as though sowing seed; promulgate extensively; broadcast; disperse." This definition, which reflects the common understanding of the word, does not adequately reflect the underlying meaning in the information context. Dissemination consists of purposive, goal-oriented communication of information or knowledge that is specific and potentially useable, from one social system to another (Louis et. al, 1988). Dissemination is therefore more than the simple distribution of paper or products; it is a process requiring a careful match among the creation of products or knowledge, and the context

of that creation, the needs, contexts, prior experiences, values, and beliefs of target audiences, and the content, media, formats, and language used in getting the outcomes into the hands, minds, and activities of those target audiences. Dissemination is the process of sharing information and knowledge hence the conduit for linking university research and construction industry practise.

In recent years, the importance of dissemination of research has been recognised especially in the development arena. The World Bank (Martin, 2000) recognised the role it plays in advancing economic and social well-being. Indeed, the Global Development Network infers that the gap between knowledge and practise can be bridged by encouraging decision makers to use the results of available research (Stone, 1999). The dissemination of research is now considered as important as the generation of research, and it is crucial to understand and address the challenges to knowledge dissemination in order to have a fully effective R&D strategy. This strategy is based on the premise that knowledge is a primary driver of economic productivity and that it is critical that knowledge be managed as a strategic national asset.

Emphasising the same, Gann (2000) resoundingly states that, "the ability to manage knowledge and information effectively and efficiently has been central to performance improvement in many industries." Information and communication technologies have in the recent past formed the basis upon which new processes have been developed. These arguments support the hypothesis that the innovation gap in the construction industry is in part a function of structure (i.e., knowledge flows).

### 2.3.2 Dissemination – Research Information Flows

The conventional model transfer has always been considered as linear whereby information is seen to flow from the information provider, via the chosen media, to the information user. This model assumes that dissemination is a one-way, top-down flow of information from experts to a passive audience. This is best explained by the current assumption that the best way to transmit research knowledge into practice is to first load it into human minds, through tedious and expensive education of professionals (Fig 2.1).

Much of the knowledge that is retained quickly usually becomes obsolete, and there is no assurance that it will be replaced by relevant new knowledge. Confirming the same, Moody (2003) opinionated that once practitioners complete their formal education, "they tend to rely primarily on tacit knowledge acquired through experience in practice this means they are operating from a knowledge base which is incomplete, out of date and biased''.

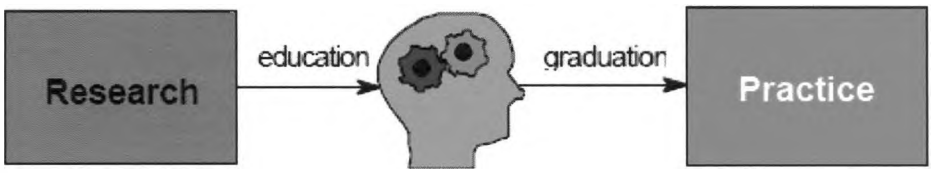



*Figure 2.1: Current Knowledge Distribution Model*
*Source: Moody (2003)*

However, this need not be the case. If all latest research knowledge was provided at construction practitioners' fingertips in the workplace, it would provide reliable channels for continuously and selectively updating their knowledge. The education process only provides a "snapshot" of knowledge in a profession at a point in time. Practitioners need to adapt when they encounter new situations. Knowledge needs to be updated continuously as this is the only workable approach given the current rate of change in most disciplines.

While university education focuses on imparting *explicit* knowledge, experience in practice supplements this with *tacit* knowledge through on-the-job learning and skills transfer. There are two key flows of knowledge which need to occur between research and practice in an applied discipline (Moody, 2003).

a) **Practice to Research**: This direction ensures that any research activity is carried out by university needs to be informed by the needs of practice and hence relevant. Outputs would therefore addresses issues that are of practical significance.

b) **Research to Practice:** Literature available has emphasised that research results should be disseminated and applied in practice. This ensures that research has impact and leads to innovations in practices and benefits to society.

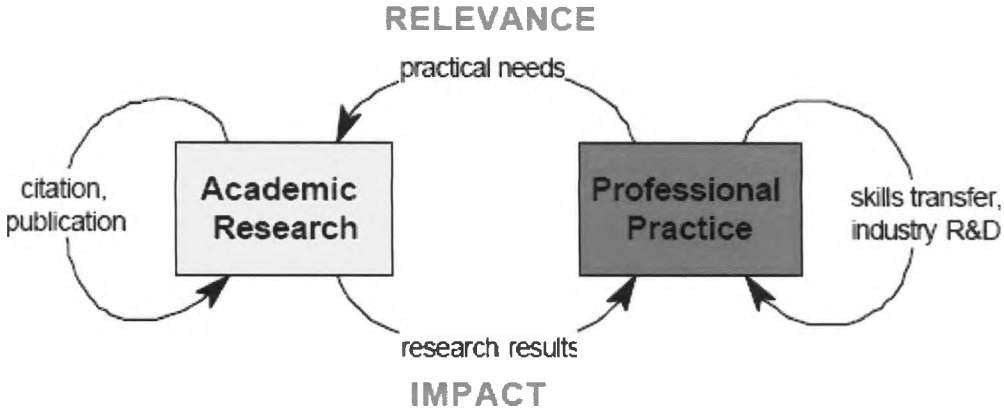



*Fig.2.2: Knowledge Flows between Research and Practice*
*Source: Moody (2003)*

In reality, information flow is now considered a far more complex process than the traditional linear model. It is an interactive, multi-directional exchange of knowledge and ideas that should be reflected in research dissemination strategies. Importantly, one should note that building practitioners are all looking for information and not necessarily from building research results.

### 2.3.3 Important Elements of Dissemination

The desired impact of dissemination is, simply, utilization. The basic reason to acquire and then disseminate new research-based information is to ensure that it is appropriately considered for use in making decisions, driving changes, or taking action designed to improve outcomes. Major elements that must be considered in developing and implementing an effective dissemination plan/strategy are suggested by literature (NCDDR, 2004; Serrat, 2005) are enumerated below (Fig 2.3):

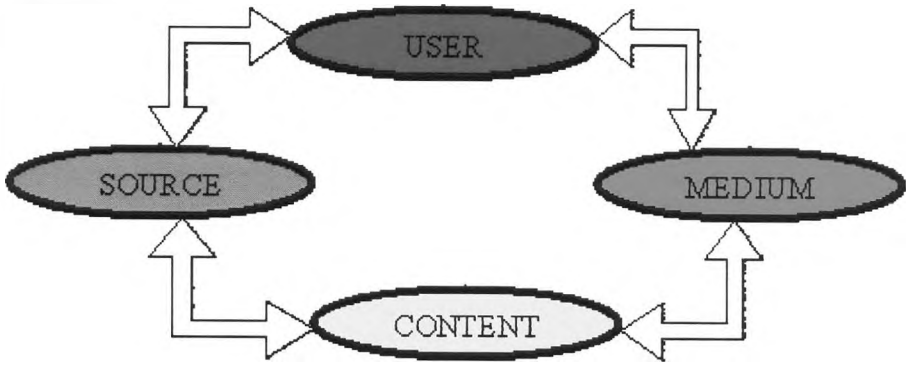



*Figure 2.3: Dimensions of the Dissemination Utilization Process*
*Source: NCDDR (2004)*

a) **Dissemination source:** - The dissemination source may include not only the individuals or agency that produced the research outcomes, but also any intermediaries, or linking agents, who work to disseminate the results to intended users. Studies show that the source of new products and information is generally more important, in terms of encouraging use among intended audiences, than the specific nature and quality of what is being disseminated. The perceived expertise and trustworthiness of researchers can therefore affect the credibility of research outcomes. NCDDR, (2004) indicate that users tend to accept assistance, information, and ideas more easily from sources they know and trust. Expertise refers to the perceived knowledge and/or competence of researchers, whereas trustworthiness refers to the perceived honesty and sincerity of researchers.

b) **Content:** That is the message that is disseminated, the new knowledge or product itself, as well as any supporting information or materials. The nature and quality of the research outcomes themselves are, of course, important to the effectiveness of dissemination efforts. However, as mentioned earlier, other factors can carry even more weight. The quality of research content appears to be a necessary, but insufficient, consideration in the successful use of research outcomes (NCDDR, 2004). The research content should take the user from awareness to

understanding to commitment. A general complaint revealed through casual discussions with construction practitioners is that the language of disseminated research results is too technical. There is a feeling that research results need to be transformed into usable, comprehensible simple and clear messages, which provide a low level of abstraction.

c) **Dissemination medium:** That is the ways in which the knowledge or product is described, packaged, and transmitted. Is the information content clear and attractive and can users conveniently access it? Perhaps the most basic finding in the literature on research utilization is that users cannot attend to a message that they do not receive. Those responsible for dissemination should not get excited about new and powerful media, such as electronic networks or interactive video. The medium by which research results are distributed to users can enhance or detract from utilization. The proliferation of IT technologies has raised new equity concerns; many practitioners may not have access to personal computers and electronic networks. However, it is critical to know and use the channels that are accessible to your intended users. Direct face-to-face personal interaction is considered the most important aspect of an effective medium for disseminating information (NCDDR, 2004). However, a number of information channels exist for construction practitioners and the dissemination strategy must determine the correct "mix" of this media for optimal spread of knowledge. These pathways are discussed further in the ensuing topic.

d) **The intended user** of the information or product to be disseminated. Is the readiness of the users to change limited? Recognising the user as an active participant in determining how she or he will make use of new information, rather than a passive recipient of knowledge, is perhaps the other important element in current understandings about knowledge use.

Effective dissemination rests upon how much the disseminator knows about the intended recipient audience characteristics which touch on all the three other elements and include (NCDDR, 2004): dissemination media preferred, perceived relevance of information to user's needs, readiness for change (Gichunge, 2000), information sources trusted, and format and level of information needed. Consequently, any strategy should incorporate Burkes (1999) model of communication flows (Fig. 2.4). The same indicates the need for any research dissemination model to consider horizontal communication between peer groups at both academia environment (peer reviews, etc) and industry practitioners levels, as well as the upwards and downwards communication routes which allow for information flow between the two groups.

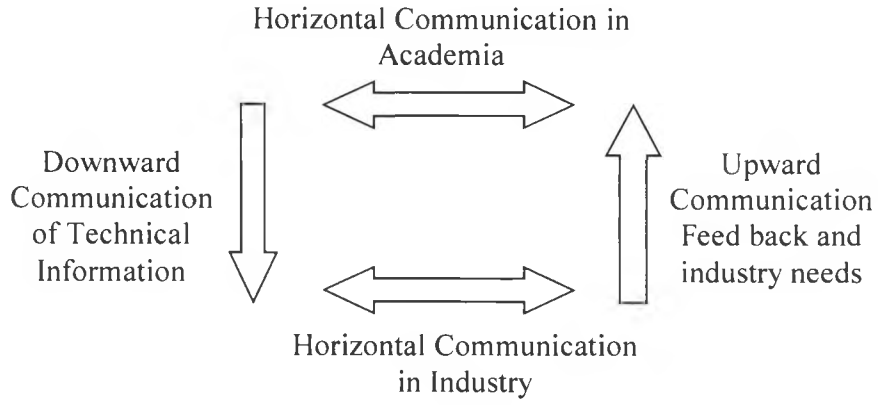



*Fig 2.4: Model Of Communication Flows Adapted from Source: Burke (1999)*

It is important to ensure that research is linked to appropriate dissemination strategies. The most general approach evident in the literature on strategies for the communication and dissemination of research revolves around the concept of 'two communities', that is, researchers and research users – and how to close the gap between (NCDDR, 1996). The factors affecting optimal dissemination strategies can be summarised as below:

| Elements Of Dissemination | Factors Of Effective Dissemination |
|---|---|
| **Source** | • Perceived competence<br>• Credibility of experience<br>• Credibility of motive<br>• Sensitivity to user concerns<br>• Relationship to other sources trusted by users<br>• Orientation toward dissemination and knowledge use |
| **Content** | • Credibility of outcomes<br>• Comprehensiveness of outcomes<br>• Utility (practicality) and relevance for users<br>• Capacity to be described in terms understandable to users<br>• Relationship between outcomes and existing knowledge or products<br>• Competing knowledge or products |
| **Medium** | • Physical capacity to reach intended users<br>• Timelines of access<br>• Accessibility and ease of use, user friendliness<br>• Flexibility<br>• Reliability<br>• Cost effectiveness<br>• Clarity and attractiveness of the information "package" |
| **User** | • Perceived relevance to own needs<br>• User's readiness to change<br>• Format and level of information needed<br>• Level of contextual information needed<br>• Dissemination media preferred<br>• Capacity to use information or product (resources, skills, and support)<br>• Time to access research information |

In conclusion, research is now about both generation and dissemination of findings. In addition to relying on established ways of publishing research findings, studies have shown that a combination of print or other media, along with interpersonal consultative strategies, is most effective in promoting knowledge use. NCDDR (1997) identifies the source of information disseminated as generally more important to users than the content of the information. Therefore, University and research institutions have to realise that they must find ways to relate research findings to practical applications in planning, policy-making, program administration, and delivery of services. This calls for dissemination policies, plans, and strategies. A dissemination policy that considers all the above elements can be an effective instrument that links research to practice (Serrat, 2005).

### 2.3.4 Dissemination and Linkage Pathways

The literature above has determined that research must consider carefully the type of language used in communication and dissemination. Researchers need to present findings in a non-technical form, so as to appeal to non-specialist practitioners. Short, clear and action-led articles may be an effective approach to dissemination and communication. To facilitate this approach it may be necessary to produce different versions of research findings suited to different target audiences. The traditional system of research communication consists of four major groups of actors (CARL, 2002):

- researchers, who produce and consume research information,
- publishers who validate and package research information,
- libraries, who collect, preserve and disseminate research results, and
- society/industry, which benefits from the outcomes of scholarly research as it is translated into government policy, public services and commercial products.

These long established roles are now in profound transition and each group is striving to adapt to the stresses of these changes in their own way. In the research community, there is a trend towards bypassing the other players in the traditional system through the development of self-publishing and archiving initiatives. Up until a few years ago, the

only mechanism for disseminating research papers was in the form of paper publication. Since the 1990s the Internet has changed the situation dramatically.

In the world that preceded word processing on personal computers and the communication channels offered by the Internet, commercial research publishers obtained their position in the publication life-cycle chain because they provided a clear value-added service. Researchers provided the content, editing, review, and quality control free. Publishers typeset the papers, printed them, and distributed them. Today this is not a problem any more: researchers lay out their papers themselves, while the Internet offers a marketing and distribution channel operating at almost zero marginal cost. In this model, authors deposit their research results into an e-print server avoiding hitherto strict copyright restrictions and time delays for publication, while providing interested parties with free access to their research. It is important that researchers should give thought to 'non-traditional' dissemination pathways so as to reach their target audiences.

Currently, a casual survey of the Kenyan situation reveals the following various pathways which have been used to disseminate research information which conform to Fisher et al., (2003) and Dinham's (1999) assertions are listed below: -

**Dissemination Pathways**

| Pathway | | | Comments |
|---|---|---|---|
| 1. Paper | – | Research reports | Detailed summary of research to satisfy funding requirements or those with high-level understanding of subject. |
| | – | Academic, refereed journal and | Directed at research community. |
| | – | Professional journals and magazines | Directed at practitioner community. |

| | | | |
|---|---|---|---|
| | – | Written books | Book chapters drawn from research studies - Educational model – influencing practice through higher education courses |
| | – | Thesis placed in a library | Should be easily accessible |
| 2. Electronic | – | Internet, e-mail | Worldwide electronic network of linked computers |
| | – | CD-Roms, DVDs | Digital information storage devices |
| 3. Consul-tations | – | Conference, workshops and seminars | Face to face contact with peers on specific subject |
| | – | Networking | Associations of individuals /agencies which share a common goal or purpose and who contribute resources in two way exchange |
| 4. Other | – | Partnerships/collabor -ations/Funding | Deliberate efforts by university and industry to work together on identified research projects. The research is problem-focussed |
| | – | Research Centers: | Intermediaries Specialist agency intervening to disseminate and explain research to practitioners |
| | – | Mass media | Publicising, Popularisation, promotional materials in newspapers, television and radio. Reaches a wider audience and influences policy from below. |

### 2.3.5 Factors Influencing Effective/Optimal Dissemination Of Research Innovation

An obstacle or a barrier is usually thought of as ''something that obstructs onward movement', which is usually considered undesirable. This obstruction can be seen as ineffective research dissemination mechanisms. In dissemination of research information, there may be barriers that prevent researchers from disseminating their work and there

may be those that prevent research findings from reaching the potential audience in a usable form.

As has already been explained, "information" falls into one of two main types: general and project-specific. To obtain the general information, such as research innovation, it is necessary for the project participant who needs it, to make an effort to enquire outside the confines of the project team, acquire the information and adapt it in response to a question of immediate and practical concern. Several research studies including Bardin et al., (1993) shows that practitioners are reluctant to invest time and effort in accessing the information they need to make informed decisions. Reading research reports is also not considered a good investment of practitioners' time: "Research is heavy jargon ... after the first page we start falling asleep" (King, 1984). The same findings also note that research institutions do not regard putting out "readable" information as a worthy use of time. Information from research sources needs "refinement" before use by practitioners.

Typically one of the main inputs to innovation is knowledge or innovation ideas. Although all participants in the construction process are a good source, universities and research institutions are the principal source of rigorously tested formal knowledge (research findings) inputs. However, according to Cowan et. al., (2001), several surveys show that service firms such as construction ones, "rely to a very limited extent on universities and research laboratories for the knowledge they require". Possible explanations are identified through already mentioned authors (NCDDR (1997); Bardin et al., (1993); King, 1984) and construction practitioners' statements from casual interactions. These factors are categorised as indicated below (table 2.3).

**Factors influencing Use Of Research Information Dissemination**

| Element | Statements |
|---|---|
| i. User Attitudes/ Views | • I do not have time to find and read research<br>• Much of the research I hear of/read bears no relevance to my professional teaching/work |

- Research is conducted by academics with no grounding in the real issues of teaching
- Universities do not have the knowledge or information that construction firms need.
- Being up-to-date with research does not aid career progression
- Keeping up-to-date with research is an essential part of professional development
- I am not confident in my ability to evaluate the quality of research
- I am not confident in my ability to interpret the findings of research correctly
- I don't have the skills to make use of research
- Industry practitioners are not willing to change their set ways of operations.

| **Element** | **Statements** |
|---|---|
| ii. Content | • Information about the existence of relevant research is not available<br>• Relevant literature is not compiled in one place<br>• Research reports/articles are not easily available<br>• The amount of research available is overwhelming<br>• There is little research related to my subject area<br>• The language of research results is not easy to understand. |

| **Element** | **Statements** |
|---|---|
| iii. Medium | • The university library does not provide access to research information<br>• Other libraries nearby do not provide access to research information<br>• Research reports/articles are not published fast enough |

- I have no access to the world wide web and the internet
- My profession/work does not encourage research based practice
- I do not have funds to attend seminars, conferences and workshops on research findings

| Element | Statements |
|---|---|
| iv. Source | • The University/Institution does not have specific copyright and intellectual ownership legislation in place<br>• The University/Institution does not have research dissemination policies and strategy.<br>• No time is allocated to dissemination research findings.<br>• There is no effort in transforming putting out "readable" information for practitioners.<br>• There is lack of awareness of the new publishing technologies, such as ETDS.<br>• There is limited access to new publishing technologies<br>• There is lack of funding for dissemination of research results<br>• There are no rewards for having research findings applied in practice. The motto for survival is "publish or perish".<br>• There are limited avenues for publication with a lack of locally peer reviewed journals that are reputable in the country |

### 2.3.6 Dissemination Models

**Linear Model**

It is accepted wisdom that innovation plays the key role in economic growth. The starting point in this linear model of innovation (Fig. 2.5) is basic research, which has been primarily the purview of universities and government research institutes. In this model, industry does not usually enter the picture until the applied research stage. Development is the last stage in this model, then leading directly to commercialisation.

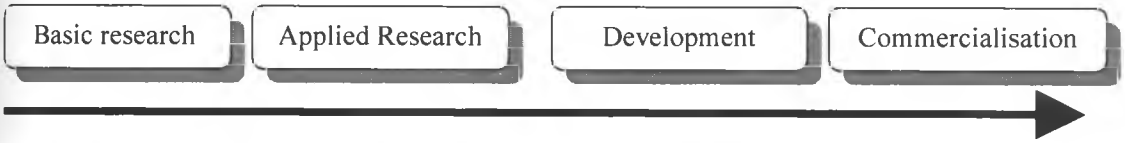



*Fig. 2.5 Linear Model Of Innovation Adapted from Benoit, (2005)*

- **Basic** (or fundamental) research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.
- **Applied** research is also original investigation undertaken in order to acquire knowledge. It is, however, directed primarily towards a specific practical aim or objective.
- **Development** is systematic work, drawing on existing knowledge gained from research and /or practical experience that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

According to the linear model, innovation takes place in distinct and sequential phases. Research is considered to be the initiating step and the source of all innovations. It however suggests that no feedback role is built into the system. The Linear model is a framework for categorizing the process of knowledge creation according to their application aims. When research is conducted with little or no regard to commercial applications it is 'basic research'. When commercially useful methods are the subject of examination, the activity is called 'applied research'. When specific products or processes are being designed and tested, the process is called 'development'.

However, recent studies demonstrate that the process of innovation moves back and forth as in the Burke (1999) model. More contemporary concepts of the research dissemination emphasise interactivity, feedback and a two way flow of information. A variety of the discussed dissemination pathways are considered and the strategies focus on the use of intermediaries as a way of communicating the information to the practitioners.

**Interactive Models**

According to Kondratova (2004), the research and scientific community is currently in the process of moving away from the traditional linear model for the dissemination of scientific information, where knowledge is channelled through paper-based, refereed, academic journals and conference proceedings, following the traditional Garvey-Griffith model (Fig. 2.6) of scientific communication. Concurring with this notion, Serrat (2005) expounds that this traditional dissemination processes based on mechanical, one-way flow of written information have not been successful in encouraging adoption and implementation of research findings. The linear intuitive approach has substantial limitations:

- It does not allow for the fact that innovation sometimes often guides research: basic science is often not the source for all new ideas, but is used to understand new innovation ideas.
- It overlooks the existence of industry publications – industry is also doing research.
- It overlooks the need for capability and capacity at the industry end for university-industry relationships to work, and
- It ignores the many 'non-linear' channels through which knowledge and benefits arise from university-industry relationships.

This recent consensus about the limitations of the linear approach does not mean that this function is no longer significant – merely that it is inadequate to describe the whole range of benefits and relationships. Publications still and will remain an important channel for the communication of new information generated by university research. However, researchers are becoming increasingly involved in publishing their articles in online-refereed journals that provide free or low fee access to scientific information. This emerging model of scientific communication, is best illustrated by the vision for research and scientific publishing for the future as presented in Fig. 2.7.

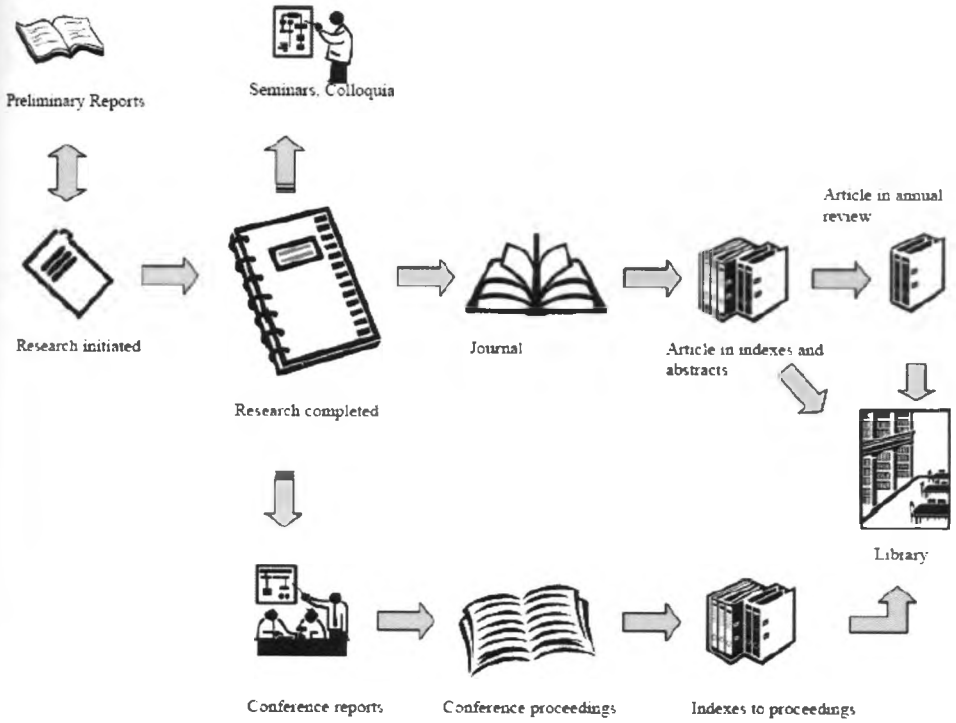



*FIG. 2.6: Garvey-Griffith traditional research dissemination model*

*Source: Kondratova (2004)*

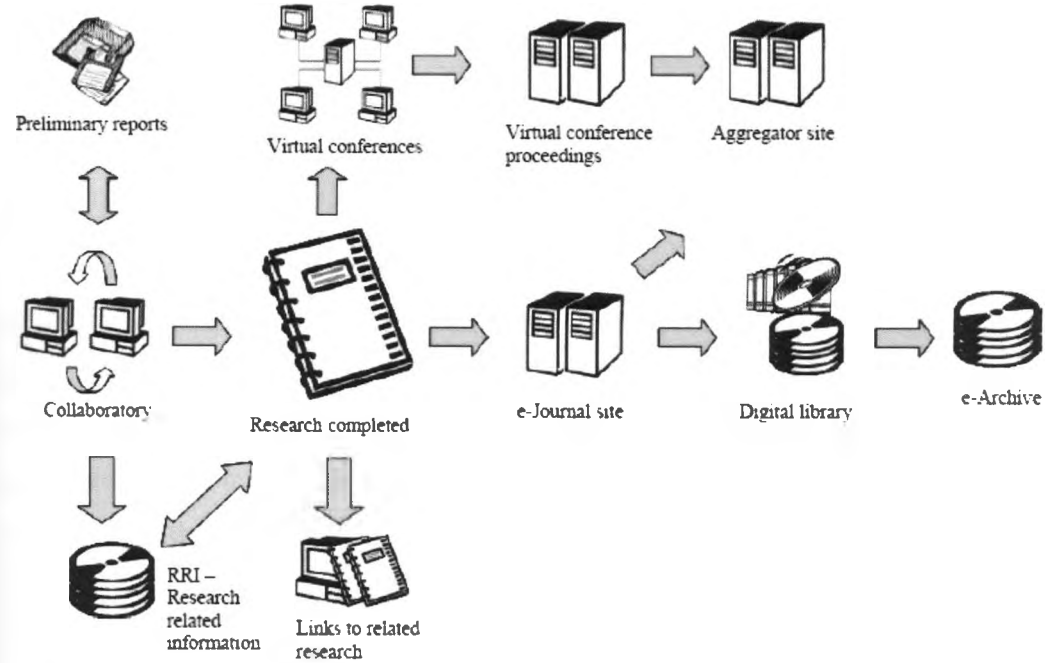



*FIG. 2.7: Emerging scientific dissemination model (Hurd's Model for 2020)*

*Source: Kondratova (2004)*

Interactive approaches suggest that more needs to be known about the needs of research users, and that ways to overcome constraints on research users accessing material need to be developed. This means that people undertaking research may need to be trained in marketing and management skills, so as to maximise the effectiveness of their dissemination strategies. However, if researchers simply provide research users with the information or knowledge they require then a patronising relationship may result.

### 2.3.7 Information Communications Technologies & Research Dissemination

New information technologies are transforming businesses and economies around the world. These technologies are ideally suited to the creation and dissemination of research, and indeed, the developed world is increasingly reliant on communication technologies. However, only in developed countries do stable support mechanisms or the possibility of targeting specific groups exist. The use of dissemination strategies based on technological media is limited in the developed world because of a range of infrastructural, cultural and economic factors. For example, it is estimated that, only 0.4% of the population of developing countries have phone lines, 0.7% a computer, and a dismal 0.05% have internet access (Stone, et. al, 2000).

Techniques of dissemination such as electronic-journals can therefore become stumbling blocks that exclude research disseminations in the developing world. Many researchers like to have their research findings published in peer-reviewed international journals. Publications in peer-reviewed journals are an indicator to the scientific productivity of scientists. Publications attest that the articles have been judged to be of high scientific quality inferring a positive reflection on the calibre of the researcher. However researchers in developing countries have limited possibilities to publish in such journals as Internet access is also still more expensive in developing countries. But the situation is improving by the day and a casual survey of the School of Built Environment at the UON indicates that all research practitioners currently have some access to computers and the Internet.

### 2.3.8 Electronic Thesis and Dissertations (ETDS)

An Electronic Thesis and Dissertation (ETD) System is a coordinated series of procedures for electronic submission, storage, and dissemination of theses and dissertations. ETDs were first developed in 1987 but only with the appearance of Adobe's Acrobat software and Portable Document Format (PDF) in the early 1990s did it become clear that students could easily prepare their own ETDs. The system requires that students and research professionals submit their research reports (thesis) in electronic form within the sponsoring institutions. To coordinate all these efforts, free, voluntary organizations such as, the Networked Digital Library of Theses and Dissertations (NDLTD) have been established to link all these information in the WWW.

UNESCO (2001) is currently championing the use of ETDs for dissemination of research results. It has the eventual goal of aiding all students at all universities worldwide to be able to create electronic documents and to use digital libraries. In so doing, it will promote the sharing of knowledge locked up in universities, and the collaboration of universities spanning across all countries and continents. There are two main types of ETDs.

a) **Researcher created**: These are documents that are prepared by the researcher using some electronic tools (e.g., Microsoft Word), and are then submitted in their approved and final electronic form to their university or institution. The documents are further converted into a form that is easy to preserve, archive, and make accessible for future readers (e.g., that follows standards, such as PDF or XML). These are then submitted, typically over a network connection, usually with related metadata (i.e., "data about data"), often cataloguing information as one might find in a library catalogue, including title, year, author, abstract, and descriptors.

b) **Scanned:** This is an electronic file that is created by scanning in the pages of existing paper thesis. The resulting ETDs require much more digital storage space, they do not easily support full text searching, cannot be flexibly manipulated (e.g.,

cannot be zoomed in on by those with poor vision), and they don't lead to the authors learning about electronic publishing (to prepare them for electronic submission of papers, proposals, or other works as now increasingly being required). Nevertheless, such page images can be made accessible at low cost so that those afar can print and read copies of the original paper pages.

Once submitted, ETDs can be *discovered* through the internet by interested parties, as a result of searching or browsing through the metadata, or by full text searching through the full document (text, and maybe even multimedia components, like images, video, or music). Advantages that could be offered by use of ETDS include: -

- Minimised duplication of effort: Research works will become more visible, reduce repetitiveness, facilitate advances in funding and eventually lead to increased collaboration made possible by electronic communication, across space and time.
- Streamline workflow and savings on time and labour: Checking of submissions and cataloguing is sped up, moving and handling of paper copies is eliminated, and delays for binding are removed.
- Reduction of dissemination costs: - This compares favourably with the amount of money otherwise required publish researches using paper or other media forms.
- Enhancing access to university research: Once ETDs are available, through diverse means, others may gain access. In particular, such access may be the only recourse open to practitioners and researchers in developing countries like Kenya who cannot afford to attend the myriad conferences that demand the considerable expenses related to travel, or who cannot pay for expensive journals.

### 2.3.9 Electronic Research Information in Kenya

**Association of African Universities- Database of African Theses and Dissertations (DATAD):** According to information from their website DATAB (2003), the Association of African Universities (AAU) found it necessary to initiate and support efforts towards putting Africa's research output onto the mainstream of world knowledge due to the

inability to access African research materials. The programme's long-term objectives include creating capacity in African universities for the collection, management and dissemination of theses and dissertations electronically. AAU has worked with eleven pioneering institutions since 1998, and successfully put together the founding records for the DATAD database. Unfortunately, currently only one institution from Kenya, The Kenyatta University, participates in this forum through the African Virtual University (AVU). This is an interactive-instructional telecommunications network based in Nairobi, Kenya with over 34 Learning Centers in 17 African countries. AVU provides a digital library offering access to educational materials, including e-books, online journals and other scholarly publications through it's website; http://www.avu.org.

**Kenya Information Preservation Society (KIPS):** Formerly called the Kenya National Microfilming Society, KIPS was registered in 1993. The broad objective of the Society was to facilitate the preservation and conservation of Kenya's national information heritage. The society's constitution provided for membership of academic and non-academic institutions as well as individuals. Kisenyi (2003) reports that, as part of its' objectives, a union list of theses and dissertations held by universities and research organizations in Kenya is being compiled by the society. This list also includes details of theses and dissertations which reflect research undertaken in Kenya but which are held by institutions located outside Kenya. The list containing the citations of approximately 3,000 theses/dissertations has been made available on CD-ROM Issue no. 1 and distributed since March 2003. The society is currently exploring the possibility of mounting the database on the website of the Kenya National Archives. However it is worthwhile to note that this has been one of the organisations that have made Kenyan theses available outside to North American libraries (Easterbrook, 2004).

Creation of research information in electronic form making it readily accessible via the Web through standard, ubiquitous and free software programs provides the key to dissemination of this information independent of the source of the research. The development of ETDs is envisioned to provide the opportunity for theses and dissertations to be recognized as a basic channel for the dissemination of research

findings and an essential resource in the discovery process (UNESCO, 2001). Therefore, the focus for the future needs to be to ensure optimal access to ETDs by Kenyan construction practitioners and research information seekers.

**Cases of Construction Research Dissemination Activities Kenya:** As opposed to Kenya, South Africa has clear linkages between research, industry and practice. In Kenya, there is neither a central nor a single large-scale research center for building research like the CSIR of South Africa, which is partly funded by the government. The same undertakes research in areas such as policy, sustainable construction, operational performance and public sector support (MOPND, 2004). In addition, public building-related research projects are carried out in many small research institutes, universities, institutes for testing materials, planning offices and by individual researchers. The agencies that have been involved in R&D and promotion and dissemination of appropriate construction technologies in the country are diverse, and include: Intermediate Technology Development Group (ITDG); German Agency for Technical Cooperation (GTZ); Building Research Center (Ministry of Public Works); Housing and Building Research Institute (HABRI); Undugu Society; Approtech; United States Agency for International Development (USAID) and Shelter Afrique to name a few.

### 2.3.10 The case of University of Nairobi

**Background**

The University of Nairobi is the largest University in Kenya. It has the largest and leading library in Kenya. The Library is a very central Unit within the University. It supports academic and research programmes of the University by identifying, acquiring, organizing and disseminating information. In addition, the Library supports academic and research activities of most academic institutions in the country, particularly the neighboring Universities. It is also a source of research information at the national level. The Library is a large complex system with:

- 12 sub-libraries scattered over 8 campuses

- Over 600,000 volumes of books and journals, including a rich collection of Africana materials that consists of higher degree Theses covering a wide area of academic disciplines
- About 300,000 catalogue records, based on universal bibliographic standards.

**Construction Research Activity**

The Research project is a core unit on all Masters degree courses undertaken within the School of Built Environment at the UON. The unit aims to develop students' abilities to frame problems and to better understand and apply novel and robust research methodologies. In order to achieve this aim the curriculum is organised such that students are provided with formal lectures and tutorial workshops to assist them with:

- topic selection
- writing, hypothesis, aims and objectives;
- developing an appropriate research methodology;
- conducting a critical literature review;
- data analysis, drawing conclusions and making recommendations.

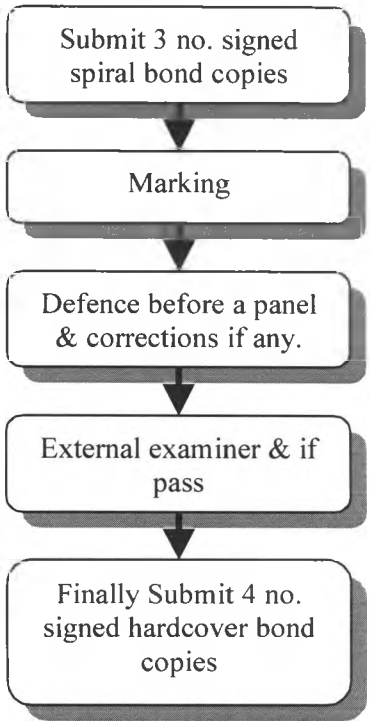
Further to this, the course tutor allocates a personal supervisor. This allocation is undertaken with regard given to the topics chosen and the subject interests of each academic supervisor. The personal supervisors guide and support students progress over the project period. An important aspect of this approach is that it enables formative feedback to be provided at critical stages of methodological development and thesis production.

For example, when the student has drafted hypothesis, aims and objectives these are presented for discussion with the academic supervisor. Supervisory feedback, advice and guidance is provided and where the proposed hypothesis, aims and objectives are not considered acceptable, the student is, with the provision of suitable advice, asked to modify the proposals. By employing this interactive development strategy, formative feedback is provided at all the critical stages of a research undertaking.

**Research Information Handling**

Once completed and accepted. The several bound hard copy thesis are simply stored into various university libraries especially at the department of Building Economics and Management, which are only easily accessible by the university community as;

- The library receives about four copies of every thesis presented to the university. Theses and dissertations are held in the Africana sections of the relevant library/college library or sub-library as the case may be. They are appropriately handled, processed, and preserved.
- The library has a card catalogue with complete bibliographic details. The catalogue is up-to-date and includes a comprehensive standardized cataloguing record. The library has also made attempts to compile a list of theses and dissertations, both in hard copy and in a computerized format, using CDS/ISIS.
- Theses and dissertations are treated like normal library materials, with restricted circulation and borrowing facilities to the general public.




The system therefore does not encourage any dissemination into practise through any other form of research publication.

**Policy issues and Digital Efforts**

**ICT Policy**: The Kenyan Government recognizes the role of ICT in the social and economic development of the nation and has promulgated a national ICT Policy based on the Economic Recovery Strategy for Wealth and Employment Creation (2003-2007). In the National Information & Communications Technology (ICT) Policy released in

January 2006, the Government's vision is to make Kenya a prosperous ICT-driven society.

The UON has also enacted an ICT policy and an established ICT center with its mission stated as "to develop, deploy and support innovative, quality and sustainable ICT solutions and services that meet the changing learning, teaching, research and management needs of the University". Dr. Omwenga (2005), the head of the ICT Center, states that the UON is in the forefront in championing e-learning (electronic distant learning) to complement its academic programs. The emphasis on e-learning will enable the UON, to capture, share, and manage knowledge and skills of the professionals who work in industry, colleges, and universities, and to get the right information to the right people, when and how they need it Accordingly, it has at its disposal, a well tested e-learning software platform - Wedusoft, that is used to provide e-learning courses within and off campus.

**Intellectual property Policy**: In Universities where properly designed and clear Intellectual Property policies exist, researchers/creators become very interested in inventions, creations and their protection. Those doing basic research begin looking for practical applications of their work and others begin doing applied research. Research relationships with industry begin to develop. Researchers start to appreciate the need to protect the inventions and creations before publication. Researchers are very pleased to see their research efforts helping society. If something is licensed commercially and is successful the researcher can share in this too and receive a financial reward.

Although the draft University Of Nairobi Intellectual Property Policy 2002 (UON, 2002) recognises that research at the UON is carried out in an unco-ordinated manner, the same has not been formalised into a Policy document. Currently, the institution still lacks an Intellectual Property policy, which can encourage its researchers to promptly and Openly disseminate their research findings especially through the earlier mentioned digital methods.

**ICT Status:** ICT development at the UON is driven by the ICT Center. One of the Center's listed functions is to increases quality of research. The center has achieved significant successes in linking the University departments through Local Area Networks (LAN) and to the WWW. However, a recent research conducted by Kavulya (2004) concluded that although modern ICT was slowly being incorporated in the management of university libraries in Kenya, their dissemination services were still not effective. To augment this shortfall, The University of Nairobi ICT and Digital Library project (UON, 2003) currently underway, has two key aspects: ICT infrastructure and library automation. The latter is mainly focused on cataloguing existing library material. Digital research dissemination is not highlighted as a core priority.

The university of Nairobi also has a website (http://www.uonbi.ac.ke/) with a link to 'research' which unfortunately contains no information. However, some departments, such as the School of Mathematics are more advanced as their website (http://www.uonbi .ac.ke/acad_ depts/maths/ index.htm) also have a link to 'research' which actually leads searchers to information about such activities in the school. Although this Internet links offers information on researches undertaken, they do not allow any form of access to information therein and as such; any one seeking the innovation must still physically pass through the actual libraries and access the theses shelves.

# CHAPTER THREE

## 3.0 STUDY METHODOLOGY

### 3.1 Introduction

This chapter identifies the methodology and research methods and techniques utilized throughout this research thesis. The methodology for a survey instrument and the sampling design selected is developed. Also research limitations of these methods and techniques are identified and explained.

### 3.2 Research Design

In order to gain an insight into the 'research link to practice' issues raised from a range of viewpoints and variables revealed by the literature review, this study has adopted descriptive survey research method.

Surveys are often used to gather data from a relatively large number of respondents as in this case, within a limited time frame on currently existing phenomenon. Survey research asks questions and is a method, which forces individuals to formulate opinions about these questions (Lindfors, 2003). A descriptive survey is aimed at understanding the relevance of a particular occurrence and describing the distribution of the result in a population (ibid.). The analytical survey would be appropriate for quantifiable data requiring statistical interpretation to gain more meaning (or theory testing).

### 3.3 Population, Sample And Sampling Technique

The survey developed to support this thesis and was administered to five separate survey groups. The study groups Architects, Engineers, Quantity Surveyors, Contractors (practitioners) and construction education academia among therein. The former group is selected primarily based on their significant input in any construction project while the latter would provide insight as the source aspects of construction research. This population will also provide more diversity to determine if there may be some unique factors for comparison data.

Each of the different practitioner groups maintain names of practitioners listed in their registration and professional bodies registers, which also contain email addresses of members. Simple random sampling of the different groups would be obtained off these respective registries. Stratified random sampling was employed against the strata of construction professionals based in Nairobi. Twenty five percent of each strata group was selected randomly so as to get a sample large enough to minimise sampling error to avoid low response of the questionnaires. The total target sample was therefore, two hundred.

*Table 3.1; Sampling Frame*

| Profession | Population Based in Nairobi | Sample size (25%) |
|---|---|---|
| Architects | 254 | 63 |
| Quantity Surveyors | 141 | 35 |
| Engineers | 283 | 70 |
| Contractors Class A,B &C | 128 | 32 |
| Totals | 806 | 200 |

*Source: AAK, IEK, MOPW*

The idea to sample from each profession group was aimed at giving a general response across board for the Kenyan construction industry. The sample size was restricted due to the time and cost limitations. All registered practising construction industry professionals had an equal chance of participating in the survey.

## 3.4 Data Collection Procedures And Tools

In order to gain an insight into the 'research into practice' process from a range of viewpoints, the study used several data collection methods, namely, literature reviews, interviews and questionnaires sent to a representative sample.

The survey instruments were structured questionnaires as presented in appendix A. The object for the survey questions was to establish a set of measurement questions to support the evaluation of Diffusion of Research Innovation in the Construction Industry, Research Dissemination Linkage Pathways, Barriers to Dissemination and Use of

Research Information, Factors Influencing Dissemination Source Of Research Information.

Structured questionnaires were sent to a representative sample of construction industry academia and practitioners (Architects, Engineers, Quantity Surveyors) and General contractors within Nairobi. Those with email addresses were sent the questionnaire digitally. Email meant that there could be quick turnaround where it was necessary to clarify a point raised in a response, hence the iterative nature of the process. In this study, there were a number of instances where emails went 'back and forth' until finally both parties were happy with the survey responses. Email also makes it possible to contact a far greater number of respondents more cheaply and quickly than is possible using other methods. There was a problem that in a small number of cases email addresses originally supplied were not contactable and messages 'bounced' back for various reasons.

## 3.5 Measurement of Variables

The dependent variable, innovation, is measured by use of a structured questionnaire as operationalised in section 2.2.4 of the literature review. Response from construction practitioners would indicate how much innovation is currently in the industry.

The independent variable, research information dissemination pathways (medium), is measured through different statements revealed by literature review through important elements of dissemination, that is, source, content, medium and user in section 2.3.3.

As it is mostly attitudes that were going to be measured, it is suitable to use attitude scaling, which is a well-established method in survey research (Oppenheim, 1992). The study uses a Likert scale because it is one of the most common scales for giving respondents the opportunity to position their attitudes towards a statement on an interval level scale. Likert scaling presumes the existence of an underlying (or latent or natural) continuous variable whose value characterizes the respondents' attitudes and opinions. Second, this scale is probably the most relevant if one wishes to study attitude patterns or explore relationships of attitudes (ibid.). The seven numerical rating Likert scale to be

used for this particular instrument rates the responses from *strongly agree* (7) to *maybe* (4) to *strongly disagree* (1) with no verbal labels for scale points. Innovation use is to be measured in another scale ranging from *Always (7)* to *occasionally (4)* to *never (1).*

Where these aggregated percentages are referred to in the text, a standardised terminology has been developed:

- Agree – disagree scale: points 1 – 3 on the scale are referred to as agree with/totally agree while points 4 – 7 are referred to as perhaps disagree/totally disagree;
- Always 'use of'– never 'use of' scale: points 1 – 4 referred to as occasional/always 'use of' while points 3– 7 represent rarely/never use.

## 3.6 Data Analysis Techniques

This research study is qualitative in nature, and since mainly categorical data is gathered, descriptive analysis techniques are employed to explore the findings. In acknowledging the discrete nature of the Likert scale categorical observations, the data has been summarized as counts (or percentages) occurring in the various response categories. Data analysis involved the use of frequency tables, whose efficacy is supported by the fact that analysts usually desire to know the percentage of the total number of sample objects that fall into a given class, than merely determining the actual frequency.

Data was input into SPSS software for analysis and testing the hypothesis based on the interval level properties offered by the 7-point Likert scales. For the test of research hypothesis, regression analysis using a significance test level of 0.05 between the dependent and independent variables as earlier defined was conducted.

# CHAPTER FOUR

## 4.0 DATA PRESENTATION AND ANALYSIS

### 4.1 Introduction

Preliminary analyses in this section are descriptive in nature and serve as the starting point for subjection of the study parameters to more elaborate and stricter tests. Out of the sample of two hundred (200) practitioners, response was received from thirty-seven (37) of them. Although this response rate was 18.5 %, it was deemed adequate for analysis of the data as the received responses were above the required minimum of 30 no. samples.

### 4.2 Findings and Analysis

The survey questionnaire was designed to establish the respondents' particulars (profession and education level), absorption of innovation, awareness of construction research innovation at the UON's School of Built Environment, sources of research information, responsibility for dissemination of research, barriers to dissemination of research and factors influencing dissemination at the source of research. These are now presented as follows and ensue the testing of the study hypothesis.

#### 4.2.1 Respondent Particulars

*Table 4.1 Respondent profession*

| Respondent profession | Frequency | Percent (%) |
|---|---|---|
| Engineer | 12 | 32.4 |
| Architect | 11 | 29.7 |
| Academia | 5 | 13.5 |
| Quantity Surveyor | 4 | 10.8 |
| Contractor | 3 | 8.1 |
| Other | 2 | 5.4 |
| Total | **37** | **100.0** |

*Source: Field Survey 2006*

*Table 4.2 Educational Level*

| Educational Level | Frequency | Percent (%) |
|---|---|---|
| College | 1 | 2.7 |
| University | 36 | 97.3 |
| Total | **37** | **100.0** |

*Source: Field Survey 2006*

Most of the respondents (97%) had university level education and as such indicative that the understood what the term research involved and should therefore be the prime users of research innovation. Engineer's had the highest response (33.4%) while contractors had the poorest (8.1%). Two respondents listed other professions as project manager and environmental specialist.

### 4.2.2 Current State of Innovation Absorption in the Kenyan Construction Industry

40.5 % of the respondents indicated that the Kenyan construction industry 'occasionally' incorporate innovative ideas in the recent projects they have been involved in. This is evidenced by cumulative 79% of respondents indicting that the incorporate some innovation in their projects from 'occasionally to always'. Although the results show that there is some innovation being undertaken by industry it does not necessarily imply that the same has been accessed through university research results.

*Table 4.3 Current State of Innovation Absorption in the Kenyan Construction Industry*

| | **Frequency** | **Percent (%)** |
|---|---|---|
| Never | 3 | 8.1 |
| Almost Never | 3 | 8.1 |
| Rarely | 4 | 10.8 |
| Occasionally | 15 | 40.5 |
| Frequently | 5 | 13.5 |
| Almost always | 4 | 10.8 |
| Always | 3 | 8.1 |
| **Total** | **37** | **100.0** |

*Source: Field Survey 2006*

### 4.2.3 Awareness of Research Innovation in Kenyan Construction Industry

The ensuing question attempted to establish how much of the industry innovation can be linked to research work identified at the university libraries. The following Table 4.4 is a summary of the detailed recorded responses as per the table in Appendix B.

*Table 4.4 Awareness of Innovation in Kenyan Construction Industry*

| Awareness of Innovation in Kenyan Construction Industry<br>**How often have you used the following innovation?** | **% indicating "occasional" to "always" use of university research innovation** |
|---|---|
| 1. Use of ICT and computers in most of your business processes. | 100.0 |
| 2. Use of *Selective Tendering* method | 89.1 |
| 3. Use of Contractors who have undergone some formal training or (for contractors)- undergone some formal training before registration. | 70.2 |
| 4. Use of new procurement methods such as *Design and build, Construction Management, Management contracting, Partnering* | 59.4 |
| 5. Use of *Project Management services* | 54.8 |
| 6. Use of off-site fabrication of more parts of the buildings under construction. | 51.3 |
| 7. Accessing innovation information in any Construction Industry Project Research and Information Center. | 51.3 |
| 8. Use of On-job training of craftsmen by field technicians in construction sites. | 45.9 |
| 9. Use of contractors' safety records as a factor in the pre-qualification of construction tendering. | 32.4 |
| 10. A *mathematical formulae* which uses the cost and height of the building for estimation of construction periods | 24.3 |
| 11. Use of a safety management plan and employing service of safety experts as a requirement in construction sites. | 29.7 |
| 12. Use of bonus incentive work targets by construction trade gangs | 29.7 |
| 13. Use of a Materials Management plan in a construction projects | 29.7 |
| 14. Employing services of a risk manager and of risk management strategy in a construction project. | 13.5 |
| 15. A mathematical model to analyse future building maintenance costs at feasibility study stage. | 10.8 |
| 16. Use of a *Marketing Specialists* to market your professional/ construction services | 10.8 |
| 17. An objective mathematical predictive model to predict on cost risk, time risk, cost overrun and time overrun. | 5.4 |

*Source: Field Survey 2006*

### 4.2.4 Use of sources of research information (Dissemination Medium)

Construction Professional journals and magazines was the most preferred path for accessing research innovation with 83.3% reporting "occasional" to "always" use of sources. The top preferred mediums included hardcopy (magazines, books and refereed journals), direct contact (networking & conferences) and the Internet (WWW). Ominously, thesis placed in a library, the currently existing dissemination strategy, was the least used medium at 16.2% together with research centers. The relatively poor score for Partnerships and collaboration (21.6%) indicates a grim picture that very little deliberate relationship between the University research and the construction industry.

*Table 4.5 Dissemination Linkage Pathways*

| Dissemination Linkage Pathways<br>**How often do you or your organisation use the following as a source of information on innovation?** | **% Indicating "occasional" to "always" use of sources of research innovation** |
|---|---|
| 1. Construction Professional journals and magazines | 83.7 |
| 2. Written books and chapters drawn from research studies | 78.3 |
| 3. Networking: *Sharing research information between professional colleagues* | 67.5 |
| 4. Construction Research in Internet, e-mail and worldwide web | 64.8 |
| 5. Conference, workshops and seminars on current research results demonstrations | 62.1 |
| 6. Academic refereed journals | 54.0 |
| 7. CD-ROMs, DVDs with research information | 45.9 |
| 8. Research reports: *Detailed summary of research* | 40.5 |
| 9. Mass media: *Construction innovations in newspapers, television and radio.* | 35.1 |

| | |
|---|---|
| 10. Partnerships/collaborations/Funding: *Working together with university/research institution on identified research projects.* | 21.6 |
| 11. Thesis placed in a library | 16.2 |
| 12. Research Centers: *Specialist agency intervening to disseminate and explain research results.* | 16.2 |

*Source: Field Survey 2006*

### 4.2.5 Responsibility for disseminating research information

Survey respondents were asked who in their opinion should be given the primary responsibility for disseminating research information and responded as below.

*Table 4.6 Responsibility for disseminating research information*

| | Frequency | Percent |
|---|---|---|
| Construction professional Bodies/Associations | 20 | 54.1 |
| Central Construction Research Information Centers | 11 | 29.7 |
| University or sponsoring institution (Library) | 4 | 10.8 |
| Researcher/Author of the research | 2 | 5.4 |
| **Total** | **37** | **100.0** |

*Source: Field Survey 2006*

More than half (54.1%) of the respondents indicate that Construction Professional bodies such as the AAK and IEK should be charged with the responsibility of disseminating research information. Inference would mean that users of construction research innovation would therefore seem to have a more comfortable relationship with the professional bodies than the research-sponsoring institute. Currently, the situation is that research innovations lie at the University library and practitioners can only access the information by physically visiting the facilities. It is therefore necessary that University thesis reports be made accessible through these professional bodies as the fastest means of disseminating the same. Respondents also favorably considered Central Construction Research Information Centers at 29.7% as the second preferred source of dissemination even though it was among the least used medium as reported in the previous section.

### 4.2.6 Barriers To Dissemination and Use Of Research Information

Respondents were asked whether they agreed with statements of perceived barriers as identified by literature review.

**User Issues:** In the User element of dissemination, the user ability to change already identified in the literature review as an important factor was rated the most significant barrier together with 'research conducted by academics with no grounding in the real issues of construction practice' both at 59 %. This lack of readiness to change is not necessarily negative, however; it may serve to question the practical worth of some research. It is however worthwhile to note that user factors were not considered great barriers as respondents 'strongly disagreed' in 70% (Appendix. C) of the barrier statements. Respondents reported that research was essential for professional growth (60%) having skills to read and use research findings while at the same time 49 % exhibited trust in the university's capacity for the required innovation knowledge generation.

*Table 4.7 User Barriers To Dissemination and Use Of Research Information*

| Barriers To Dissemination and Use Of Research Information<br>**Do you agree with the following statements?** | | **% Indicating from 'moderate' (perhaps) or great barrier (strongly agree).** |
|---|---|---|
| **USER ATTITUDES** | 1. Construction Industry practitioners are not willing to change their set ways of operations. | 59.4 |
| | 2. Research is conducted by academics with no grounding in the real issues of construction practice/teaching | 59.4 |
| | 3. Universities do not have the knowledge or information that construction firms need. | 48.6 |
| | 4. I do not have time to find and read research | 45.9 |
| | 5. Much of the research I hear of/read bears no relevance to my professional teaching/work | 43.2 |
| | 6. I am not confident in my ability to interpret the findings of research correctly | 23.9 |
| | 7. Keeping up-to-date with research is not an essential part of professional development. | 18.9 |
| | 8. I am not confident in my ability to evaluate the quality of research | 18.9 |
| | 9. Being up-to-date with research does not aid career progression | 13.5 |
| | 10. I don't have the skills to make use of research | 13.5 |

*Source: Field Survey 2006*

**Content Issues:** These issues are related to access and relevance of the research information and respondents did not consider the language content used in research difficult to understand as only 29% considered it a great barrier. On the issue of relevance, 59% of respondents believed that there was little research related to their subject area and this was a significant barrier in dissemination of research innovation. Again, this could be cause d by inability to readily access the same as observed earlier. Echoing findings of dissemination mediums used, respondents affirmed that relevant research literature was not compiled in common access areas (91%), was not easily available (83%) and that information about existing research was also not available (81%).

*Table 4.8 Content Barriers To Dissemination and Use Of Research Information*

| Barriers To Dissemination and Use Of Research Information<br>**Do you agree with the following statements?** | | **% Indicating from 'moderate' (perhaps) or great barrier (strongly agree).** |
|---|---|---|
| CONTENT | 1. Relevant literature on research is not compiled in one place | 91.5 |
| | 2. Research reports/articles are not easily available | 83.7 |
| | 3. Information about the existence of relevant research is not available | 81.0 |
| | 4. There is little research related to my subject area | 59.4 |
| | 5. The language of research results is not easy to understand. | 35.1 |
| | 6. The amount of research available is overwhelming | 29.7 |

*Source: Field Survey 2006*

**Medium Issues:** Responses to these barriers were based on the current status of research accessed through thesis reports placed in the university library and as such, respondents confirmed that this was not the most efficient channel of disseminating research results. The literature reviewed denotes direct personal interaction as the most important aspect of an effective medium for disseminating information yet 59% of respondents agreed that lack of funds was a great inhibiter to facilitate contact through seminars and other forms of meetings. 89% of the respondents have access to the World Wide Web and the Internet therefore acknowledging the need for research innovation to be disseminated through opportunities offered by the medium.

*Table 4.9 Medium Barriers To Dissemination and Use Of Research Information*

| Barriers To Dissemination and Use Of Research Information<br>**Do you agree with the following statements?** | | **% Indicating from 'moderate' (perhaps) or great barrier (strongly agree).** |
|---|---|---|
| MEDIUM | 1. Research reports/articles are not published fast enough | 75.6 |
| | 2. The university library does not provide access to research information | 67.5 |
| | 3. Other libraries nearby do not provide access to research information | 59.4 |
| | 4. I do not have funds to attend seminars, conferences and workshops on research findings | 59.4 |
| | 5. My profession/work does not encourage research based practice | 37.8 |
| | 6. I have no access to the World Wide Web and the Internet | 10.8 |

*Source: Field Survey 2006*

**Source Issues:** The source of research innovation under examination in this context was the universities currently undertaking construction research. Respondents who had participated in any for of this kind of research were asked whether they agreed with some predetermined barrier statements. Responses to these barriers statements were considered as among the great barriers to effective research dissemination averaging 68%. About 82% stated that the University(s) did not have research dissemination policies and strategy, while 68% were not aware of new publishing technologies such as ETD's. Interestingly, only about 18% of the responses indicated having no access to the Internet.

Generally, the responses indicated that construction research currently undertaken at the institutions was not focused on dissemination. Once a report is accepted and placed in the library, little effort is made to inform the affected parties (practitioners) of the innovations.

*Table 4.10 Source Barriers To Dissemination and Use Of Research Information*

| Barriers To Dissemination and Use Of Research Information<br>**Do you agree with the following statements?** | | **% Indicating from 'moderate' (perhaps) or great barrier (strongly agree).** |
|---|---|---|
| **SOURCE**<br>(Percentages are multiplied by a factor of 1.32 since only 28 of the 39 samples responded. | 1. The University/Institution does not have research dissemination policies and strategy. | 82.1 |
| | 2. No time is allocated to dissemination research findings. | 78.5 |
| | 3. There is no effort in transforming putting out "readable" information for practitioners. | 78.5 |
| | 4. There is lack of funding for dissemination of research results | 78.5 |
| | 5. The University/Institution does not have specific copyright and intellectual ownership legislation in place. | 75.0 |
| | 6. There is limited access to new publishing technologies | 75.0 |
| | 7. I am not aware of the new publishing technologies, such as ETDS. | 67.8 |
| | 8. It is not my responsibility to disseminate research. | 67.8 |
| | 9. There are no rewards for having research findings applied in practice, as the motto for survival is "publish or perish". | 64.2 |
| | 10. There are limited avenues for publication with a lack of locally peer reviewed journals that are reputable in the country | 64.2 |
| | 11. I have no access to the world wide web and the internet | 17.8 |

*Source: Field Survey 2006*

**Barriers To Research Dissemination Summary:** In summary the barriers attributed to the source element of dissemination scored the highest indication (68.12%) of a great obstruction to effective dissemination of research innovation as indicated by the average tallies in Table 4.11. User barriers at 34.5% were not considered as significant to the dissemination process.

*Table 4.11 Elements of Dissemination Barriers to use of Research Information*

| Barriers To Dissemination and Use Of Research Information | | **Average % Indicating from 'moderate' (perhaps) or great barrier (strongly agree).** |
|---|---|---|
| **Dissemination Elements** | 1. Source | 68.1 |
| | 2. Content | 63.4 |
| | 3. Medium | 51.8 |
| | 4. User | 34.5 |

*Source: Field Survey 2006*

## 4.3 Relationships Analysis.

Tests carried out involved the study dependent variable (an aggregated weighted scoring of all research innovations) and the independent variable (all surrogates of the dissemination pathway factors). Statistical relationships between variables rely on notions of correlation and regression. The study used these two concepts aim to describe the ways in which variables relate to one another.

3.1 **Descriptive Statistics:** The mean and standard deviation are as indicated in Table 4.12. The histogram (Fig. 4.1) indicated a close to normal distribution, thus indicating that the statistical parameters were close to normal distribution. The skew ness is less than one, which means that the data had a normal distribution.

*Table 4.12: Descriptive Statistics*

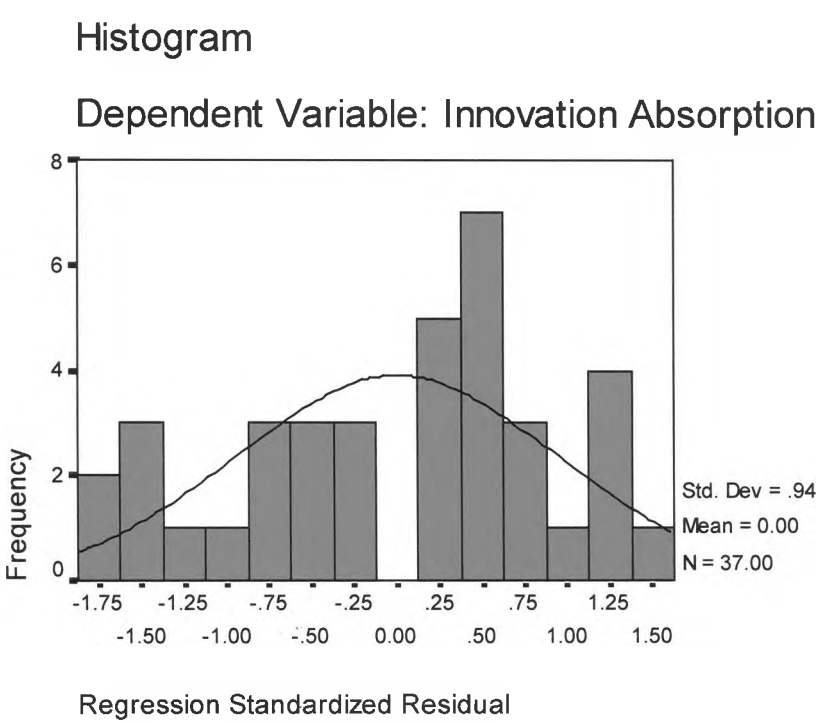
| | Mean | Std. Deviation | N |
|---|---|---|---|
| Innovation Absorption | 4.35 | 1.75 | 37 |
| Research reports: Detailed summary of research | 3.19 | 2.05 | 37 |
| Academic refereed journals | 3.51 | 1.82 | 37 |
| Written books and chapters drawn from research studies | 4.95 | 1.60 | 37 |
| Construction Professional Journals and Magazines | 4.46 | 1.54 | 37 |
| Thesis placed in a library | 2.08 | 1.40 | 37 |
| CD - Rom, DVDs with research information | 4.35 | 2.02 | 37 |
| Construction Research in Internet, e -mail and worldwide web | 3.41 | 1.99 | 37 |
| Conference, workshops and seminars on current research results demonstrations | 3.81 | 1.65 | 37 |
| Networking: Sharing research information between professional colleagues | 4.08 | 1.59 | 37 |
| Partnerships/collaborations/Funding: Working together with university/research institution on identified research projects | 2.08 | 1.69 | 37 |
| Research Centers: Specialist agency intervening to disseminate and explain research results | 1.78 | 1.18 | 37 |
| Mass media: Construction innovations in newspapers, television and radio | 2.68 | 1.65 | 37 |

*Source: Field Survey 2006*

4.3.2 **Correlation Among Variables:** Correlation tests are used to determine how strongly the scores of two variables are associated or correlated with each other. The most commonly used relational statistic is the correlation *coefficient*, known as *Pearson's R*. It is used to a measure the strength and direction of the relationship between two variables.

The test was hence used to determine the relationship between the variables under study. A correlation coefficient above + 0.7 shows that variables are highly correlated. Interpretation of a correlation coefficient does not even allow the slightest hint of causality. Correlation performed on the independent variables show only how values relate among themselves. This is necessary because any two variables having a correlation of more than 0.7 implies that one of the independent variables is redundant and hence should be dropped from the model. The analysed correlation data is in Table 4.12. To avoid multi-co-linearity, such interrelated variables were removed.

*Figure 4.1:Histogram*




*Source: Field Survey*

*Table 4.13 Correlation of Research Variables*

| | | Innov. | Res. rep | Acad. ref | Written | Prof Jou. | Thesis | CD - Rom, | Internet | Conference, | Network | Partners. | Cent | media: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pearson Correlation | Innov. | 1.000 | .020 | -.006 | .196 | .423 | .079 | .019 | .308 | .024 | -.260 | -.094 | .051 | -.046 |
| | Res. rep | .020 | 1.000 | .754 | .630 | .508 | .612 | .574 | .572 | .446 | .430 | .508 | .567 | .330 |
| | Acad. ref | -.006 | .754 | 1.000 | .497 | .469 | .626 | .381 | .416 | .441 | .177 | .546 | .557 | .390 |
| | Written | .196 | .630 | .497 | 1.000 | .722 | .386 | .644 | .688 | .587 | .505 | .207 | .273 | .256 |
| | Prof Jou. | .423 | .508 | .469 | .722 | 1.000 | .278 | .385 | .527 | .265 | .223 | .146 | .148 | -.016 |
| | Thesis | .079 | .612 | .626 | .386 | .278 | 1.000 | .373 | .316 | .247 | .097 | .513 | .564 | .180 |
| | CD - Rom, | .019 | .574 | .381 | .644 | .385 | .373 | 1.000 | .669 | .547 | .641 | .293 | .243 | .152 |
| | Internet | .308 | .572 | .416 | .688 | .527 | .316 | .669 | 1.000 | .515 | .507 | .328 | .463 | .362 |
| | Conference | .024 | .446 | .441 | .587 | .265 | .247 | .547 | .515 | 1.000 | .399 | .185 | .378 | .580 |
| | Network | -.260 | .430 | .177 | .505 | .223 | .097 | .641 | .507 | .399 | 1.000 | .163 | .202 | .339 |
| | Partners. | -.094 | .508 | .546 | .207 | .146 | .513 | .293 | .328 | .185 | .163 | 1.000 | .788 | .149 |
| | Cent | .051 | .567 | .557 | .273 | .148 | .564 | .243 | .463 | .378 | .202 | .788 | 1.000 | .447 |
| | media: | -.046 | .330 | .390 | .256 | -.016 | .180 | .152 | .362 | .580 | .339 | .149 | .447 | 1.000 |
| Sig. (1-tailed) | Innov. | . | .454 | .486 | .123 | .005 | .322 | .455 | .032 | .445 | .060 | .289 | .382 | .394 |
| | Res. rep | .454 | . | .000 | .000 | .001 | .000 | .000 | .000 | .003 | .004 | .001 | .000 | .023 |
| | Acad. ref | .486 | .000 | . | .001 | .002 | .000 | .010 | .005 | .003 | .147 | .000 | .000 | .009 |
| | Written | .123 | .000 | .001 | . | .000 | .009 | .000 | .000 | .000 | .001 | .109 | .051 | .063 |
| | Prof Jou. | .005 | .001 | .002 | .000 | . | .048 | .009 | .000 | .056 | .092 | .195 | .191 | .462 |
| | Thesis | .322 | .000 | .000 | .009 | .048 | . | .012 | .028 | .070 | .284 | .001 | .000 | .144 |
| | CD - Rom, | .455 | .000 | .010 | .000 | .009 | .012 | . | .000 | .000 | .000 | .039 | .074 | .185 |
| | Internet | .032 | .000 | .005 | .000 | .000 | .028 | .000 | . | .001 | .001 | .024 | .002 | .014 |
| | Conference | .445 | .003 | .003 | .000 | .056 | .070 | .000 | .001 | . | .007 | .136 | .011 | .000 |
| | Network | .060 | .004 | .147 | .001 | .092 | .284 | .000 | .001 | .007 | . | .167 | .115 | .020 |
| | Partners. | .289 | .001 | .000 | .109 | .195 | .001 | .039 | .024 | .136 | .167 | . | .000 | .189 |
| | Cent | .382 | .000 | .000 | .051 | .191 | .000 | .074 | .002 | .011 | .115 | .000 | . | .003 |
| | media: | .394 | .023 | .009 | .063 | .462 | .144 | .185 | .014 | .000 | .020 | .189 | .003 | . |
| Z | Innov. | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Res. rep | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Acad. ref | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Written | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Prof Jou. | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Thesis | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | CD - Rom, | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Internet | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Conference | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Network | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Partners. | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | Cent | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| | media: | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |

*Source: Field Survey*

### 4.3.3 Regression Analysis:

Regression is the closest thing to estimating causality in data analysis, and that's because it predicts how much the numbers "fit" a projected straight line, known as linearity or linear relationship. The simple regression was carried out to determine the extent to which the independent variables (dissemination pathways) could be used to predict the dependent variable (innovation absorption). Step-wise regression method adoption was because it showed only the variables that were important. A high significance level of 0.05 was applied. This meant that the analysed results had a 95% confidence level.

*Table 4.14 Correlations Variables Entered/Removed*

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | Construction Professional Journals and Magazines | . | Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100). |
| 2 | Networking: Sharing research information between professional colleagues | . | Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100). |
| 3 | Construction Research in Internet, e -mail and worldwide web | . | Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100). |
| 4 | Academic refereed journals | . | Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100). |

*Dependent Variable: Innovation Absorption*

*Source: Field Survey*

### 4.3.4 Model summary:

The first entry was 'Construction Professional Journals and Magazines', followed by 'networking', then 'construction research in Internet' and lastly 'academic refereed journals'. Hence, these represented the four predictors of innovation absorption. The first one contributed to the effects of the dependent variable at R square of .179, implying that

it accounted for 17.9 percent of the research innovation absorption. Together with networking, their combined resultant effect by the R square was .311 meaning they cumulatively accounted for 31.1 percent of research innovation absorption. Combining the two with 'construction research in Internet', resultant effect by the R square was .406 (40. 6 percent). The four variables together accounted for .480 (48%) to predicting research innovation absorption. This means that the four variables out of the total twelve account for 48% variance by the data.

The rest of the variables (67% of the total) (*research reports, written books and chapters, thesis placed in a library, CD-Roms, conference, workshops and seminars, partnerships/collaborations/ funding, research centers, and mass media*) accounted for 52.0% of innovation absorption.

*Table 4.15: Model Summary*

| | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .423 | .179 | .155 | 1.61 | .179 | 7.627 | 1 | 35 | .009 |
| 2 | .558 | .311 | .271 | 1.50 | .132 | 6.534 | 1 | 34 | .015 |
| 3 | .637 | .406 | .352 | 1.41 | .095 | 5.271 | 1 | 33 | .028 |
| 4 | .693 | .480 | .415 | 1.34 | .074 | 4.563 | 1 | 32 | .040 |

*Source: Field Survey*

### 4.3.5 F statistic

This showed the combined influence of all the independent variables, which are the significant predictors of the dependent variable. The Table 4.16 provides the value of the F-statistic and its significance. There is a linear relationship between innovation absorption and the entire set of independent variables, 'Construction Professional

Journals and Magazines', 'networking', 'construction research in Internet' and 'academic refereed journals'.

For testing the hypothesis the research preferred to use F-test for significance instead of multiple runs of t-tests to avoid Type 1 error. F-tests are also considered much more powerful statistically, as they allow explanation of variance in one variable accounted for by variance in another variable. In this sense, they are very much like the coefficient of determination.

*Table 4.16: ANOVA*

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 19.759 | 1 | 19.759 | 7.627 | .009 |
| | Residual | 90.674 | 35 | 2.591 | | |
| | Total | 110.432 | 36 | | | |
| 2 | Regression | 34.375 | 2 | 17.188 | 7.683 | .002 |
| | Residual | 76.057 | 34 | 2.237 | | |
| | Total | 110.432 | 36 | | | |
| 3 | Regression | 44.850 | 3 | 14.950 | 7.523 | .001 |
| | Residual | 65.582 | 33 | 1.987 | | |
| | Total | 110.432 | 36 | | | |
| 4 | Regression | 53.035 | 4 | 13.259 | 7.392 | .000 |
| | Residual | 57.397 | 32 | 1.794 | | |
| | Total | 110.432 | 36 | | | |

*Source: Field Survey*

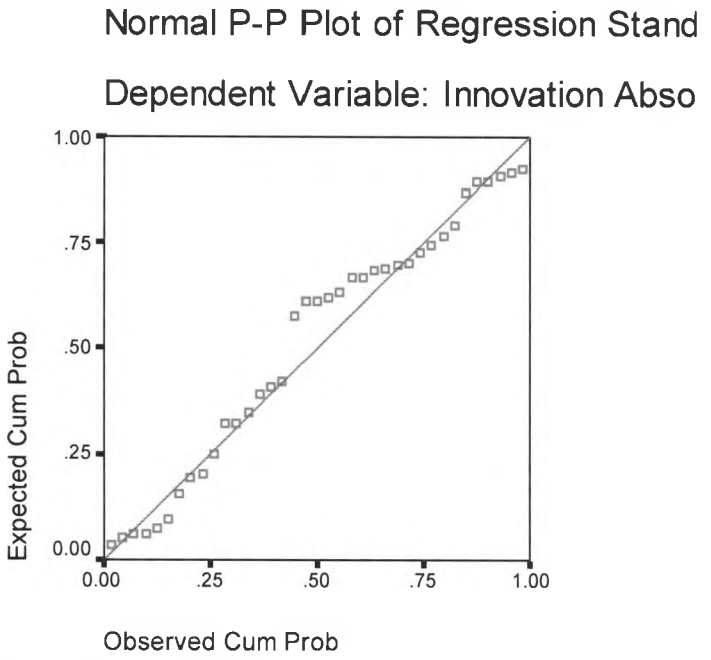



*Figure 4.2: Regression' Line Of Fit'*
*Source: Field Survey*

## 4.4 Hypothesis Testing

In the first chapter this research suggested a direct positive relationship between construction research findings dissemination to the Kenyan construction industry and the absorption rate of construction innovation. Testing this premise at 95% confidence level. has the implication that based on the data available from the respondents to the questionnaires; that one can be 95% confident, allowing for 5% error that the hypothesis formulated in respect of any independent variable with respect to the manual handling is true or false. For a given number of variables, the null and alternative hypothesis for each variable was formulated in the form:

Null Hypothesis:

$$H_o : {}^{2}_{1.235.....n} : \delta^{2}_{2.125} = \delta^{2}_{.1235..... n-1}$$

Alternative Hypothesis:

$$H_A : {}^{2}_{1.235.....n} : \delta^{2}_{2.125} = \delta^{2}_{.1235..... n-1}$$

Where: $\delta^{2}_{2.125}$ .... Are expected variances of $X_1$, $X_2$ .....$X_n$; when the effect of all other variables except the $X_i$ under consideration is held constant.

**Testing Using The F Test:** The null hypothesis $H_o$, states that there is no relationship between each of the independent variables and the dependent variable. The alternative hypothesis $H_A$ states that there is a direct positive relationship between the independent and the dependent variable. The F statistic will be used to test the existence or otherwise of a relationship.

$H_0$: The variances are equal in the two variables. ($\sigma^2_1 = \sigma^2_2$)

$H_A$: The variances are *not* equal in the two variables. ($\sigma^2_1 \neq \sigma^2_2$)

The group degrees of freedom are one less than the number of groups; $df_{group} = k-1$; so in this case we have 2 groups and therefore 1 degrees of freedom in the numerator. Using F distribution tables (Source: Spedecor, et al. (1980), the same indicate as below.

*Table 4.17: Relationship Of Dissemination To Innovation Absorption.*

| Variable | F – calculated | F- tabulated | $H_A$ Tested at 95% Confidence Level |
|---|---|---|---|
| Construction Professional Journals and Magazines | 7.627 | 4.84 | Accepted |
| Networking: Sharing research information between professional colleagues | 7.683 | 4.96 | Accepted |
| Construction Research in Internet, e - mail and worldwide web | 7.523 | 5.15 | Accepted |
| Academic refereed journals | 7.392 | 5.32 | Accepted |

*Source: Field Survey*

Since in the academic refereed journal the ultimate contributing entry into the regression model 7.392> 5.32 at $p<0.05$ we can reject the null hypothesis $H_o$. Therefore, there is a causal relationship between the dissemination of research findings and the absorption rate of innovation.

# CHAPTER FIVE

## 5.0 CONCLUSIONS

### 5.1 Introduction

From the onset, it was the goal that the results of this research project would give momentum to and highlight ~~the importance~~ the importance of research dissemination to an innovative construction industry. From the findings presented herein, deductions have been made as a result of the reviewed literature and the data collected from the survey. The same have also been analyzed against the objectives set at the onset with consideration of the stated study limitations.

### 5.2 Study Limitations

Time and limited resources (funds) were the main limiting factors for this research study. The course timeline required that a report be handed in within three months and as such impacted on the narrow scope of the study area and the time to collect all study questionnaires. With limited funds, the survey had to geographically be conducted only within Nairobi city as reaching practitioners throughout the country was not possible. These two limitations hence contributed significantly to the general design of the research study.

Therefore, because the innovation concept encompasses and can be sourced from wide spheres (industry design, experimenting, informal sector, R&D centers, other universities, etc.) and that it cannot be measured in a standard manner, the study was limited to innovations emanating only from university of Nairobi construction research. The resultant survey sample was thus limited to formal construction professional practitioners who by nature of their training, were assumed to have some awareness of formal research processes. The focus on this group was driven by the fact that the survey principally concerned dissemination of university research innovation into industry rather than the broader range of innovation activities (including the informal sector) within the entire industry. These limitations however focused the study to a manageable project.

## 5.3 Discussions

The first objective was to establish the level of use (absorption) of research innovation by industry practitioners. The responses ranged between 100% (ICT use) to 5.4% (an objective mathematical predictive model to predict on cost risk, time risk, cost overrun and time overrun). The study found that only a weighted average 41.6% of the seventeen identified construction research innovations had been used by the construction practitioners. This indicates that there has not been effective dissemination of the research information by the university as there was only a contribution of 16.2% of the current dissemination tool used, 'thesis placed in library', to the calculated weighted average.

On the second objective, the study intended to determine which dissemination mediums practitioners use to access research innovation. The study identified the following.

**User issues/attitudes:** The user barriers ranged between 59.4% and 13.5%. 59% of practitioners believed that construction industry practitioners are not willing to change their set ways of operations and that, universities do not have the knowledge or information that construction firms need. Most of the users also did not believe that they did not have necessary skills to read (13.5%) and evaluate the quality of research (19%). Importantly, only 45% of respondents intimated that they had no time to find and read research although the same is considered as a great barrier in reviewed literature. These issues can be resolved if the research process focuses on cooperation between researchers and industry. Interaction between the two could alleviate this issue of trust and improve application of research in construction industry processes. The user barriers averaged at 34.5% were not considered great impediments to research dissemination.

**Content issues:** The content barriers stretched between 91.5% and 29.7%. Although most of the respondents believed that the university is competent in research activities, 91% of practitioners felt that relevant literature on research is not compiled in one place and as such, relevant research reports/articles are not easily available. In addition the

information about the existence of relevant research is not also available to practitioners. Almost 60% of practitioners therefore held a view that there is little research related to their subject area. This view was probably held due to inaccessibility of already existing research information as the completed theses are only stored at the university library. In relation to perceived user barriers (at 38.4%), practitioners believed that university research was relevant and as such, the quality of research content appears to be a necessary, but insufficient, consideration in the successful use of research outcomes as revealed by the literature review.

**Medium issues:** The medium barriers ranged between 75.6% and 10.8%. On the mediums preferred by the study respondents, only 16% use the current dissemination medium 'thesis placed in library or research centers as a source of research innovation. Publications (construction professional journals and magazines) at 83.3% still and continue to remain an important channel for the communication of new information generated by university research. The 67% use of networking by respondents to source research innovation was in concurrence with reviewed theories that consider direct face-to-face personal interaction the most important aspect of an effective dissemination medium.

However, if we consider that ICT use was recorded as the highest used innovation, 64% of practitioners use the internet for information on research innovation and that less than 20% considered 'no access to the WWW' as a barrier, there appear to be a strong case for exploring these use of electronic technologies for effective dissemination pathways.

**Source of research issues:** The user barriers ranged between 82.1% and 17.8%. The study found that the following barriers existed as per over 60% respondents in agreement accorded to the various statements. Most importantly, the University/Institution appears not have a research dissemination policies and strategy and consequently;

- No time is allocated to dissemination research findings.
- There is no effort put into transforming putting out "readable" information for practitioners.

- There is lack of funding for dissemination of research results
- The University/Institution does not have specific copyright and intellectual ownership legislation in place.
- There is limited access to new publishing technologies
- Most researchers were not aware of the new publishing technologies, such as ETDS.
- Most researchers felt that it was not their responsibility to disseminate research.
- There are no rewards for having research findings applied in practice
- There were also limited avenues for publication with a lack of locally peer-reviewed journals that are reputable in the country.

Literature reviewed indicated that the source of information disseminated is generally more important to users than the content of the information and the study identified the source (university) as the element exhibiting the most averagely weighted barriers (averaged at 68.1%) to dissemination of research information. It is therefore imperative that its inherent issues be first addressed for effective dissemination of research innovation to practise.

The medium used at the research source, 'thesis placed in library' is not considered effective link to dissemination of research innovation as indicated by the findings. It was also noted that while only about 18% of practitioners indicated having no access to the Internet, 68% were not aware of new publishing technologies such as ETD's now considered as an effective medium of research dissemination.

The fourth objective was to examine optimal dissemination strategies that will enhance linkages between research institutions and industry. The study identified dissemination as the process of sharing information and knowledge hence the conduit for linking university research and construction industry practise. In modern systems, research is now about both generation and dissemination of findings. The source (universities) having been identified as the most important element should be the prime mover in the dissemination strategy. The study also recognized that for the university to be effective

in stimulating innovation and industrial growth, it must collaborate with industry and use the right mix of the following main dissemination medium.

- Construction Professional journals and magazines
- Networking: *Sharing research information between professional colleagues*
- Construction Research in Internet, e-mail and worldwide web
- Academic refereed journals

Respondents (54%) intimated that this kind of collaboration be pursued through their respective professional organisations. Interactive approaches suggest that more needs to be known about the needs of research users, and that ways to overcome constraints on research users accessing material need to be developed. The thesis placed in library can redistributed into the optimum 'medium mix'. In addition, from reviewed literature, ETD's, although currently not well known by industry practitioners, would offer the best channel of designing the dissemination mix.

The fifth objective was to establish the relationship between university construction research findings dissemination and the absorption rate of construction innovation in the Kenyan construction industry. The variance analyses and the ensuing acceptance of the research hypothesis indicate that the dissemination of research information has some direct positive influence on the rate of absorption use. This is despite the significant variables of dissemination, 'Construction Professional Journals and Magazines', 'networking', 'construction research in Internet' and 'academic refereed journals'. accounting for only 48% towards predicting the use of innovation.

## 5.4 Implication of Findings

The study has established that effective dissemination of research findings has a positive influence in the absorption rate of innovation with the construction industry. The implication of the findings is that if the university research innovation is to significantly stimulate innovation and industrial growth, the university should prioritise and focus on implementing optimum strategies for disseminating its existing research information so as to improve on this relatively low influence the tested variable currently exhibit.

## 5.5 Recommendations

1. To improve on dissemination through collaboration between the university and practitioners, the author recommends that the School of Built Environment pursue possibilities of 'action research'. Action Research demands collaboration between the researcher and the researched and leads to the development of a shared understanding. The same can be approached using the following strategies:

   - For students, particularly those studying by the part time route, the use of their own business organisation or workplace as a context for a dissertation research project provides further dimensions for dialogue and research partnerships between practitioners and academia.

   - The University collaborate with practitioners (who are also their students) through their professional bodies to identifying the current and future needs of the construction industry in terms of research and in need of practical solutions. The identified problems can then be prioritised and put forward to postgraduate students for research solutions. This way, the issue of irrelevance is solved and practitioners can now be convinced to fund some of the research project.

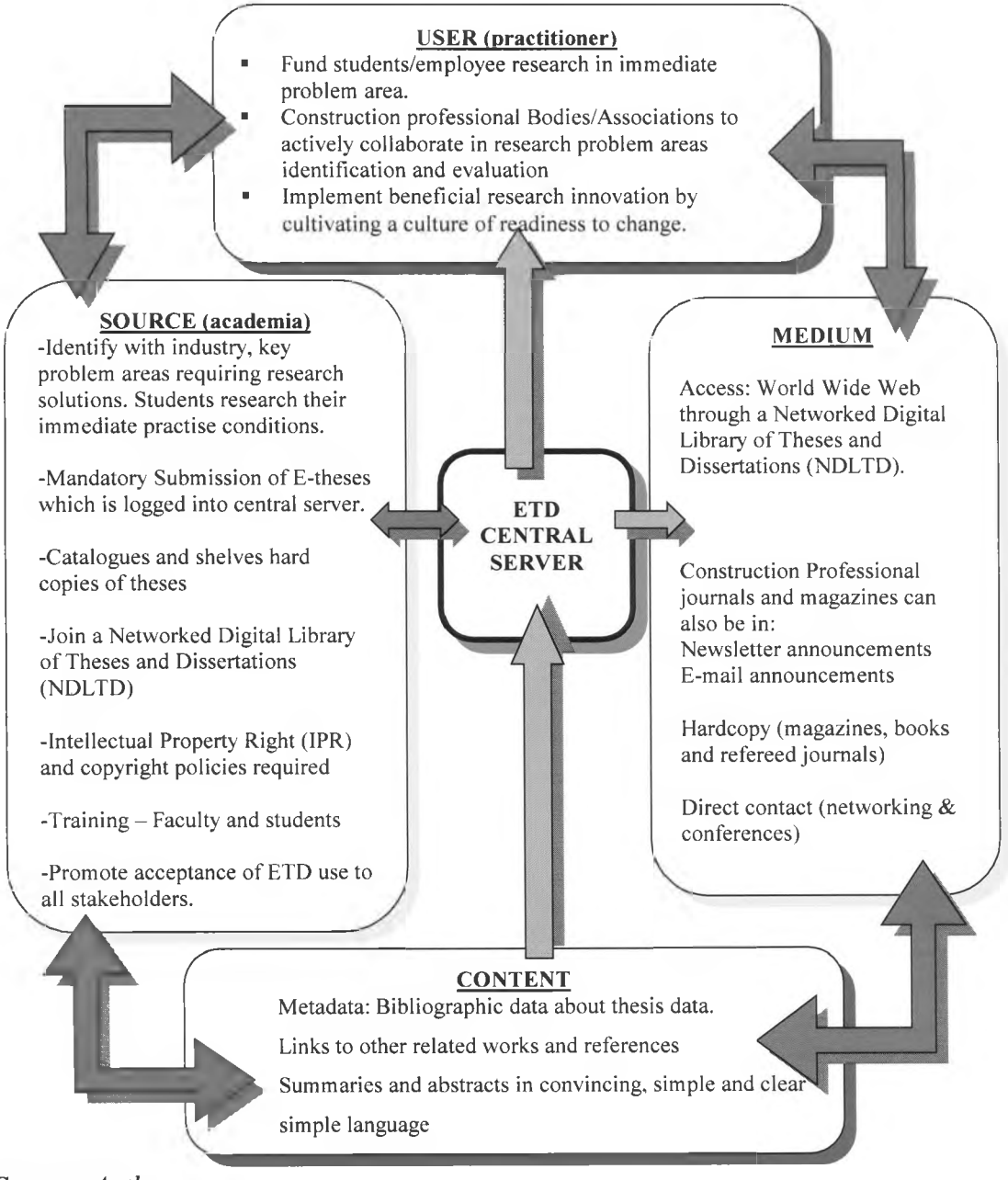
   - The University should create an awareness scheme seeking to encourage construction firms to consider undertaking or accessing research findings for the first time. This will focus construction industry attention upon the importance of basic research for its own sustainability and that of its clients. This will make it easier for firms to support and encourage the establishment of organized research programs, and play an active role in such programs once established.

2. The study's second recommendation is that the UON to rapidly proceed towards adopting a policy of accepting, storing, and providing access to electronic theses in their existing ICT policy. The Graduate Studies Office, in consultation with Senate, will need to revise the thesis regulations to allow electronic submission. A subsequent revision could follow that would require mandatory electronic submission.

The basic technology is already available and easily adaptable to create a system for undergraduate and graduate theses for the entire UON. It is incumbent upon faculties such as the School of Built Environment to liaise with the University ICT Center to implement such novel ideas. Creation of research information in electronic form making it readily accessible via the WWW through standard, ubiquitous and free software programs provides the key to dissemination of this information independent of the source of the research. The other benefits offered by an ETD system, such as wider dissemination of research and higher-quality multimedia documents, will help students, researchers, the university, and the construction practitioners at large. Consequently, the development of ETDs by the University is envisioned to provide the opportunity for theses to be recognized as a direct basic channel for the dissemination of research findings and an essential resource in the research discovery process. Funding for the same can be explored through UNESCO, which is a champion for such projects. The system is represented in a conceptual diagram as in figure 5.1

3. Finally, there is a need for the UON to priorities dissemination of research innovations into its existing policy documents. This will help the institutions' researchers plan and integrate a dissemination strategy in the thesis life cycle. In addition, concerns about intellectual property rights and plagiarism will need to be addressed, some policy revision will need to occur as the ETD System is initiated and develops. These issues can be urgently incorporated in the developing UON Intellectual Property Policy 2002.

*Figure 5.1:* Proposed Schematic Representation of Dissemination Requirement.




*Source: Author*

Finally, as with any technological and media shift a learning curve is involved for students, staff, faculty, administrators and practitioners. Moreover, a movement toward electronic and digital forms may provoke a radical rethinking of what constitutes a dissertation. In practical terms, shifting toward ETDs may also imply a rethinking of how we collect and disseminate academic knowledge and creative products.

## 5.6 Suggested Areas of Further Study

- Investigation into factors that influence the creation and use of innovation in the Kenyan construction industry.
- Knowledge transfer and the Kenyan construction sector in the context of innovation dissemination.
- Impact of introduction of electronic thesis systems to construction research education.

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## APPENDIX A

| Absorption of Research Innovation in Kenyan Construction Industry<br>**How often have you used the following innovation?** | | Never | Almost Never | Rarely | Occasionally | Frequently | Almost Always | Always | Totals |
|---|---|---|---|---|---|---|---|---|---|
| Use of *Selective Tendering* method | F | 2 | 1 | 1 | **15** | 6 | 6 | 6 | 37 |
| | % | 5.4 | 2.7 | 2.7 | **40.5** | 16.2 | 16.2 | 16.2 | 100 |
| A *mathematical formulae* which uses the cost and height of the building for estimation of construction periods | F | **22** | 4 | 2 | 2 | 4 | 1 | 2 | 37 |
| | % | **59.5** | 10.8 | 5.4 | 5.4 | 10.8 | 2.7 | 5.4 | 100 |
| A mathematical model to analyse future building maintenance costs at feasibility study stage. | F | **27** | 4 | 2 | 4 | 0 | 0 | 0 | 37 |
| | % | **73.0** | 10.8 | 5.4 | 10.8 | 0 | 0 | 0 | 100 |
| An objective mathematical predictive model to predict on cost risk, time risk, cost overrun and time overrun. | F | **25** | 6 | 4 | 1 | 1 | 0 | 0 | 37 |
| | % | **67.6** | 16.2 | 10.8 | 2.7 | 2.7 | 0 | 0 | 100 |
| Use of new procurement methods such as *Design and build, Construction Management, Management contracting, Partnering* | F | 5 | 4 | 6 | **12** | 5 | 5 | 0 | 37 |
| | % | 13.5 | 10.8 | 16.2 | **32.4** | 13.5 | 13.5 | 0 | 100 |
| Use of *Project Management services* | F | 5 | 4 | 4 | **11** | 5 | 5 | 3 | 37 |
| | % | 13.5 | 10.8 | 10.8 | **29.7** | 13.5 | 13.5 | 8.1 | 100 |
| Use of a *Marketing Specialists* to market your professional/ construction services | F | **27** | 3 | 3 | 2 | 1 | 1 | 0 | 37 |
| | % | **73.0** | 8.1 | 8.1 | 5.4 | 2.7 | 2.7 | 0 | 100 |
| Use of a Materials Management plan in a construction projects | F | **18** | 5 | 3 | 4 | 4 | 1 | 2 | 37 |
| | % | **48.6** | 13.5 | 8.1 | 10.8 | 10.8 | 2.7 | 5.4 | 100 |
| Employing services of a risk manager and of risk management strategy in a construction project. | F | **23** | 7 | 2 | 2 | 3 | 0 | 0 | 37 |
| | % | **62.2** | 18.9 | 5.4 | 5.4 | 8.1 | 0 | 0 | 100 |
| Use of off-site fabrication of more parts of the buildings under construction. | F | 7 | 5 | 6 | **9** | 5 | 3 | 2 | 37 |
| | % | 18.9 | 13.5 | 16.2 | **24.3** | 13.5 | 8.1 | 5.4 | 100 |
| Use of a safety management plan and employing service of safety experts as a requirement in construction sites. | F | **17** | 6 | 3 | 8 | 1 | 2 | 0 | 37 |
| | % | **45.9** | 16.2 | 8.1 | 21.6 | 2.7 | 5.4 | 0 | 100 |
| Use of contractors' safety records as a factor in the pre-qualification of construction tendering. | F | **15** | 6 | 4 | 8 | 4 | 0 | 0 | 37 |
| | % | **40.5** | 16.2 | 10.8 | 21.6 | 10.8 | 0 | 0 | 100 |
| Accessing innovation information in any Construction Industry Project Research and Information Center. | F | 10 | 5 | 3 | **12** | 4 | 2 | 1 | 37 |
| | % | 27.0 | 13.5 | 8.1 | **32.4** | 10.8 | 5.4 | 2.7 | 100 |
| Use of ICT and computers in most of your business processes. | F | 0 | 0 | 0 | 4 | 5 | 5 | **23** | 37 |
| | % | 0 | 0 | 0 | 10.8 | 13.5 | 13.5 | **62.2** | 100 |
| Use of bonus incentive work targets by construction trade gangs | F | **14** | 8 | 3 | 5 | 6 | 0 | 0 | 36 |
| | % | **37.8** | 21.6 | 8.1 | 13.5 | 16.2 | 0 | 0 | 97.3 |
| Use of On-job training of craftsmen by field technicians in construction sites. | F | 8 | 8 | 3 | **12** | 4 | 1 | 0 | 36 |
| | % | 21.6 | 21.6 | 8.1 | **32.4** | 10.8 | 2.7 | 0 | 97.3 |
| Use of Contractors who have undergone some formal training or (for contractors)- undergone some formal training before registration. | F | 8 | 2 | 1 | 8 | **9** | 5 | 4 | 37 |
| | % | 21.6 | 5.4 | 2.7 | 21.6 | **24.3** | 13.5 | 10.8 | 100 |

## APPENDIX B

| Dissemination Linkage Pathways<br>**How often do you or your organisation use the following as a source of information on innovation?** | | Never | Almost Never | Rarely | Occasionally | Frequently | Almost Always | Always | Totals |
|---|---|---|---|---|---|---|---|---|---|
| Research reports: *Detailed summary of research* | F | 11 | 6 | 5 | 6 | 1 | 5 | 3 | 37 |
| | % | 29.7 | 16.2 | 13.5 | 16.2 | 2.7 | 13.5 | 8.1 | 100 |
| Academic refereed journals | F | 6 | 7 | 4 | 11 | 3 | 3 | 3 | 37 |
| | % | 16.2 | 18.9 | 10.8 | 29.7 | 8.1 | 8.1 | 8.1 | 100 |
| Construction Professional journals and magazines | F | 0 | 3 | 3 | 11 | 5 | 6 | 9 | 37 |
| | % | 0 | 8.1 | 8.1 | 29.7 | 13.5 | 16.2 | 24.3 | 100 |
| Written books and chapters drawn from research studies | F | 1 | 4 | 3 | 12 | 6 | 8 | 3 | 37 |
| | % | 2.7 | 10.8 | 8.1 | 32.4 | 16.2 | 21.6 | 8.1 | 100 |
| Thesis placed in a library | F | 19 | 6 | 6 | 3 | 2 | 1 | 0 | 37 |
| | % | 51.4 | 16.2 | 16.2 | 8.1 | 5.4 | 2.7 | 0 | 100 |
| Construction Research in Internet, e-mail and worldwide web | F | 4 | 4 | 5 | 7 | 3 | 7 | 7 | 37 |
| | % | 10.8 | 10.8 | 13.5 | 18.9 | 8.1 | 18.9 | 18.9 | 100 |
| CD-Roms, DVDs with research information | F | 7 | 10 | 3 | 6 | 3 | 5 | 3 | 37 |
| | % | 18.9 | 27.0 | 8.1 | 16.2 | 8.1 | 13.5 | 8.1 | 100 |
| Conference, workshops and seminars on current research results demonstrations | F | 4 | 6 | 4 | 8 | 10 | 4 | 1 | 37 |
| | % | 10.8 | 16.2 | 10.8 | 21.6 | 27.0 | 10.8 | 2.7 | 100 |
| Networking: *Sharing research information between professional colleagues* | F | 2 | 5 | 5 | 11 | 6 | 6 | 2 | 37 |
| | % | 5.4 | 13.5 | 13.5 | 29.7 | 16.2 | 16.2 | 5.4 | 100 |
| Partnerships/collaborations/Funding: *Working together with university/research institution on identified research projects.* | F | 21 | 8 | 0 | 4 | 1 | 2 | 1 | 37 |
| | % | 56.8 | 21.6 | 0 | 10.8 | 2.7 | 5.4 | 2.7 | 100 |
| Research Centers: *Specialist agency intervening to disseminate and explain research results.* | F | 22 | 8 | 1 | 5 | 1 | 0 | 0 | 37 |
| | % | 59.5 | 21.6 | 2.7 | 13.5 | 2.7 | 0 | 0 | 100 |
| Mass media: *Construction innovations in newspapers, television and radio.* | F | 12 | 10 | 2 | 6 | 5 | 2 | 0 | 37 |
| | % | 32.4 | 27.0 | 5.4 | 16.2 | 13.5 | 5.4 | 0 | 100 |

## APPENDIX C

| Barriers To Dissemination and Use Of Research Information<br><br>**Do you agree with the following statements?** | | Strongly Disagree | Disagree | Slightly Disagree | Perhaps | Slightly Agree | Agree | Strongly Agree | Totals |
|---|---|---|---|---|---|---|---|---|---|
| I do not have time to find and read research | F | 8 | 6 | 6 | 11 | 0 | 6 | 0 | 37 |
| | % | 21.6 | 16.2 | 16.2 | 29.7 | 0 | 16.2 | 0 | 100 |
| Much of the research I hear of/read bears no relevance to my professional teaching/work | F | 9 | 8 | 4 | 5 | 7 | 3 | 1 | |
| | % | 24.3 | 21.6 | 10.8 | 13.5 | 18.9 | 8.1 | 2.7 | |
| Research is conducted by academics with no grounding in the real issues of construction practice/teaching | F | 8 | 5 | 2 | 13 | 2 | 5 | 2 | |
| | % | 21.6 | 13.5 | 5.4 | 35.1 | 5.4 | 13.5 | 5.4 | |
| Universities do not have the knowledge or information that construction firms need. | F | 8 | 6 | 5 | 7 | 5 | 5 | 1 | |
| | % | 21.6 | 16.2 | 13.5 | 18.9 | 13.5 | 13.5 | 2.7 | |
| Being up-to-date with research does not aid career progression | F | 21 | 7 | 4 | 0 | 3 | 1 | 1 | |
| | % | 56.8 | 18.9 | 10.8 | 0 | 8.1 | 2.7 | 2.7 | |
| Keeping up-to-date with research is not an essential part of professional development. | F | 22 | 6 | 2 | 4 | 1 | 1 | 1 | |
| | % | 59.5 | 16.2 | 5.4 | 10.8 | 2.7 | 2.7 | 2.7 | |
| I am not confident in my ability to evaluate the quality of research | F | 18 | 9 | 3 | 4 | 0 | 1 | 2 | |
| | % | 48.6 | 24.3 | 8.1 | 10.8 | 0 | 2.7 | 5.4 | |
| I am not confident in my ability to interpret the findings of research correctly | F | 19 | 6 | 3 | 4 | 2 | 1 | 2 | |
| | % | 51.4 | 16.2 | 8.1 | 10.8 | 5.4 | 2.7 | 5.4 | |
| I don't have the skills to make use of research | F | 20 | 10 | 2 | 2 | 1 | 1 | 1 | |
| | % | 54.1 | 27.0 | 5.4 | 5.4 | 2.7 | 2.7 | 2.7 | |
| Construction Industry practitioners are not willing to change their set ways of operations. | F | 4 | 5 | 6 | 9 | 1 | 6 | 6 | |
| | % | 10.8 | 13.5 | 16.2 | 24.3 | 2.7 | 16.2 | 16.2 | |
| Information about the existence of relevant research is not available | F | 4 | 2 | 1 | 11 | 2 | 6 | 11 | |
| | % | 10.8 | 5.4 | 2.7 | 29.7 | 5.4 | 16.2 | 29.7 | |
| Relevant literature on research is not compiled in one place | F | 1 | 2 | 0 | 4 | 5 | 10 | 15 | |
| | % | 2.7 | 5.4 | 0 | 10.8 | 13.5 | 27.0 | 40.5 | |
| Research reports/articles are not easily available | F | 3 | 1 | 2 | 7 | 5 | 10 | 9 | |
| | % | 8.1 | 2.7 | 5.4 | 18.9 | 13.5 | 27.0 | 24.3 | |
| The amount of research available is overwhelming | F | 13 | 8 | 5 | 4 | 3 | 1 | 3 | |
| | % | 35.1 | 21.6 | 13.5 | 10.8 | 8.1 | 2.7 | 8.1 | |
| There is little research related to my subject area | F | 5 | 5 | 5 | 10 | 2 | 5 | 5 | |
| | % | 13.5 | 13.5 | 13.5 | 27.0 | 5.4 | 13.5 | 13.5 | |
| The language of research results is not easy to understand. | F | 14 | 8 | 2 | 8 | 1 | 3 | 1 | |
| | % | 37.8 | 21.6 | 5.4 | 21.6 | 2.7 | 8.1 | 2.7 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| The university library does not provide access to research information | F | 6 | 5 | 1 | 15 | 3 | 2 | 5 | |
| | % | 16.2 | 13.5 | 2.7 | 40.5 | 8.1 | 5.4 | 13.5 | |
| Other libraries nearby do not provide access to research information | F | 7 | 7 | 1 | 11 | 2 | 3 | 6 | |
| | % | 18.9 | 18.9 | 2.7 | 29.7 | 5.4 | 8.1 | 16.2 | |
| Research reports/articles are not published fast enough | F | 4 | 0 | 5 | 12 | 3 | 7 | 6 | |
| | % | 10.8 | 0 | 13.5 | 32.4 | 8.1 | 18.9 | 16.2 | |
| I have no access to the World Wide Web and the Internet | F | 29 | 2 | 2 | 1 | 1 | 1 | 1 | |
| | % | 78.4 | 5.4 | 5.4 | 2.7 | 2.7 | 2.7 | 2.7 | |
| My profession/work does not encourage research based practice | F | 20 | 2 | 1 | 3 | 2 | 5 | 4 | |
| | % | 54.1 | 5.4 | 2.7 | 8.1 | 5.4 | 13.5 | 10.8 | |
| I do not have funds to attend seminars, conferences and workshops on research findings | F | 9 | 2 | 3 | 11 | 2 | 4 | 5 | |
| | % | 24.3 | 5.4 | 8.1 | 29.7 | 5.4 | 10.8 | 13.5 | |

| Factors Influencing Dissemination Source Of Research Information<br>**Do you agree with the following statements?** | | Strongly Disagree | Disagree | Slightly Disagree | Perhaps | Slightly Agree | Agree | Strongly Agree | Totals |
|---|---|---|---|---|---|---|---|---|---|
| The University/Institution does not have specific copyright and intellectual ownership legislation in place. | F | 0 | 1 | 3 | 10 | 5 | 0 | 6 | 28 |
| | % | 0 | 2.7 | 8.1 | 27.0 | 13.5 | 0 | 16.2 | 64.8 |
| The University/Institution does not have research dissemination policies and strategy. | F | 1 | 1 | 0 | 10 | 1 | 5 | 7 | 28 |
| | % | 2.7 | 2.7 | 0 | 27.0 | 2.7 | 13.5 | 18.9 | 64.8 |
| No time is allocated to dissemination research findings. | F | 1 | 0 | 1 | 7 | 2 | 7 | 6 | 28 |
| | % | 2.7 | 0 | 2.7 | 18.9 | 5.4 | 18.9 | 16.2 | 64.8 |
| There is no effort in transforming putting out "readable" information for practitioners. | F | 1 | 0 | 1 | 6 | 1 | 9 | 6 | 28 |
| | % | 2.7 | 0 | 2.7 | 16.2 | 2.7 | 24.3 | 16.2 | 64.8 |
| I am not aware of the new publishing technologies, such as ETDS. | F | 2 | 3 | 0 | 3 | 3 | 2 | 11 | 28 |
| | % | 5.4 | 8.1 | 0 | 8.1 | 8.1 | 5.4 | 29.7 | 64.8 |
| There is limited access to new publishing technologies | F | 1 | 1 | 1 | 10 | 0 | 5 | 6 | 28 |
| | % | 2.7 | 2.7 | 2.7 | 27.0 | 0 | 13.5 | 16.2 | 64.8 |
| It is not my responsibility to disseminate research. | F | 2 | 2 | 1 | 7 | 3 | 5 | 4 | 28 |
| | % | 5.4 | 5.4 | 2.7 | 18.9 | 8.1 | 13.5 | 10.8 | 64.8 |
| There is lack of funding for dissemination of research results | F | 1 | 1 | 0 | 8 | 0 | 7 | 7 | 28 |
| | % | 2.7 | 2.7 | 0 | 21.6 | 0 | 18.9 | 18.9 | 64.8 |
| There are no rewards for having research findings applied in practice as the motto for survival is "publish or perish". | F | 3 | 2 | 1 | 4 | 2 | 6 | 6 | 28 |
| | % | 8.1 | 5.4 | 2.7 | 10.8 | 5.4 | 16.2 | 16.2 | 64.8 |
| I have no access to the world wide web and the internet | F | 17 | 2 | 0 | 2 | 2 | 1 | 0 | 28 |
| | % | 45.9 | 5.4 | 0 | 5.4 | 5.4 | 2.7 | 0 | 64.8 |
| There are limited avenues for publication with a lack of locally peer reviewed journals that are reputable in the country | F | 0 | 2 | 4 | 7 | 1 | 4 | 6 | 28 |
| | % | 0 | 5.4 | 10.8 | 18.9 | 2.7 | 10.8 | 16.2 | 64.8 |

# APPENDIX D

**Introduction**

The study is carried out through the University of Nairobi. It is a study on the influence of university research information to the Kenyan construction industry innovation. I am requesting your participation in this study because you are a stakeholder in the Kenyan construction industry. Only by identifying the most effective communication channel(s) can we ensure that important innovations reach the right users at the right time. Professionals, like yourself, play a vital role in providing industry with information about new technologies and innovations. All information gathered will be treated with strict confidence.

**Question 1: Respondent Particulars.**

Which of the following best describes your profession/practise? [Please check one box only]

- Academia (lecturer, researcher, etc) ☐
- Architect ☐
- Quantity Surveyor ☐
- Engineer (Civil, Structural, Services and Electrical) ☐
- Contractor ☐
- Other (please specify) ☐

What is your level of education? [Please check one box only]

- Did not attend formal school ☐
- Primary level certificate ☐
- Secondary level certificate ☐
- College certificate ☐
- University degree ☐
- Other (please specify) ☐

Innovation is defined as "the application of new knowledge to industry, and includes new products, new processes and social and organisational *change*". It is the channel of reducing costs, increasing productivity, improving quality of construction works and finishing projects in time. Innovation in the construction industry occur in four main ways:

- Innovative Construction Technologies: - These include innovative materials (e.g. soil blocks) and novel construction technologies (e.g. modular construction).
- Innovative Construction Business Processes: - These include innovative procurement practices (e.g. partnering, collaborative and concurrent engineering (e.g. value engineering)).
- Advanced Information and Communications Technologies: –These include integration of IT systems, and communications infrastructures for virtual construction project teams.
- Sustainable Construction: – These include environmental conservation and recycling of materials.

**Question 2: Current State of Innovation Absorption in the Construction Industry**

| | Always | | | Occasionally | | | Never |
|---|---|---|---|---|---|---|---|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 2. Of the recent projects that you have been involved in, how often have new innovative changes been incorporated in the design and construction processes? [Please check one box only] | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**Question 3: Absorption of Research Innovation in Kenyan Construction Industry**

3. **How often have you used the following innovation?** [Please check one box only for each statement]

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Use of *Selective Tendering* method | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| A *mathematical formulae* which uses the cost and height of the building for estimation of construction periods | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| A mathematical model to analyse future building maintenance costs at feasibility study stage. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| An objective mathematical predictive model to predict on cost risk, time risk, cost overrun and time overrun. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of new procurement methods such as *Design and build, Construction Management, Management contracting, Partnering* | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of *Project Management services* | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of a *Marketing Specialists* to market your professional/ construction services | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of a Materials Management plan in a construction projects | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Employing services of a risk manager and of risk management strategy in a construction project. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of off-site fabrication of more parts of the buildings under construction. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of a safety management plan and employing service of safety experts as a requirement in construction sites. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of contractors' safety records as a factor in the pre-qualification of construction tendering. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Accessing innovation information in any Construction Industry Project Research and Information Center. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of ICT and computers in most of your business processes. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of bonus incentive work targets by construction trade gangs | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of On-job training of craftsmen by field technicians in construction sites. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Use of Contractors who have undergone some formal training or (for contractors)- undergone some formal training before registration. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**Question 4: Use of sources of research information (Dissemination Linkage Pathways)**

4. **How often do you or your organisation use the following as a source of information on innovation?** [Please check one box only]

| | | Always | | | Occasionall | | | Never |
|---|---|---|---|---|---|---|---|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| i. | Research reports: *Detailed summary of research* | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| ii. | Academic refereed journals | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| iii. | Construction Professional journals and magazines | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| iv. | Written books and chapters drawn from research studies | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| v. | Thesis placed in a library | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| vi. | Construction Research in Internet, e-mail and worldwide web | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| vii. | CD-Roms, DVDs with research information | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| viii. | Conference, workshops and seminars on current research results demonstrations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| ix. | Networking: *Sharing research information between professional colleagues* | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| x. | Partnerships/collaborations/Funding: *Working together with university/research institution on identified research projects.* | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| xi. | Research Centers: *Specialist agency intervening to disseminate and explain research results.* | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| xii. | Mass media: *Construction innovations in newspapers, television and radio.* | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**Question 5: Responsibility for Dissemination Of Research Information**

5. **Who in your opinion should have primary responsibility for disseminating research information?** [Please check one box only]

Researcher/Author of the research ☐
University or sponsoring institution (Library) ☐
Central Construction Research Information Centers ☐
Construction professional Bodies/Associations ☐
Other (Please specify here) ☐

**Question 6: Barriers To Dissemination and Use Of Research Information**

**6. Do you agree with the following statements?**

| Statement | Strongly agree 7 | 6 | 5 | Perhaps 4 | 3 | 2 | Strongly disagree 1 |
|---|---|---|---|---|---|---|---|
| I do not have time to find and read research | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Much of the research I hear of/read bears no relevance to my professional teaching/work | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Research is conducted by academics with no grounding in the real issues of construction practice/teaching | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Universities do not have the knowledge or information that construction firms need. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Being up-to-date with research does not aid career progression | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Keeping up-to-date with research is not an essential part of professional development. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am not confident in my ability to evaluate the quality of research | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am not confident in my ability to interpret the findings of research correctly | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I don`t have the skills to make use of research | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Construction Industry practitioners are not willing to change their set ways of operations. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Information about the existence of relevant research is not available | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Relevant literature on research is not compiled in one place | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Research reports/articles are not easily available | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| The amount of research available is overwhelming | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| There is little research related to my subject area | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| The language of research results is not easy to understand. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| The university library does not provide access to research information | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other libraries nearby do not provide access to research information | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Research reports/articles are not published fast enough | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I have no access to the World Wide Web and the Internet | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| My profession/work does not encourage research based practice | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I do not have funds to attend seminars, conferences and workshops on research findings | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**Question 7: Factors Influencing Dissemination Source Of Research Information**

**Please answer this question if you have previously undertaken or are taking part in any identified university research project.**

7. Do you agree with the following statements?

| Statement | Strongly agree 7 | 6 | 5 | Perhaps 4 | 3 | 2 | Strongly disagree 1 |
|---|---|---|---|---|---|---|---|
| The University/Institution does not have specific copyright and intellectual ownership legislation in place. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| The University/Institution does not have research dissemination policies and strategy. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| No time is allocated to dissemination research findings. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| There is no effort in transforming putting out "readable" information for practitioners. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am not aware of the new publishing technologies, such as ETDS. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| There is limited access to new publishing technologies | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| It is not my responsibility to disseminate research. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| There is lack of funding for dissemination of research results | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| There are no rewards for having research findings applied in practice as the motto for survival is "publish or perish". | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I have no access to the world wide web and the internet | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| There are limited avenues for publication with a lack of locally peer reviewed journals that are reputable in the country | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Thank you for your participation.