Research in Ethiopian Construction Industry: Review of Past Studies and Future Need Assessment

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Declaration

I the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all sources of materials used for the thesis have been duly acknowledged.

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Dedication

I need this work to be dedicated to my late parents W/ro. Hiwot Reda and Ato. Eshetu Worku, who passed away without seeing what they were dreaming for my life.

Habenom Gebru Zeray

Abstract

Construction industry plays a vital role for developing countries as they are considerably dependent on the growth and development of physical infrastructures: furthermore, its relation to both economic and social sectors is very significant. Construction research is the systematic process of collecting and analyzing information to increase our understanding of every critical occurrence under study which plays a large role in the development of the industry. However, in Ethiopia the trend of using construction research works is very low: consequently, the role of research works in the construction industry is insignificant. In this respect, the main objective of the research was to identify the current and future research needs of the construction industry based on different perspectives.

In order to identify the current and future research needs of the construction industry it was essential to find out if the past and current construction research which is done by academic institutions is directly correlated with the construction industry demand. To determine their alignment and correlation, evaluations of the rankings of construction research trends and industry demands were carried out. The assessment was done through a review of one hundred sixteen construction research papers from Addis Ababa Institute of Technology, School of Civil and Environmental Engineering, Construction Technology and Management post-graduate program. The research papers were classified into common construction research topics areas. The industry research need was then gathered using a questionnaire survey. Each research topic area was given a ranking based on the quantity of researches classified into the common construction topic areas. Besides, questionnaires were sent to professionals from Ethiopian Roads Authority, Addis Ababa City Roads Authority, Real estate developers, Consultants, and Foreign and Local Contractors to find their ranking of the research topic areas by the individual sectors. Additionally, questions were raised to determine the possible causes for the less involvement of construction research findings in the industry, identify the benefits, and possible methods to enhance the university industry linkages.

The results show that the top three topic areas by the research ranking was concrete technology, industry overview, and constructability, on the other hand questionnaire respondents determined that the most important research topic areas for the construction industry participants are economics or cost control, delay and cost overrun, and productivity. The result of the Pearson correlation test indicates that there is no linear relationship among the most researched topic areas from the university and the current needs of the research participant of the construction industry professionals. The research, additionally, also makes available recommendations on how to improve these conditions.

Keywords: Construction industry, Construction research trend, University -Industry linkage, Industry research need.

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Abbreviations

- AACRA – Addis Ababa City Roads Authority
- AAiT - Addis Ababa institute of Technology
- ADR - Alternate Dispute Resolution
- ASCE - American Society of Civil Engineers
- BSc – Bachelor of Science
- CICE – Construction Industry Cost Effectiveness
- CII – Construction Industry Institute
- EC - Ethiopian Calendar
- ERA - Ethiopian Roads Authority
- GC – Gregorian Calendar
- GDP - Gross Domestic Product
- GTP II - Growth and Transformation Plan Two
- ICE - Institution of Civil Engineers
- IP - Intellectual Property
- ISIC - International Standards Industrial Classification
- IT – Information Technology
- MoFED - Ministry of Finance and Economic Development
- MoST – Ministry of Science and Technology
- MoUDCo - Ministry of Urban Development and Construction
- MSV – Mean Score Value
- OECD – Organization for Economic Co-operation and Development
- Ph.D – Doctor of Philosophy
- R&D - Research and Development
- STI - Science Technology and Innovation
- TTO - Technology Transfer Offices
- UN – United Nation
- UNEP - United Nations Environmental Program

1. INTRODUCTION

1.1 Background

Construction industry plays a vital role in any developing country. This is mainly because developing countries are considerably dependent on the growth and development of their physical infrastructures and because the linkage of the construction industry to both economic and social sectors is very significant. A wide range of buildings and construction facilities are required by our modern society, including residential and commercial property, manufacturing facilities, schools, hospitals, complex transport infrastructure, and so on. Thus, the construction industry is a major sector of the economy of the country.

In addition, construction is not just the personnel's who are on the job site performing the actual construction, but that it also includes many professionals who focus on research and development to discover new technologies and materials that improve the methods and processes of construction (Abudayyeh et al. 2004).

The construction industry is the largest and most complex fragmented industry involves owners (government, industry, private parties, and investors), designers and construction monitors (engineers and architects), constructors, field managers, supervisors and craftsmen. Furthermore, the product is usually "custom made," with almost every project a separate and unique entity, conceived, financed, designed, constructed, and operated separately. Each of the groups that contribute directly or indirectly to construction is represented by individuals, organizations, or associations with diverse and often fragmented interests. All the other contributors, to the overall construction effort, including government representatives, planners, engineers, architects, bankers, bonding companies, material suppliers, lawyers, accountants and others are equally diverse in their talents, interests, and ways of operating (Oglesby 1990).

Therefore, education and research allow for the development of new and promising technologies for all concerned parties, thus creating significant savings in time and money to firms who take advantage of these developments is vital. Since it is a rather new phenomenon, construction research is constantly changing and the best actions to take are still being debated (Abudayyeh et al. 2004).

Research and development is the main driving force toward the technology advancement of modern industry (Warszawski 2007). In Ethiopia, it is mostly carried out in higher educational institutes, usually in fulfillment of graduate programs.

1.2 Research motivation

The initiation for the study of this research is largely due to the less involvement and influence of construction related researches of higher educational institutes in the Ethiopian construction industry. Discussion with professionals along with reading of past studies and researches showed that construction related researches are not involved in the construction industry, because of many factors, some of these include the lack of communication between the construction professionals between the industry and institutes, the weakness of the construction industry to be involved in research and development work, the lack of research seminar and workshops among both parties.

After observing these problems, I would like to study the past and current construction research and study the future need of the construction industry regarding to topic areas.

1.3 Statement of the research problem

The research problem arises from the relationship between the construction industry and higher educational centers regarding serving each other by solving real and actual problems. Among many interrelation difficulties this research focuses on the research problem that we do not know if the higher academic institutes research related to construction are in alignment with the desires of the construction industry.

1.4 Research questions

i. Which construction research topic areas are most common in university?
ii. How do construction professionals rank the common construction research topic areas?
iii. Is the construction research trend in alignment with the current industry need?
iv. What are the benefits of university – industry linkages and what methods are essential to enhance their relationship?
v. What are the possible causes for the less involvement of construction research in the industry?

1.5 Research objectives

- To examine the construction research trends in Ethiopia.
- To identify topic areas which are relevant for existing construction industry demand.
- To identify the future research needs of the construction industry based on different perspectives and industry type.

1.6 Research significance

Depending on the research objectives the outcomes of this research is believed to mainly benefit the construction industry and any other interested stakeholders.

- Results from this study will help prioritize future research areas.
- Findings of the study will confirm whether the well-liked research topics are in fact most important to the construction industry and try to understand the needs of the industry, and increase the relevance of future research.

1.7 Scope and limitations of the study

The scope of the study is limited to the study of the construction research in contrast with the needs of the Ethiopian construction industry. The survey respondents will be limited to construction professionals of Ethiopian Roads Authority, Addis Ababa City Roads Authority, real estate developers, foreign contractors, consultants and local contractors. Contractors and consultants are selected from registered lists of MoUDCo contractor's and consultant catalog of 2009 EC and the selection for contractors only focused on BC, RC and GC from level one to level three and the consultant selection focused only on category one to three. The real estate developers' population size was determined from ethioconstruction.net website. The study of construction research trends is also limited to a review of research papers from Addis Ababa Institute of Technology, School of Civil and Environmental Engineering, Construction technology and management post graduate program researches.

Due to the time and resource shortages other stakeholders of the construction industry beyond the mentioned parties are not included in this study.

1.8 Organization of the research

The research will be generally organized in five chapters and appendices:

- Chapter - 1 Introduction

  It contains the background of the construction. It also describes in detail the research motivations, statement of the problem, research questions, objectives, significance, scope and limitations of the study and organization of the research.

- Chapter - 2 Literature Review

  This section covers literature review, and comprises the various related works mainly focusing and analyzing issues associated with construction related researches and needs of the industry.

- Chapter - 3 Research Methodology

  Here the chapter includes the research methodology as one chapter, including the research approach, scope of the study, research design, sampling technique, data source and collection methods plus data analysis and interpretations.

- Chapter - 4 Data Analysis and Discussions

  This part comprises the analysis, discussions and evaluation part.

- Chapter - 5 Conclusions and Recommendations

  The last stage of the research covered the conclusions of the research together with recommendations.

Finally references and appendices are included.

2. LITERATURE REVIEW

2.1 Introduction

Research in common phrasing refers to a search for knowledge. One can also define research as a scientific and systematic search for pertinent information on a specific topic. In fact, research is an art of scientific investigation. Some people consider research as a movement, a movement from the known to the unknown. It is actually a journey of discovery. We all possess the vital instinct of curiosity for, when the unknown confronts us, we wonder and our inquisitiveness makes us search and attain full and fuller understanding of the unknown. This inquisitiveness is the mother of all knowledge and the method, which man employs for obtaining the knowledge of whatever the unknown, can be termed as research (Kothari 2004).

Concise Oxford Dictionary (1995) provides a more extensive definition of research as 'the systematic investigation into and study of materials and sources, in order to establish facts and reach new conclusions'. The emphasis lies on determining facts in order to reach new conclusions, that is, new knowledge. The issue of 'facts' is not as clear, philosophically speaking, as is commonly assumed (Richard and Anita 2008).

Research is also defined as human activity based on intellectual application in the investigation of matter. In other words, research is the systematic process of collecting and analyzing information to increase our understanding of the phenomenon under study. It is the function of the researcher to contribute to the understanding of the phenomenon and to communicate that understanding to others. It may be said that the general aims of research are to observe, describe, predict, determine causes and explain (Abiy et al. 2009).

2.2 The construction industry

The construction industry itself meets another meaning of paradox, that of "a state of affairs with seemingly contradictory qualities". In its share of the nation's gross national product it is the largest industry, but the vast majority of its hundreds of thousands of participants are small businesses. Its firms are intensely competitive among themselves in the best traditions of the classical free enterprise system, yet compared to other industries its technological advances sometimes appear trivial (Boyd and Paulson 1975).

In national economy, various sectors provide different goods and services. As the agriculture sector provides agricultural products and the education sector provides educational services, the construction sector provides constructions in co-operation with

public control and management systems, financial organizations etc. In national economy, constructions required by all kinds of investments have caused a great demand in construction sector. Furthermore, direct or indirect inputs and outputs of the construction sector affect the related sectors and sub-sectors (Kuruoglu and Ergen 2002).

The Ethiopian industry sector largely driven by the expansion of manufacturing industries (with focus on light manufacturing), is expected to make significant contribution to growth and structural change during the period of GTP II. Construction, electricity and mining are also expected to make remarkable contribution to growth. Thus, industrial GDP is projected to grow at annual average rate 19.8% during the period of GTP II. The manufacturing subsector GDP (both large and medium and micro and small scale) is projected to grow at an annual average rate of 23.9% during the same period. As a result, the share of industry is expected to increase from 14.6% in 2014/15 to 22.8% by the end of 2019/20 (GTP II 2015).

The construction industry is a very competitive market and is highly fragmented. These are a few reasons that funding in construction research is lower than most other industries. The discretionary funds to be used towards research are minimal or non-existent. Support for research in the construction industry is primarily a result of the economics of construction as it relates to profit margins, procurement of projects and time sensitive results.

2.2.1 Construction industry institute

The United Kingdom experience in the construction industry institute concept was done in Institution of Civil Engineers in 1818 GC; ICE is an independent professional association for civil engineers and a charitable body which exists to deliver benefits to the public. ICE supports the civil engineering profession by offering professional qualification, promoting education, maintaining professional ethics, and liaising with industry, academia and government. Under its commercial arm, it delivers training, recruitment, publishing and contract services. As a professional body, ICE is committed to support and promote professional learning (both to students and existing practitioners), managing professional ethics and safeguarding the status of engineers, and representing the interests of the profession in dealings with government. ICE sets standards for membership of the body; works with industry and academia to progress engineering standards and advises on education and training curricula. As well as supporting their members to become qualified, they also encourage them to continue their professional development by providing a variety

of civil engineering knowledge resources. These include industry-leading publications from ICE Publishing and tailored courses from ICE Training (ICE 2017).

The Construction Industry Institute concept was developed at the University of Texas at Austin in early 1982. Its faculty had been involved in the Business Roundtable's CICE Project, had conducted successful research programs for Texaco, Inc. and other large owners, and had designed several successful productivity improvement programs on large industrial projects in the United States and Canada. The initial suggestion evolved from a remark at the Construction Productivity Improvement conference in 1982 (Tucker 2007).

The initial principles of CII's establishment were developed over months of initial study and with the input from both industry and academic representatives (Tucker 2007). These principles have covered different concerns, the primary CII mission is to perform research for industry improvement and the research will be conducted by university faculty and graduate students with industry input and although much of the research will be conducted at the University of Texas at Austin as well as the CII will be national in nature plus involve faculty and students from many other universities, furthermore the priorities of research topics will be established by the Board of Advisors with appropriate funding allocations. Moreover no censorship will be made of research reports to the CII also publications of the CII require approval of the Board of Advisors and the faculty is involved in CII research are permitted to submit publications to established industry journals without CII approval in addition the CII will maintain a proactive program of implementation of its products and the CII member companies and committees of the CII will be composed of approximately equal numbers of owners and contractors (Tucker 2007).

2.2.2 The role of the construction industry in the economy

In order to discuss the role of the construction industry in a given economy we need to have a clear definition of the construction industry itself. According to UN (1996) International Standards Industrial Classification (ISIC), Rev. 3, construction is defined generally as an economic activity directed to the creation, renovation, repair or extension of fixed assets in the form of buildings, land improvements of an engineering nature, and other such engineering constructions as roads, bridges, dams and so on.

The industry consists of a group of establishments engaged in one or more of the following activities: site preparation; building of complete constructions or parts thereof, civil engineering; building installation, building completion and renting of construction or

demolition equipment with operators. The industry includes all activities of construction; irrespective of whether they are carried out by private or public construction firms, whether done on a contractual basis or of own accounts (EEA 2008).

In the case of Ethiopia, although the definition adopted by the National Accounts department of MoFED is the same as that of ISIC, the activities actually covered under the industry are the construction and maintenance activities of:

- Residential buildings in urban and rural areas,
- Non-residential buildings, i.e. factory buildings, ware houses, office buildings, garages, hotels, schools, hospitals, clinics, etc.,
- Other construction works, like roads, dams, dikes, athletic fields, electricity transmission lines, telephone and telegraph lines, etc.

In principle, activities undertaken by the construction industry which do not fall under the industry such as the quarrying of stone, gravel crushing, and manufacturing of bricks, are not part of the industry's production and hence should, if possible, be allocated to separate group of economic activities. This, however, would not be possible in most cases and hence such output is also included in the construction sector (EEA 2008).

Construction industry makes significant contributions to the socio-economic development process of the country. Its importance emanates largely from the direct and indirect impact it has on all economic activities. It contributes to the national output and stimulates the growth of other sectors through a complex system of linkages. It is noted that about one-tenth of the global economy is dedicated to constructing and operating homes and offices. UNEP further observes that the industry consumes one-sixth to one half of the world's wood, minerals, water and energy. It contributes to employment and creates income for the population and has multiplier effects on the economy (EEA 2008).

The construction industry employs large unskilled labor. Throughout the developing world, the majority of employees in the industry are unskilled. Women are also found to be beneficiaries of the employment in the industry. However, the employment in the industry is mainly temporary in nature and once the job is over, the workers are obliged to find other jobs or return to their place of origin. Similar to all other socio-economic activities, another key contribution of the construction industry is revenue generation to government (UN 1996).

The construction industry contributes to economic activity through generation of revenue for government from corporate income taxes of companies, the rental income, sales tax, capital gain tax and employees income tax from those employed in the construction industry, which in turn goes to the financing of public services such as schools and health institutions among others. In order to identify and estimate the total economic contribution of the construction industry to an economy, one has to look beyond the direct expenditures made by the industry itself, since there is a ripple effect of the expenditures made for goods and services supplied to the industry. Likewise, business revenues generated from supplying of goods and services to the construction industry are paid out in wages, and material costs, which in turn are spent on living costs. This multiplier effect enlarges the economic impact of the initial construction industry expenditures. In other words, the initial wave of spending generates a second and third wave of spending as wages paid and profits made on the direct construction spending spins through the economy in several cycles. Thus, the original direct expenditure yields a greater economic impact than just initially spent (EEA 2008).

2.3 University - construction industry linkage

The overall innovation process encompasses a spectrum of activities from basic research to commercial application and marketing. For the innovation process to be productive, the generation of new knowledge and the translation of that knowledge into commercial products and services must be linked. Such linkage depends on close interaction between those who perform basic research and those for whom the results of basic research are the raw materials for product development and commercialization. Because a major share of basic science is done in the universities and colleges, whereas technological development is lodged primarily in industry, strong university - industry relationships can enhance the basic research innovation link linkage. Historically, academia and industry had a productive relationship, each helping to support the other's mission. However, the links between universities and industries weakened in the two decades following World War II, approaching their lowest point in the early 1970's, the following have identified three principal factors underlying this decline (Denis and Gilbert 1980).

i. The separation of academic research from perceived industrial needs. This separation came as a result of the increasing role of the government in science and technology, stimulated first by World War II and then by Sputnik with the federal government of United States supplying the major portion of available research funds, universities had much less incentive to establish, or strengthen, ties with industrial firms.

ii. The decreased interest among university graduates in industrial research careers. With the availability of federal funds for academic research and education, more and more graduates eschewed industrial careers for faculty appointments, and graduate training programs became oriented toward careers in academic research. Industrial research was judged to be too applied and industrial research positions viewed as second-rate.

iii. Industry's diminishing role in basic research. The industrial share of basic research spending declined steadily between 1955 and 1972, and the proportion of in-house R & D budgets allocated to basic research dropped dramatically after 1966.

Since the key to effective interaction between universities and industry was scientist to scientist contact on research matters of common interest, the gradual decline in industrially performed basic research decreased such contacts and impeded university - industry relations. As a result of these and other factors, there has been a marked decline in the linkages between academia and industry. This decline may be a contributing factor to the erosion of the innovation process because it impedes the kind of two way communication that influences the direction of research and facilitated its practical application. Such separation also complicates research that falls between pure, basic science and applied R & D (Denis and Gilbert 1980). Collaboration between universities and industries is critical for skills development (education and training), of the generation, acquisition, and adoption of knowledge (innovation and technology transfer), and the promotion of entrepreneurship (start-ups and spin offs). The benefits of university - industry linkages are wide-reaching: they can help coordinate R&D agendas and avoid duplications, stimulate additional private R&D investment (additional effect), and exploit synergies and complementarities of scientific and technological capabilities. University - industry collaboration can also expand the relevance of research carried out in public institutions, foster the commercialization of public R&D outcomes, and increase the mobility of labor between public and private sectors. The benefits of university - industry collaboration are also evident in developing countries. For example, a study in Chile and Colombia shows that collaboration with universities substantially increased the propensity of firms to introduce new products and to patent (Guimón 2013). The many types of university - industry links have different objectives, scopes, and institutional arrangements. Collaboration may be more or less intense and may focus on training or research activities. Collaboration may be formal or informal, from formal equity partnerships, contracts, research projects, patent licensing, and so on, to human capital mobility, publications, and interactions in conferences and expert groups and among others.

Also it is useful to differentiate between short-term and long-term collaboration. Short-term collaborations generally consist of on demand problem solving with predefined results and tend to be articulated through contract research, consulting, and licensing. Long-term collaborations are associated with joint projects and public - private partnerships (including private funded university institutes or chairs, joint university - industry research centers, and research consortia), often allowing firms to contract for a core set of services and to periodically re-contract for specific deliverables in a flexible manner. As shown in Table 2.1 longer term collaborations are more strategic and open ended, providing a multifaceted platform where firms can develop a stronger innovative capacity in the long run, building upon the capabilities, methods and tools of universities (Guimón 2013).

Table 2.1 - A typology of university - industry links, from higher to lower intensity

High (Relationships)	Research partnerships	Inter-organizational arrangements for pursuing collaborative R&D, including research consortia and joint projects.
	Research services	Research related activities commissioned to universities by industrial clients, including contract research, consulting, quality control, testing, certification, and prototype development.
	Shared infrastructure	Use of university labs and equipment by firms, business incubators, and technology parks located within universities.
Medium (Mobility)	Academic entrepreneurship	Development and commercial exploitation of technologies pursued by academic inventors through a company they (partly) own (spin-off companies).
	Human resource training and transfer	Training of industry employees, internship programs, postgraduate training in industry, second to industry of university faculty and research staff, adjunct faculty of industry participants.
Low (Transfer)	Commercialization of intellectual property	Transfer of university-generated IP (such as patents) to firms (via licensing).
	Scientific publications	Use of codified scientific knowledge within industry.
	Informal interaction	Formation of social relationships (conferences, meetings, social networks).

Source: Adapted from José Guimón 2013.

2.4 Different priorities at different stages of economic development

The priorities and scope of university - industry collaboration differ significantly between developed and developing countries, as shown in Table 2.2. In developing countries, a major concern is the poor quality of education and the lack of financing available to universities, which often indicate insufficient capacity to join industry in innovation related projects. Building effective university - industry linkages in this context takes time and sustained effort, in part because universities in developing countries generally have little experience in industry collaboration and limited managerial capacity in research. Existing collaboration tend to be more informal and to focus on the firms' recruitment of university graduates for staffing, internships and consulting. The research activity of universities is less likely to lead to spin-offs or patents that can be commercially exploited. In many developing countries university - industry collaboration is constrained by historically based cultural and institutional barriers, which take time to overcome (Guimón 2013).

Table 2.2 - Priorities for university - industry partnerships at different stages of economic development along the three missions of universities

	Most developed countries	**Least developed countries**
Teaching University	• Private participation in graduate programs • Joint supervision of PhD students	• Curricula development to improve undergraduate and graduate studies • Student internships
Research University	• Research consortia and long term research partnerships to conduct frontier research	• Building absorptive capacity to adopt and diffuse already existing technologies • Focus on appropriate technologies to respond to local needs
Entrepreneurial University	• Spin-off companies, patent licensing • Entrepreneurship education	• Business incubation services • Entrepreneurship education

Source: Adapted from José Guimón 2013.

The natural economics of research require a decision process to allocate funds based on immediate needs and also the time involved to reach substantial results. This planning process requires a strategic method for determining what is most important first. Industrial

research is driven primarily on immediate application of results and less on purpose driven results that are found in other areas of research. Determining research priorities through strategic plans or agendas is an effective way to direct knowledge and research results to immediate application. Changes in the construction industry occur at a very rapid rate, which causes many challenges in the establishment of research priorities. The purpose of developing a strategic research plan is to tackle the need to increase professional knowledge in the areas associated with building and the general knowledge necessary for the solution of the current problems (Warszawski et al. 2007).

2.5 The relationship of research and industry

Construction industry is the primary customers of construction management and engineering educational programs. The graduates fill many of their employment needs on a regular basis. Universities fulfill one of their primary goals when they adequately prepare students for the demands of full time employment in the construction industry. Through the years both parties have apparently added value to their organizations through effective communication.

In many instances, construction related programs have developed advisory committees made up of professionals and executives in the construction industry. The advisory committee informs on current changes in the construction industry and on the needs in organizations, which leads to improvement in the curriculum offered the students (Graham 2010). The role of an effective industry advisory committee approaches that of a governance or trusteeship board, where members accept some accountability for the outcomes of the program. In addition to improving the quality of the construction program these committees or similar types of organizations should be used to develop solid research topics for professors and graduate students. These topics would be based on the important needs of the industry (Graham 2010).

Without direct communication between construction industry and researchers, the topics selected for research are derived from inferred ideas from literature and other second hand sources. This method leads to topics that can be meaningless and trivial. Researchers need communication with the industry. In turn, the industry needs the input from research findings to develop and maintain a competitive advantage. Universities, where much of the research is done, have the advantage of promptly integrating research results into curriculum. The students invariably go to work in the industry; making this a benefit for both parties. The

beneficial cycle is: needs, research, results and application. Thus the role of education and research is to make the concepts and practices known and useable (Oglesby 1990).

2.6 Mutual benefit among research and industry

Robert Harris, in "A Challenge for Research," argues that the research needs the industry and also the industry needs research for some of the following important reasons;-

2.6.1 Research needs the industry

According to Robert Harris in the United States even though graduates with advanced degrees in construction from research institutions find their futures in firms near the top of the industry, their numbers clearly are not sufficient to satisfy the industry's demand for skilled people. The indifference of general contractors is a major hurdle that the research community must overcome if it is to provide these employees and lead the industry into professionalism.

Furthermore Robert Harris state that a quick assessment might be that the industry must become more aggressive in advancing its own' interests, but on further thought it is the research community that must take the lead, for its own survival. According to Robert Harris research needs the industry for the following basic reasons;

a. Research needs the industry to learn what needs to be researched

Many engineer-constructors have in-house research and development units to solve problems, but with a few exceptions they usually do not interact with research institutions. General contractors have their own problems but do not have the expertise for solving them, and they do not call upon academic institutions when these problems arise. One reason for this lack of interaction is that the time between problem recognition and project finalization is too short for a research study. Academic researchers are learners, and learning takes time, so neither group can afford to turn a current problem over to some graduate student (Harris 1992).

Without communication with either general contractors or engineer-constructors, researchers cannot accumulate contractors' problems and develop research studies. Instead, researchers resort to using library resources and hearsay to develop study topics believed to benefit industry. This process often leads to choosing research topics that appear to be, and often are, unreal and trivial. The research then becomes merely a means to satisfy academic requirements.

Another result of the isolation of researchers from industry is that researchers frequently resort to using a survey technique to obtain data for a research project. In such surveys the amount of information derived is small and not very useful. Submittals to general contractors might give data that are more representative of the industry.

b. Research needs the industry to bring realism to research

Most research being conducted is carried out by students seeking the Master's and Ph.D. degrees. A great many of these students have been in an academic setting since high school and have not had construction experience. They do not know what is really happening on construction sites and they waste great amounts of time developing their research study programs; they sometimes conduct research studies in overly complicated and abstract ways. Again, better communication between researchers and the construction industry could prevent many of these educational difficulties.

According to Robert B. Harris upon reading many papers submitted for publication in ASCE's *Journal of Construction Engineering and Management,* one sees that some authors are so out of touch with the industry that the terminology they use is either not understandable or not accurate, and the construction procedures they express are unworkable or even imaginary (Harris 1992). Authors sometimes write about research studies that propose very exotic solutions to very simple problems; and sometimes it appears that the researcher developed a set of solutions and then sought a problem to which they might apply (Harris 1992).

c. Research needs the industry to educate faculties

Over the past 20 years construction faculties also have become more and more isolated from construction contractors. Professors may have done research as students under the direction of teachers who had field experience in construction, but they were urged to take positions as professors after graduation and not enter the industry in western and European countries. The pressures surrounding a new faculty person are frequently so great that there is very little opportunity for the teacher to even take summer employment in construction. These forces have created a body of faculty members who are now directing research without truly understanding its implications for the industry. One can only wonder what it is that the students under that faculty person are receiving in the courses being taught.

d. Research needs the industry to evaluate construction programs and their faculties

With the maturing of construction education programs, college administrations are evaluating the production of research faculties for two main reasons. First, academic budgets are being reduced and funds for research from college sources often are not forthcoming without a show of support from the intended user of the research results. Without industry support and acceptance of research results, construction programs are easy targets for elimination when the budget axe falls. Second, administrations are looking more and more closely at the value of the research before promotion and tenure decisions are made. Review committees are not impressed with published research papers so weak that anyone, even someone not knowledgeable of the subject, could easily reject them as evidence of the professor's abilities. Also, as a part of the supporting documentation, many administrations are asking persons in industry for recommendations as to the quality and usefulness of the candidate's research.

e. Research needs the industry to capture the creativity of men and women working on construction projects

On a construction site, problems naturally arise every day. These problems are solved on an unplanned basis by workers and supervisory personnel in an effort to keep the job moving forward. Many of the solutions are uniquely creative, and in a university setting might be called research. However, industry people do not see the solving of their day to day problems as research and development, but as simply doing their jobs. There is no shortage of creativity among construction personnel, but these creative resources are lost because of the lack of communication between the contractor and the research institution.

f. Research needs the industry to increase applicability of research to construction processes

It must be remembered that there is more to the construction process than just management, although that certainly is a major function. There is more to the process than just structural design or geotechnical evaluation, although these too are essential functions. The main function in construction is to bring two items together and connect them in some way. Are there better ways to bring items together? Are there better ways to effect a connection? One could go on listing many such questions aimed at opportunities to create better methods for construction.

Judging from published work in the *Journal of Construction Engineering and Management*, present research endeavors are almost all devoted to the management area and involve the use of computers; very few research endeavors are devoted to the process area (Harris 1992). Of 47 papers published in 1990- 91, 85% were management related, and only 13% were related to field methods (Harris 1992). The other papers centered on law and contracts. Computers are a necessary tool, but computers do not build a project. It appears that the research community has lost the assembly concept, and it must be regained; researchers must work in concert with the industry to do more "hard" research as opposed to the "soft" research now being done (Harris 1992).

2.6.2 The industry needs research

It is not only the academic research community that needs research to solve its future problems. The construction industry itself needs the input from research to find ways to increase its competitive edge, to have available the best technologies, and to enter into the worldwide construction market. It needs people with a research background to ensure its continued growth and to create the profession envisaged by its leaders of the 1950s and 1960s (Harris 1992).

a) The industry needs research to increase its competitive potential

Everyone knows that construction is a competitive enterprise, and when the word "competition" is used, the general contractor usually thinks in monetary terms. The costs associated with a project derive from the materials specified and the methods used. Good management can reduce the cost of materials, equipment, and labor, but it is the choice of method that has the greatest potential for cost reduction. The contractor that can plan work using nontraditional methods clearly has a competitive edge.

Even though construction personnel are creative in devising new methods, the source of new ideas can be increased by utilizing the publications of the research community. One reason for not making greater use of this valuable resource may be that contractors have little time to read. However, by developing closer ties to the research community, contractors can overcome this difficulty and develop a greater ability to use nontraditional methods. They subsequently can become stronger competitors.

b) The industry needs research in innovative projects

Project designers are creating unique designs for a variety of uses, and many of these designs call for innovative construction practices. Innovation implies a new application of older principles. To become involved with innovation a general contractor must be a large diversified company or must have access to a research organization with a construction background. The academic construction research institutions are uniquely suited to supplying this necessary support to contractors (Harris 1992).

c) The industry needs research to participate in worldwide construction

The world's political and economic environment has changed greatly over the past 10 years, and the opportunity for contractors to participate in foreign markets has grown with these changes. Many countries seek international tenders for proposed projects, and it can be anticipated that many general contractors will become involved, especially since some trade restrictions are being eased. It may be said that construction has become a worldwide industry. Some domestic contractors object to the incursion of foreign firms into construction markets and to the resultant loss of winning bids. Very often it is the research available to the foreign contractor that gives them the competitive edge. More domestic general contractors will be threatened by international contractors if they do not have the researched techniques to help them meet the challenge. Research is becoming necessary for contractors wishing to engage in international construction.

d) The industry needs research to provide top management personnel

Contractors who expect long-term corporate growth must choose and develop employees to fill top management positions. Persons who have grown up with the company or who have only received time proven training in methods and business procedures may not be the best candidates for these posts. Forward looking contractors will seek out people who have the management ability, the creative skill, and the future vision most likely found in those who have graduated from a rigorous educational program that has included research. It is these graduates who will lead the company with an infusion of new ideas, and who will replace those that depart because of retirement or death. It is my opinion that the future leadership of the industry is likely to be strongly influenced by graduates with the advanced degrees; ones who have done research while in school.

Bakens (1997) notes the research community is beginning to focus more of its attention on the industry and its needs. The needs of the industry ideally should determine the priorities of researchers. Bakens specifically states, “Research methodologies have to be oriented more towards developing applicable products and in doing so there has to be cooperation and consultation with those who are expected to actually apply them.” This cooperation will not only change the methods of research but also the priorities of the topics being researched. Identifying priorities is an activity that must require the involvement of two parties, the industry and research community.

The avoidance of cooperation must not be entirely blamed on the contractors or their lack of support. The industry may be hesitant to involve itself with academia because of the process of tenure. The popular belief of others outside of academia understand that “publish or perish” may result in pressure to research in areas that can produce quick results and require little involvement from others. Both the industry and the research community would mutually benefit by strengthening the ties between these institutions. Benefits can be recognized through an increase in collaboration between industry and academia. Research will always be an effective method of improving construction processes and techniques. However, it is a necessity to achieve greater support and coordination with the industry. Industry plays a key role in identifying the needs to bring realism to research, to capture the creativity of the individuals working on construction projects, and to increase applicability of research to construction processes (Graham 2010).

2.7 Motivations and barriers for collaboration

Successful industry - university collaboration needs to support the missions and motivations of each partner. For universities, typical motivations to collaborate with industry include the improvement of teaching, access to funding, reputation enhancement, and access to empirical data from industry. For firms, the motivations to collaborate with universities may include gaining access to complementary technological knowledge (including patents and tacit knowledge), tapping into a pool of skilled workers, providing training to existing or future employees, gaining access to the university’s facilities and equipment, gaining access to public funding and incentives; firms may also seek to reduce risks by sharing the costs of R&D, and to influence the overall teaching and research agenda of universities (Guimón 2013).

According to Guimón 2013, despite the growing strength of these motivations, many barriers to university - industry collaboration persist, including the following:-

- There is an inherent mismatch between the research orientations of firms and universities, with an excessive focus on fast commercial results in firms and on basic research in universities. Collaboration is costly and the returns only accrue in the medium to long run, but firms seek short-term results and clear contributions to current business lines.
- In terms of outputs, firms are usually interested in how quickly new patents or new products can be obtained, and want to delay publications to avoid disclosing information. University researchers, in contrast, are typically motivated to publish research results as fast as possible.
- Industry is concerned about secrecy and misalignment of expectations with regard to intellectual property (IP) rights and making a profit from them. Thus agreements need to be established in a commercially timely manner that ensures the ability to commercialize with appropriate returns.
- Difficulties in negotiating collaboration include lack of information, difficulties finding contact persons, and transaction costs of finding the right partner among others.

In view of these obstacles to university - industry collaboration, a report of the Joint Project of the United States National Council of University Research Administrators and the Industrial Research Institute recommends the following guiding principles for university-industry endeavors;-

- Successful university - industry collaboration should support the mission of each partner. Any effort in conflict with the mission of either partner will ultimately fail.
- Institutional practices and national resources should focus on fostering appropriate long-term partnerships between universities and industry.
- Universities and industry should focus on the benefits to each party that will result from collaborations by streamlining negotiations to ensure timely conduct of the research and the development of the research findings.

These recommendations are equally relevant for all countries, although the barriers to university - industry collaboration are especially acute in low-income countries. On the university side, there is often a lack of financial and human resources and capabilities to

produce research results that can be converted into economic returns through patents, spin-offs, or other means like consulting and contracting. On the industry side, low technological capability and low interest in technological innovation limit the demand for the external knowledge that universities could provide. In the words "Absent its own R&D capacity, the private sector cannot 'absorb' what is done in public research" (Guimón 2013).

Incentives for enhancing the university - industry connection, universities have a number of motivations for reassessing their ties with industry. There is a growing research interest in solving critical domestic problems and a renewed appreciation for the role of industry in such problem solving. However, the primary motivations are more pragmatic.

Some seem to believe that all industrial research is applied product development; that the competence of industrial researchers and the quality of their research is inferior; and that university - industry interaction means industry direction of university research, applied research only, lower standards of quality, no publications, only proprietary work, and no real interaction that is, industry supplies the money, university supplies the brains. Conversely, university research is viewed by industry as ivory tower with little thought to applicability and too much reliance on the cumbersome publications process. Industry often finds university graduates to be too theoretical and unable to make the transition to the more applied orientation of industrial research. Such attitudes are the most difficult barriers to overcome and constitute the most significant challenge to those who believe that increased numbers of formal university - industry research relationships are desirable (Denis and Gilbert 1980).

2.8 Policies to promote university - industry collaboration

Public policy may influence the propensity of firms to collaborate with universities and the scope of such collaborations in many different ways - through a direct role in providing funds to universities and R&D projects, as well as through a regulatory role, which influences the rule sets of public universities and shapes the intellectual property rights regime. Another role of public policy is to provide the necessary infrastructure and intermediate organizations such as technology transfer offices, science parks, and business incubators. Furthermore, governments can stimulate collaboration through soft measures, such as providing specific support services to firms/universities in the search for partners and conducting outreach activities to promote networking and raise awareness of the importance of collaboration (Guimón 2013).

The experience of Sri Lanka in overall R&D and innovation activities in University - Industry collaboration developed by spending a total of US$69.4 million on R&D in 2010.This corresponds to 0.16 percent of the country's gross domestic product, which was a considerable increase, over the amount spent in 2008 (0.11 percent). The business enterprise sector contribution to R&D expenditure increased in 2010, which was 41 percent of the total R&D expenditure and 0.06 percent of GDP. Historically, Sri Lankan universities have had a low level of R&D activity, as the prime duty of their faculty is teaching. In 2010, only 11 percent of R&D expenditure was carried out by universities, compared with 45 percent by government research institutes and 44 percent by business enterprises. It is likely, therefore, that R&D expenditures at universities currently account for more than 11 percent of total R&D expenditure in Sri Lanka (Kurt et al. 2016).

Transformation of knowledge into wealth requires tripartite or triple helix: that is network between university/researchers – industry – government in which each element recognizes the mutual benefit of such cooperation and evolving networks of communication. The United Kingdom strategies for innovation developed by university challenging seed fund to support collaborative research, provide finance for brining research to point of commercialization by allocating sixty million Pound sterling to fifty seven universities. The knowledge transfer partnerships also developed by United Kingdom's premier technology – knowledge transfer program by assisting young graduates by providing high level training (Ellen 2006). The Canada foundation for innovation which is Independent Corporation created to fund research infrastructure to transform the way research is done, which create a strong and vibrant research environment across Canada and enhance research productivity and the training of highly qualified people to build new national and international networks and partnerships by funding up to 40% of a project's cost (Ellen 2006).

A study on university – industry collaboration in Italy and Spain shows that the impact of university-industry interactions on regional development became even more important since higher education institutions moved from a traditional role, focused on basic research and training, to a new role more involved in innovation and productive tasks. In "Triple Helix Mode" model, universities will be one blade, together with firms and governments, for the development and use of new knowledge in the economy and so for promoting competiveness and economic progress. Under this view new functions of universities are emphasized such as technology transfer, spin-off creation, patent licensing, etc. More recent contributions have somehow renewed the "triple helix" idea pointing to the

existence of a “quadruple” and even “quintuple” helix innovation model. Thus the quadruple helix mode will incorporate media, culture and the civil society perspective into the process of knowledge creation and innovation whilst the quintuple mode will do the same with the natural environments of society (Manuel et al.2015).

It is becoming increasingly difficult for Nigerian universities to go it alone in terms of serving as a citadel of learning, coping with the huge wage bill and competing with their peers in other parts of the world, due to competitive, economic and other pressures. As a consequence, Nigerian universities are left with no option than to carry their industrial partners along in terms of research and development through the formation of partnerships for their mutual benefit. Since the industries are established for profit making and the universities for knowledge enhancement, such partnerships would help in spreading the costs in terms of provision of knowledge and costs of research (Anthony and Hongyou 2011).

Given these challenges and the very limited budgets and multiple competing priorities developing countries face, their governments should concentrate efforts on the most appropriate policy instruments. The following sections review policy options to promote university-industry collaboration, specifically as they relate to the case of developing countries.

Promoting university - industry linkages in spite of different successes, opinions are divided over the proper federal role in the initiation and maintenance of formal university-industry research relationships. Some are convinced that the government has no role and should allow universities and industry to develop relationships as appropriate. These people argue that government participation might limit the flexibility or diversity of industry - university arrangements. Others visualize a range of federal roles. At a minimum, they see the government contributing by attempting to remove disincentives to research and innovation in general. At the next level of involvement, the government could identify problems requiring research, help identify potential partners, and facilitate negotiations. A more active role would involve the government's providing start-up funds. Finally, the government could be a third partner, sharing costs with the industry and university. In this case, too large a government role could lead to federal interventions in activities that should be the responsibility of business and industry.

On the basis of this review of the status of, and potential for, formal university - industry research relationships, several means of promoting the establishment of university -

industry linkages can be suggested. There is a need to accelerate contacts between university administrators and scientists and their industrial counterparts. The objectives of these contacts are to erase preconceptions; increase understanding of goals, management philosophies, and research orientations; and lay the groundwork for improved relations and potential research cooperation. The government can facilitate this process in some cases by identifying individual and institutional barriers to improved communication and by instituting specific programs (information exchange, personnel exchanges, and conferences) designed to stimulate contacts and substantive interaction. Such activities should attempt to remove inter institutional impediments and focus on scientific matters of mutual interest. Successful relationships depend on joint efforts of individuals with sufficiently strong interest and competence in a scientific question or engineering problem that institutional barriers are surmounted. Representatives of both the academic and industrial sections have stated strong support for the use of federal grants as seed money to facilitate initiation of new university-industry relationships. Such grants would enhance industrial support of university research programs meeting specific criteria including demonstrable university-industry cooperation (Guimón 2013).

2.9 University – industry linkage in Ethiopia

In Ethiopia national development plans (GTP I and GTP II), a more knowledge intensive approach to development is increasingly becoming the main route for bringing sustained and outward oriented development and thereby bringing the country into a middle income country by 2020-2025 GC. Currently, there is a clear shift from the agricultural led to the industrial led economy that demands for more quality graduates in the areas of science and engineering, and research and innovation activities. The universities' role in this regard is accelerating human development and technological capacity building and ensuring its sustainability. This suggests that the institutional environment for universities is changing in the Ethiopian context that demands universities to be responsive to the economic development of the country (Mulu, N.K. 2017).

The Ethiopian Ministry of Science and Technology (MoST) has been established by proclamation No. 691/2010 as one of the most important regulatory bodies in the areas of science, technology and innovations. Preparing national science and technology research and development programs based on the country's development priorities; coordinating science and technology development activities and national research programs; and facilitating

interaction and collaboration among government and private higher education and research institutions and industries. The government has also established national STI council and the national forum for university industry linkage which are coordinated by MoST.

Many of the universities have opened university industry linkage and technology transfer offices under the vice president for research and technology transfer to facilitate their interaction with industries in terms of training, research and innovation. The Research and Technology Transfer Conceptual and Governance Framework of Ethiopian Higher Learning Institutions are another new policy framework developed by the Ministry of Education. It defines the vision, mission and objectives of research and technology transfer framework including opportunities and challenges in the universities. Under this framework, institutions will be supported through provision of funding for innovation, perhaps on a competitive basis. This shows the intention of the Ethiopian government to facilitate the science and innovation endeavors of the country (Mulu, N.K. 2017).

Addis Ababa University, as a pioneer higher education institution, has been playing its critical role in the formation of human capital in the country. It has been articulating research undertaking as one of its missions since its establishment in 1950. The movement to establish a link between the university's research and training to industry began to the 1980's that culminated with the formation of a University Industry Cooperation Program in 1986. The university has also made a similar attempt to establish a link with industry in 2000. However, all this attempts could not be translated into meaning action due to lack of adequate and coordinated efforts to stimulate a sustainable institutional linkage between the university and industry. Engagement in mutually rewarding on-going collaboration with its stakeholders is still one of the missions of the Addis Ababa University. Recently, the university has put in place policies and thematic priority areas for research and offices to coordinate and lead research, university-industry linkage and technology transfer since 2010. There is also an increasing in fund allocation for research since 2012. Even though the overall scenario for collaboration and working with the industry appears to be limited, relative strengths were reported in the interviews conducted. Many respondents from the university explained that public universities especially the Addis Ababa University engage the public in setting out their institutional research agenda and in opening up new programs (Mulu, N.K. 2017).

However, the role of academic research in terms of enhancing the productivity of the economic sector is generally dismal. Most of the research works undertaken by the academic and research institutions and PhD students are either shelved or presented in conferences or published in journals for the purpose of academic promotion (Mulu, N.K. 2017).

2.10 Methods to enhance the university - industry relationship

2.10.1 Research and development incentives and grants

A typical approach to stimulating university - industry collaboration is to design R&D research grants, matching grants, and tax incentives with a requisite of a consortium of firms and universities for project eligibility. The innovation voucher is another possible instrument to promote collaboration that has been successfully tested in countries like the Netherlands, Ireland, and United Kingdom (OECD 2010). Innovation vouchers are small lines of credit provided by governments to firms (generally small and medium enterprises) to purchase services from universities and public research centers, with a view to introducing innovations in firms' business operations. Its simplicity makes the measure easily adoptable in developing countries.

The problem in many developing countries is that firms have shown little interest in requesting grants, because they either do not feel the need to collaborate with universities, are not ready to match the funds with internal resources, or find the grant application process too complex. More fundamentally, universities often do not provide the incentives to align their research agendas with market demands, and therefore they are not very relevant to the needs of local enterprises. In Uganda a grant scheme specifically to promote university - industry collaboration was launched in 2007 with funding from the World Bank, but firms had little interest in participating in the program (Guimón 2013).

2.10.2 Performance based funding of universities and reward systems for researchers

Governments can seek to stimulate university - industry collaboration through their role in funding public universities. The performance measures that determine the funding received by public universities normally include indicators like numbers of students, PhD graduates, scientific publications, and patents. In order to stimulate collaboration with industry, other criteria should be introduced, such as the number of consulting or R&D contracts with industry, income from patent licensing, number of spin-offs, number of start-ups by university faculty or graduates, and so on. The United Kingdom, Canada, India and Singapore governments, for example, offer universities supplementary earmarked funding for research, conditioned on the university achieving a certain level of contracts with industry, spinoffs, or start-ups (Guimón 2013).

2.10.3 Intellectual property rights regime and technology transfer offices

The United States pioneered in introducing new regulations to stimulate the patent activity of universities and to enable commercialization of research products. The Bayh-Dole Patent and Trademark Amendments Act of 1980 provided blanket permission for performers of federally funded research to file for patents on research products and to grant licenses for those patents to private firms. Following the United States experience, during the 1990s most OECD countries introduced similar legislation, and since the 2000s many low and middle income countries such as China, Brazil, Mexico, South Africa, Malaysia and Philippines, in particular have followed suit. Besides legal reforms, regulatory frameworks also include voluntary guidelines for IP management and codes of conduct in collaborative projects.

Further, the creation of technology transfer offices (TTO) in universities has become a widespread institutional mechanism to assist researchers in patenting their findings and obtaining license fees and royalties. TTOs provide a wide array of services aimed at improving the technology transfer cycle, such as support in the patent application process, licensing agreements, search for partners and funding sources, and training and support in the creation of university-based spin-offs (Guimón 2013).

2.10.4 Science parks, spin-offs and business incubators

National governments can further shape university - industry links by developing science parks in the vicinity of universities and by spurring university research spin-offs and start-ups with university connections, for example through public venture capital and grants to entrepreneurs. Science parks are intended to create clusters and promote collaboration between firms and research institutions, and they often include business incubators to support spin-off and start-up companies. The number of science park initiatives has exploded in both developed and developing countries, although examples of failure abound where ambitious science parks turned into no more than real estate players with unsustainable financials. In particular, there is a lack of compelling evidence of success of these initiatives in low and middle income countries (Guimón 2013).

2.10.5 Education and training

For the majority of firms, the most important link to a university is through recruitment of skilled graduates. Education and training remains one of the key roles of universities, especially in lower income countries where the lack of skilled workers is a major

bottleneck hindering the competitiveness and innovative capacity of firms. Governments may seek to improve the quality of university graduates by fostering a stronger collaboration of universities with industry. A first step is to establish a consultative process whereby the voice of relevant business managers is considered in curriculum development, so that university programs better respond to industry needs. Governments can also establish and support student internship programs for undergraduates, as well as seek the participation of firms in graduate programs, and even the joint supervision of PhD students, who may undertake part of their research within firms.

2.10.6 Globalization and university - industry collaboration

National innovation systems in most countries are becoming more integrated with global innovation networks and more dependent on foreign sources of knowledge. Collaborations between local industry and foreign universities can play a critical role in the absorption and adaptation of knowledge developed abroad. The globalization of innovation brings both opportunities and challenges for developing countries. Multinational companies (MNCs) have substantially expanded their global innovation networks, and their aim to collaborate with universities located abroad has been identified as one of the main drivers of the internationalization of their R&D centers. As universities also become globalized, a growing number of leading universities from developed countries are opening up campuses in developing countries to provide training in situ or to engage in R&D. This allows universities to globally leverage their reputation, knowledge base, and management practices (Guimón 2013).

2.11 Establishing research priorities

Determining research priorities through strategic plans or agendas is an effective way to direct knowledge and research results to immediate application. Changes in the construction industry occur at a very rapid rate, which causes many challenges in the establishment of research priorities. The purpose of developing a strategic research plan is to tackle the need to increase professional knowledge in the areas associated with building and the general knowledge necessary for the solution of the current problems (Graham 2010).

In the development of a strategic plan, the main knowledge required for the design, the construction, and the operation of buildings to be advanced by means of research can be

divided into five main disciplines, following the classification customary in the engineering schools and in the international information exchange activity (Warszawski et al. 2007).

1. *Structural engineering*: Concerned mainly with the strength and stability of buildings and their components.
2. *Building materials and technology*: Deals with the examination and improvement of building material properties and durability, their production, and installation in structures and buildings, as well as with the development of new building materials and technologies.
3. *Geo-technology*: Deals with properties and behavior of the different types of soils and rocks and with their interaction with foundations, buried structures, retaining walls, and with various other civil engineering structures and construction works.
4. *Construction management and economics:* Deals with the realization of a building and its operation, including the attention to their total managerial, economic, and engineering aspects.
5. *Physical performance of buildings*: Deals with the various physical attributes of building performance, integrating between the user needs (safety, health and comfort) and the building and its components.

This scope excludes the aesthetic, cultural, and functional aspects of the building, which in Israel, as well as in most other countries, are pursued in the departments of architecture. Their research is funded through separate research budgets. Then to find research topics for potential research he promotes conducting a review of literature of publications, conference proceedings, and academic journals. The review should focus on recent years to avoid topics that have become irrelevant with time. Once discovered, the research topics should be classified under the previously determined topics, and then ranked to determine importance to the topic. The ranking should be from those who are the end users, the industry professionals. In Warszawski's study he asked the responders to rank the topics very important or urgent, important but without urgency, subject not justifiable for their research costs. However it is important to note that opinions of industry professionals may be distorted by problems they are facing immediately, or there may be little familiarity with a large amount of research already available on a topic. Nevertheless, the experience and insight of industry professionals "bring an invaluable dimension to the knowledge acquisition process (Warszawski et al. 2007)."

In a study to identify research priorities in management, Brochner (2005) combines both methods to elicit priorities. His first process used was a search of keyword and suggestions from a focus group to develop 114 suggestions for research topics. These topics were reduced to twenty themes through clustering ideas that were similar in nature (Graham 2010). A survey was then developed to rank the ten most important themes based on a Likert-type scale. This survey was distributed to 260 Swedish firms. This method produced results that ranked the themes based on research rank versus trend rank from 1 to 20. This produced a simple method to analyze the views of the industry and trends in research. There are common processes in establishing research priorities as demonstrated by the studies discussed above. It is important to do a review of literature to determine the trends from topics recently published. It is also critical to consult with industry professionals for feedback on research priorities. These are the underlying elements in determining a real basis for applicable research and establishing research priorities (Graham 2010).

2.12 Research in the construction

According to Boyd and Paulson, "Goals for Basic Research in Construction", the meaning of "basic research" is subject to continuing debate, and to link the terms "construction" and "basic research" would appear to invite a paradox. Construction implies designing and building facilities to meet specific needs. Most of the industry's research advances come from solving specific problems when encountered on new projects; often this involves applied scientific and engineering research of a very high order. On the other hand, "basic research" implies investigation of fundamental concepts or principles, but with no conscious intent that it leads to tools which are expected, much less guaranteed, to solve problems.

In defining "basic research" in construction, one could argue that since this is a very applied field even within engineering, then research that might not be viewed as basic research in the context of more theoretical fields such as physics, chemistry, or even engineering mechanics might still legitimately be called "basic research" in construction. It is worth noting that the other fields mentioned have been distinct disciplines for at least half a century. Nevertheless, certain characteristics of basic research should still apply to construction. There are many ways to describe basic research. Some characterize it as "long-range" and "theoretical", as contrasted to short-term applied problem solving. Others say that it means the problem itself has not been defined yet. Perhaps more relevant than a general definition of basic research would be an assessment of its role (Boyd and Paulson 1975).

In addition the following six international trends were identified by Wim Bakens in 1997, as likely to have the most profound influence on construction research. According to Wim Bakens, the actual selection of these trends as ones which are expected to have the most profound influence was a result of discussions with senior researchers and research managers from different types of companies and organizations in different parts of the world, the first four trends were anticipated to have a major influence on the way construction research in general has to be managed and executed. Trends 5 and 6 were expected to have a marked effect on topics and priorities in construction research program (Bakens 1997).

1. Growing partnership between the research community and the industry
2. Internationalization of competition and collaboration in the research community
3. Growing emphasis on integrated topics and approaches in research
4. Electronic collaboration
5. Information Technology (IT) in Construction
6. Sustainable Development and Construction

2.13 Establishment of research trends and needs

According to "Analysis of Trends in Construction Research from 1985 up to 2002", Journal of Construction Engineering and Management, to discuss the trends in construction research as depicted by the Journal of Construction Engineering and Management, the 18-year period under investigation was divided into three 6-year periods. Period one is from 1985 to 1990 and includes volumes 111–116, period two is from 1991 to 1996 and includes volumes 117–122, and period three is from 1997 through 2002 and includes volumes 123–128. Statistics were calculated for the various study issues for each period. Then, period totals were analyzed and compared to identify changes and trends over time (Abudayyeh et al.2004).

According to Sterling T. Graham in 2010, Master Thesis, "Analysis of Construction-Related Research Compared to Needs of Industry Professionals", the themes were collected during the review of literature from multiple studies that explored construction research trends, current industry issues and common construction topics. The primary authors in the publication of popular themes included: Brochner, Abudayyeh, Bakens, and Warszawski. The original list included 41 themes which upon review were reduced by common topics. By further review the list was narrowed to 22 themes. The goals were to cover similar topics in one theme and also formulate the theme so it could be used for potential research topics.

These themes were then reviewed and approved by a committee of construction management faculty from Brigham Young University and with feedback from additional construction professionals. Each theme was then defined so that it was relevant to the industry so that an accurate opinion could be formed while participating in the survey instrument (Graham 2010).

In addition an effort was made by Sterling T. Graham to obtain a national distribution list of general contractors, members of the Associated General Contractors (AGC). The organization was unwilling to provide the distribution list for protection to its members and therefore the selection of respondents was made from smaller geographical region were contact could more easily be acquired (Graham 2010). The assumption was that construction professionals in northern California have similar views to construction professionals nationally. The study was conducted using a sampling of construction professionals throughout Northern California. A random sampling for the survey was collected from a member search of general contractors on the website of the Association of General Contractors of California (Graham 2010).

According to "Strategic Planning For Building Research - a Process Oriented Methodology", Journal of Construction Engineering and Management, the classification of themes was performed by means of the “product tree” method. It consists of a hierarchical division of the whole subject. The division was done using tree branch into three to seven secondary branches with common features, targets, or impacts resulted at the lowest level in 100–150 subareas per discipline. Each subarea would then be contracted out by the sponsor as one or more research projects depending on his particular considerations and the research proposals submitted by the research community (Warszawski et al. 2007). Several systematic methods for the generation of the product tree can be considered: It is relatively easy to construct the tree based on the building’s physical components on various levels, for instance main spaces, then assemblies, works, elements, and even resources. Each component can then be examined for its possible research needs in the given discipline. This simplistic approach, although following to some extent the design sequence, is not linked strongly to the research areas, and is less suitable for the methodical arrangement of knowledge. Under a more rigorous approach, the tree’s components can be examined also from the project realization aspect. Accordingly, each component would be examined in the context of different stages of realization, as follows (Warszawski et al. 2007);

- Planning: First, a conceptual planning, later a general planning, and finally, a detailed planning,
- Construction/production: Design, contracting, erection, and measurement/control, and
- Operation: Maintenance, performance, and decommissioning.

The combination of a component at a certain level with any realization stage generates a combination at which a problem that requires a solution may occur. Consequently, a systematic examination of a product tree with respect to all realization stages of its components/branches covers all the possible research needs. Another method, more suitable for the identification of research subjects using a product tree focuses on the division of the total discipline into separate areas of work in research (Warszawski et al. 2007).

According to "Strategic Planning For Building Research - a Process Oriented Methodology", journal of Construction Engineering and Management , the approach which was implemented in the study in order to identify the interdisciplinary total building sector problems was based on the desired objectives of the building sector, as they were identified in discussions within the research team and with others. It was also based on the economic and social reality pushing for their attainment, as it is expressed in various change drivers. The ultimate list of the total building sector problems in Israel, was formed in its preliminary version, with the aid of the six disciplinary seminars with practice experts (Warszawski et al. 2007). Subsequently, the conclusions of that stage were discussed within the research team and classified according to the main objectives of the Israeli building sector, and verified by the identification of the change engines which cause them. The list shaped in this manner was presented for a final discussion by an interdisciplinary team composed of experts in the various areas. Interdisciplinary total sector problems were grouped according to their respective objectives into eight groups as follows (Warszawski et al. 2007):

1. Improving building user’s welfare;
2. Improving efficiency of the construction process;
3. Optimal utilization of land;
4. Sustainable development;
5. Protection of buildings from environmental damage;
6. Improvement of building safety;
7. Supply of supporting knowledge; and
8. Integration and implementation of knowledge from other fields.

According to Warszawski, the study defined the research needs and their priorities in five professional disciplines, as follows:

i. Structural engineering,
ii. Materials and technology,
iii. Geo-technology,
iv. Construction management, and
v. Physical performance of buildings.

Each one of these disciplines has been divided into primary areas, and at a higher level of detail to secondary areas and subareas. Some 100–150 subareas have been identified for each discipline and every subarea received as priority rank of its research needs. Then thirty interdisciplinary sectorial problems were identified, which due to their size and severity justify investment in research and development for their solution. Each of the problems could be related to one of eight society sectorial objectives, which would be served by its solution. The importance rating of these objectives will depend on the prevailing circumstances and current needs. Consequently, their rating should be determined for each annual plan by the research sponsor (Warszawski et al. 2007).

2.14 Findings from past studies

According to "Analysis of Trends in Construction Research from 1985 up to 2002", Journal of Construction Engineering and Management, construction trends as described in the paper show that research is increasing throughout the world and topics are changing to address current needs. As long as these trends continue to improve in a positive way, the construction industry will be significantly enhanced by research. However, there is a need to increase research collaboration between industry and academia, between government and academia, as well as between industry and government to advance the construction industry (Abudayyeh et al.2004). As it is shown in Table 2.3, the journal indicates the top construction research topics from 1985 up to 2002 with three period categories with respect to there 18 years ranking.

Table 2.3 - Top construction research topics during each period

Topic	Number of papers	18-Year rank
Period 1 (1985–1990)		
Scheduling	15	1st
Productivity	13	2nd

Management	9	14th
Cost control	9	9th
Education	7	19th
Innovation	7	10th
Bar codes	5	44th
Bridge construction	5	11th
Robotics	5	39th
Technology	5	11th
Period 2 (1991–1996)		
Scheduling	12	1st
Constructability	10	3rd
Planning	9	5th
Productivity	9	2nd
Safety	9	6th
Simulation	9	4th
Cost control	8	9th
Computer systems	7	7th
Highway construction	7	13th
Technology	7	11th
Period 3 (1997–2002)		
Simulation	16	4th
Scheduling	14	1st
Productivity	13	2nd
Performance	10	16th
Optimization	9	15th
Constructability	8	3rd
Highway construction	8	13th
Cost control	8	9th
Computer systems	7	7th
Planning	7	5th

Source: Adapted from Abudayyeh et al.2004.

According to Sterling T. Graham in 2010, Master Thesis, "Analysis of Construction-Related Research Compared to Needs of Industry Professionals", findings in this study demonstrated that construction professionals believe that more research should be completed in the area of constructability or similar topics regarding the ability of a project to be built. With feedback from industry, valuable research on the theme of constructability should be conducted. The findings from this research demonstrate that much of the research emphasis (research fads) of academia is not what is important to the construction professionals (Graham 2010). According to Sterling T. Graham the themes were collected during the review of literature from multiple studies that explored construction research trends, current industry issues and common construction topics. The original list included 41 themes which upon review were reduced by common topic. By further review Graham narrowed the list to 22 themes. Four research journals were selected for their focus on construction research. Articles from each of these journals were gathered from the volumes between the years 2006 and 2007.

Sterling T. Graham gathered the data from the four research journals included journal, title, and year of publication. He classified these articles into themes based on the primary topic of the research in the article. The total number of articles that were gathered and stored was 607. All the articles were collected into a database for storage and sorting. Each article was then classified into one of 22 themes based upon the primary research topic. The number of occurrences of each theme was then counted and recorded into the database. Each theme was then ranked based upon the total number of occurrences from the journals and it is presented in Table 2.4 (Graham 2010).

Table 2.4 - Research and Industry ranking comparison

Research topic areas	Research ranks	Industry ranks
• Training/ Human Resources	1	20
• Management/ Risks	2	7
• Technology/ Innovation	3	11
• Economics/ Cost Control	4	3
• Globalization	5	22
• Estimating/ Bidding	6	2
• Scheduling	7	17
• Design/ BIM	8	4

• Performance	9	8
• Safety	9	9
• Industry Overview	11	21
• Legal/Contracts	12	15
• Sustainability	13	18
• Computer systems/ Expert systems	14	14
• Project Delivery	15	6
• Productivity/ Optimization	16	10
• Constructability	17	1
• Materials/ Equipment	18	5
• Project/ Quality Management	19	12
• Facilities Management	20	16
• Procurement	21	13
• Heavy Civil Construction	21	19

Source: Adapted from Graham 2010.

Results from the comparison demonstrate that there are some common themes which rank high for both researchers and industry professionals; estimating, economics, management and design were ranked in the top ten from both research results and industry ranking (Graham 2010). He point out that although much research has been done in these areas there is still a need for discovery and advancement in these themes. The influence of the economic themes at the time of the study may have influenced the ranking from industry professionals. It was acknowledged that this study was developed to create a ranking of themes and the opinion of the industry professionals is dependent on current issues and trends (Graham 2010).

According to Sterling T. Graham (2010), the purpose of the study was to compare popular research themes to a ranking by construction professionals. The comparison was utilized to view whether the themes that were most commonly being researched were directly correlated to the perceived needs of the construction industry. The null hypothesis of Sterling T. Graham was there is no difference between the priorities of construction-related research and the needs of the construction industry. The results of the study rejected the null hypothesis. It is astounding that there was no correlation between what investigators are

researching and the needs of construction professionals. The findings of the research showed that the ranking result of the industry and research has got significant difference such as training or human resource and constructability. This result may show that the industry professionals believe that topic areas like training or human resource are being adequately studied and the discoveries might be accredited. But more research on these topic areas is not the necessity for the recent industry. Instead, excessive efforts shall be made on current demands of the industry in order to produce various results.

According to "Strategic Planning For Building Research, a Process Oriented Methodology", Journal of Construction Engineering and Management, given that proper research includes all six characteristics, the differences between the research work and a regular engineering investigation are as shown in Table 2.5, apparently, using research to devise a solution for any specific engineering problem will be more expensive and will take more time than applying a regular engineering design procedure. It may be expected, however, the solution obtained will be superior in terms of its quality, depth, operation, reliability, or other pertinent effectiveness aspects. Moreover, the research-based solution will usually provide more general tools for solving the generic problem enabling its application in various cases, whereas the engineering-type investigation will be limited to the specific problem at hand. The feasibility of research application to any particular problem will depend, therefore, on the value of its tangible and non-tangible benefits versus costs (Warszawski et al. 2007).

Table 2.5 - Research versus design Performance

Feature	**Research**	**Engineering design**
Up-to-dateness	Very high	Limited to few items
Objectivity	Highly pursued	To a limited extent
Measurement of inputs and outputs	Always measured	Selective measurement
Novelty	Always pursued	Addresses general state of art
Contribution to knowledge	Always	Seldom
Systems approach	To a large extent	Not necessary

Source: Adapted from Warszawski et al. 2007

2.15 Summary

The construction industry demands major enhancement in university - industry relationships. Even though significant institutional and attitudinal obstacles to such relationships exist, the possible benefits are sufficiently convincing to produce assurance that those obstacles can be defeated. The main approach for encouraging university - industry collaboration depends on the country's technological and institutional donations and its willingness to consider the promotion of university - industry linkages as part of a broader science, technology, and innovation policy program. The governments will face to choose strategy mechanisms that best serve the needs of both the university and industry, but this can be solved by consulting and involving the key stakeholders of the construction.

As it is discussed in the previous section, reviews of literature from past and recent publications and discussion of industry professionals through surveys or direct consultation is the paramount system to realize if the research that is currently being done is significant to the needs of the industry. At the same time as research is carried out based on the needs of the construction industry, more applicable results will be formed.

Moreover, focus on the needs of the industry will help the research population to set up priorities for topics that are most urgent and important.

2.16 Gaps identified throughout the literature review

The literature review covers different topics in a logical manner, beginning from the introduction of research and construction industry, discussing the mutual benefits of university industry linkages, clarifying the motivations and barriers for collaboration, and including the policies and methods to improve the university industry linkages. Subsequently, it tries to discuss the establishment of research priorities, research trends and needs as well as findings from past studies were discussed.

Among the gaps that were found in the existing literature regarding the university industry relationship it was very important to analyze the reason of the less involvement of the construction research papers in the industry, to study the methods to enhance the university industry linkages and to evaluate if the trend of the construction research is in alignment with the need of the industry. In addition the research has covered various topics that are considered significant in attainment of a superior understanding of the research and construction industry. A critical consideration should be given by the construction industry

professionals and the academic community in Ethiopia to identify the needs of the industry, to improve the involvement of construction research papers in the industry and to improve the university industry relationships.

In order to give solutions for the above problem it is vital to identify the influencing factors. After the factors are identified and issues are well-known, all the responsible stakeholders can take individual actions to moderate these problems. Therefore, this research aims to determine the needs of the construction industry regarding to research topics, to identify the critical factors influencing the less involvement of construction research papers in the industry and to identify the methods to enhance the university industry linkages.

3. RESEARCH METHODOLOGY

3.1 Introduction

Research is the systematic method consisting of enunciating the problem, formulating a hypothesis, collecting the facts or data, analyzing the facts and reaching certain conclusions either in the form of solutions towards the concerned problem or in certain generalizations for some theoretical formulation (Kothari 2004). Therefore research methodology is a way which brings all the research processes together and leads the researcher to accomplish the objectives of the study.

Accordingly the purpose of this section is to present research methodology which will be followed to accomplish the objectives of the research which is specified at the commencement. It begins with an overview of the general approach and methods used in the research. The focus area of the research is to identify the construction research trends and topic areas which are relevant for existing and future construction industry of Ethiopia, which is a comparison study of construction research trends and rankings from construction professionals, was used to explore this issue. In order to accomplish this focus area the choice of the research method, determination of the sample size and sampling technique and the systems of data collection and analysis are justified and well described.

One of the main objectives of this research is concerned with the investigation of the construction research trends in Ethiopia which needs a quantitative approach. Quantitative approach typically concentrates on measuring or counting and involves collecting and analyzing numerical data and applying statistical tests.

The other main objectives are concerned with identifying the current and future research needs of the construction industry in Ethiopia which needs a both quantitative and qualitative approach. Qualitative approach focuses on research data in the form of description that can be gathered by group discussion and observation. Therefore a combination of quantitative and qualitative research approaches was used depending on the nature of the research objectives. Mixed methods approach is a pragmatic knowledge claims, collection of both quantitative and qualitative data sequentially (Creswell 2003).

3.2 The research design

A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with in procedure. In fact, the research design is the conceptual structure within which research is conducted; it constitutes the blueprint for the collection, investigation and analysis of data (Kothari 2004).

Generally the research will follow both qualitative and quantitative approach, which emphasize in detailed investigation of information's through collection of currently available relevant data. In addition it can be categorized as basic and explanatory researches and also descriptive research with correlational studies. It is basic research because its primary objective is the advancement of knowledge and the theoretical understanding of the relations among variables and it is basically concerned with contribution to the existing body of knowledge. Moreover it is also explanatory research since it aims at establishing the cause and effects relationship of the less involvement of the construction researches in the construction industry. In addition it is also descriptive research with correlational studies for the reason that it tries to describe the construction related research performance of engaging on the construction industry by trace the relationships and performing Pearson correlation test among the construction research trends and industry needs in order to gain greater situational insight.

3.3 Scope of the study

The scope of the study is limited to the study of the construction research in contrast with the needs of the Ethiopian construction industry. The survey respondents will be limited to construction professionals of Ethiopian Roads Authority, Addis Ababa City Roads Authority, real estate developers, foreign contractors, consultants and local contractors. Contractors and consultants are selected from registered lists of MoUDCo contractor's and consultant catalog of 2009 EC and the selection for contractors only focused on BC, RC and GC from level one to level three and the consultant selection focused only on category one to three. The real estate developers' population size was determined from ethioconstruction.net website. The study of construction research trends is also limited to a review of research papers from Addis Ababa Institute of Technology, School of Civil and Environmental Engineering, Construction technology and management post graduate program researches.

3.4 Classification and development of topic area

The information was gathered and stored in Microsoft excel spreadsheet containing the following information:- title of the paper, name of the author, construction industry sector, topic area, research methodology, time of data collection, data collection approach, data collected and data instance, analysis technique, abstract, key findings or conclusion plus city and country.

Topic areas are collected during the review of literature from past researches that explored construction research trends, current industry issues and common construction topics. Then similar topics are covered in one topic area and also formulate the topic area so it could be used for potential research topics. These research topic areas are then reviewed and approved by thesis advisor and academicians with feedback from additional construction professionals. Each topic area was defined so that it will be relevant to the industry and an accurate opinion could be formed by survey instrument participants. The development of themes is mainly adopted from Sterling T. Graham (2010). Master Thesis, "Analysis of Construction-Related Research Compared to Needs of Industry Professionals", Brigham Young University - Provo, December 2010. Some modifications have been made.

A list of topic areas and abbreviated definitions will look like;-

1. *ADR (Alternate Dispute Resolution)* – related to disputes, conflicts and resolution methods.
2. *Change orders / Variation* – connected with the replacement or substitution of demand, command or order in the construction.
3. *Computer systems / Expert systems* – associated to the use of artificial intelligence to offer advice, make decisions, creating, enhancing computer software or else calibrating some part of the software and creating or proving formulas related to the construction.
4. *Concrete technology* – related with concrete making material, the overall concrete production, the characteristics of concrete and other related issues about concrete.
5. *Constructability* – linked to the ability of a project to be built, or the technique to review the construction process or study on current construction practice or construction defects.
6. *Delay and cost overrun* – associated with constructions with slow or late deliveries and high cost beyond the estimated value.
7. *Demolition* – related with the demolition of structures.
8. *Economics / Cost control* – connected to factors that influence the financial aspect of companies, projects and the entire industry.

9. *Estimating / Bidding* – associated with judging the cost of a project or estimating and securing the work through bidding.
10. *Facility Management* – interrelated to integration of multiple disciplines to maintain the functionality of a structure.
11. *Health and safety* – related with the study of techniques and advances in construction safety.
12. *Industry Overview* – A look at the industry in general, such as the history, progress or trends.
13. *Insurance* – related with construction insurance issues throughout the entire construction industry.
14. *Legal/Contracts* – studies that involve contracts, claims, or other legal issues.
15. *Material and equipment management* – linked with efficient use of materials and equipment before, during and upon completion of a building process in the construction and it is associated with the selection of proper equipment and materials to complete construction projects.
16. *Performance* – linked with research of measurement techniques of performance of construction entities or individuals and evaluation of performance.
17. *Price escalation* – connected with cause and effect of price fluctuation or adjustment techniques.
18. *Procurement* – This topic area consist the process of obtaining projects, labor, material or project delivery method.
19. *Productivity* – connected with the study of individual techniques and methods, labor and equipment productivity or general productivity.
20. *Quality Management* – attached with the method of controlling the quality of a project.
21. *Risk management* – related with the development of programs, practices or strategies for minimizing risk.
22. *Scheduling and planning* – associated with establishing the sequence and duration of activities on a construction project or issues concerned about planning and scheduling.
23. *Sustainability* – connected with sustainability techniques, harmful material reduction methods, and environmental impacts.
24. *Technology/Innovation* – linked to the development and implementation of new technology or technique.

A study of the researches produced a list of all the topics that have been published in Addis Ababa Institute of Technology, School of Civil and Environmental Engineering,

Construction technology and management post graduate program. Research published in each article varied and required classification into a general topic area. Classifications of articles allowed for an observation of general trends in construction research. Although the topic of some papers could fall into multiple categories, only the main topic was classified. The topics were used as the basis for respondents ranking of construction research trends. Each article was classified into one of the research topic areas mentioned above.

3.5 The ranking of construction topics

This study compared the past and current trends in construction research and the needs as seen through the construction professionals. The ranking portion of the study determined the views of the industry leaders. This allowed for a comparison to be made to the current research trends. The number of articles that were categorized under one topic area established rankings in research trends. The ranking of each topic area was based on the number of articles within each specific topic area. These rankings were used to compare with the ranking from construction professionals. The ranking of construction professionals was obtained through the questionnaire survey.

3.6 Research methods

The thesis used the following source of information and methods of data collection;

- Source of information
  - ✓ Existing information ~ Reports, previous researches, books, journals and any documents related to the research topic.
  - ✓ Peoples ~ Advisor, professionals and volunteers.
- Methods of data collection

The thesis used both primary and secondary data, the primary data will be in a form of questionnaire, designed to gather a large volume of data from contractors, consultants and clients. The primary function of the survey is to collect information that can be analyzed and interpretation made to produce conclusion about the demand of the construction industry. The secondary data which involves information from published document such as academics publications, journals, government publications, past research papers and internet resources are used to support the primary data.

The above two methods of data collection will be used to examine the correlation of construction research trends and the needs of the construction industry. The study of construction research trends will be done through a review of research papers from Addis

Ababa Institute of Technology, School of Civil and Environmental Engineering, Construction technology and management post graduate program researches, furthermore classification of those research topics will be done. The research topic areas will be given a research ranking based upon the number of articles that will contain. The second part of the study will be a survey to the construction industry professionals asking them to rank research topics by their importance to the industry then the results of both studies will be compared in addition other questions which are required for the research are included in the questionnaire and they are going to be analyzed.

The questionnaire survey will cover the following parties in the construction industry;-

1. For local contractors
    - Questionnaire distributed to local contractors
2. For foreign contractors
    - Questionnaire distributed to foreign contractors
3. For consultants
    - Questionnaire distributed for consultants
4. For construction industry clients
    - Questionnaire distributed to ERA
        - ✓ Eastern region
        - ✓ Northern region
        - ✓ Southern region
        - ✓ Western region
        - ✓ Central region
        - ✓ Design Bid department
        - ✓ Express way department
    - Questionnaire distributed to AACRA
    - Questionnaire distributed to real estate developers

3.7 Sample size

The required sample size for the research for each parties involved in the survey was determined statistically using the following expression (Kish, 1965 cited in Tadesse Ayalew, 2009).

- $no = \frac{p*q}{V^2}$ ..... [Eq. 3.1]
- $n = \frac{no}{\left[1+\left(\frac{no}{N}\right)\right]}$ ..... [Eq. 3.2]

Where:

- no: First estimate of sample size
- p: The proportion of the characteristic being measured in the target population
- q: Complement of p or 1-p
- V: The maximum standard error allowed
- N: The population size
- n: The sample size

To maximize, p was set at 0.5. To account for possible error in the respondent answers from the questionnaire, the maximum standard error V was set at 10% or 0.1. The target populations, N were 472, 7 and 211 for the local contractors, foreign contractors and consultant respectively. For major clients' real estate developers, ERA and AACRA the population size were 71, 129 and 56 respectively.

Therefore the sample size will be as follows using the above Eq. 3.1 and 3.2;-

$no = \frac{p*q}{V^2}$.

no = (0.5 * 0.5)/0.1^2 = 25

$n = no$ / [1+ (no /N)]

n = 25 / [1+ (25/ N)]

Thus the sample size 24, 6, 22, 18, 21 and 17 will be for the local contractors, foreign contractors, consultant, real estate developers, ERA and AACRA respectively.

The professionals included directors, department heads, section heads, lead engineers and project engineers from employer's side, architect, resident and contract engineers from the consultant's side, project managers, office and site engineers from the contractor's side.

3.8 Sampling technique

The guiding principle behind simple random sampling technique is that each element must have an equal and nonzero chance of being selected. This can be achieved by applying a table of random numbers or a computer generated random numbers to a numbered sampling frame (Abiy et al. 2009). In this research, simple random sampling using Microsoft Excel was carried out so that each member of the population has an equal chance of being selected.

First I inserted the names of the sample population in the Microsoft Excel sheet in a new column within the spreadsheet, then in the first cell of the next column I inserted the Random function which is "=RAND( )", after inserting the function in the entire rows of the specific column the random values appeared. Finally I sorted the random values from smallest to largest values in the Data tab and pick the sample population names from one up to the specific sample size.

3.9 Data analysis and interpretation

Data analysis and interpretation of research involves examining, categorizing, tabulating, testing or otherwise combining mixed evidences to address the initial problem statement. The analysis of the data will depend on the specific research problem and questions. Finally the research instruments will be designed properly to ease examining, categorizing and tabulating the research findings and responses. Then comparison between the construction research trends and the industry ranking will take place;-

- All industry ranking Vs Construction research trends ranking
- ERA ranking Vs Construction research trends ranking
- AACRA ranking Vs Construction research trends ranking
- Real estate ranking Vs Construction research trends ranking
- Foreign contractors ranking Vs Construction research trends ranking
- Consultants ranking Vs Construction research trends ranking
- Local contractors ranking Vs Construction research trends ranking

3.10 Reliability test

Any research based on measurement must be concerned with reliability. Reliability is concerned with the ability of an instrument to measure consistently whether the test designer was correct in expecting a certain collection of items to yield interpretable statements about individual differences. Before analyzing the questionnaires, returned questionnaires were checked for their reliability and the valid responses were analyzed.

3.11 Correlation test

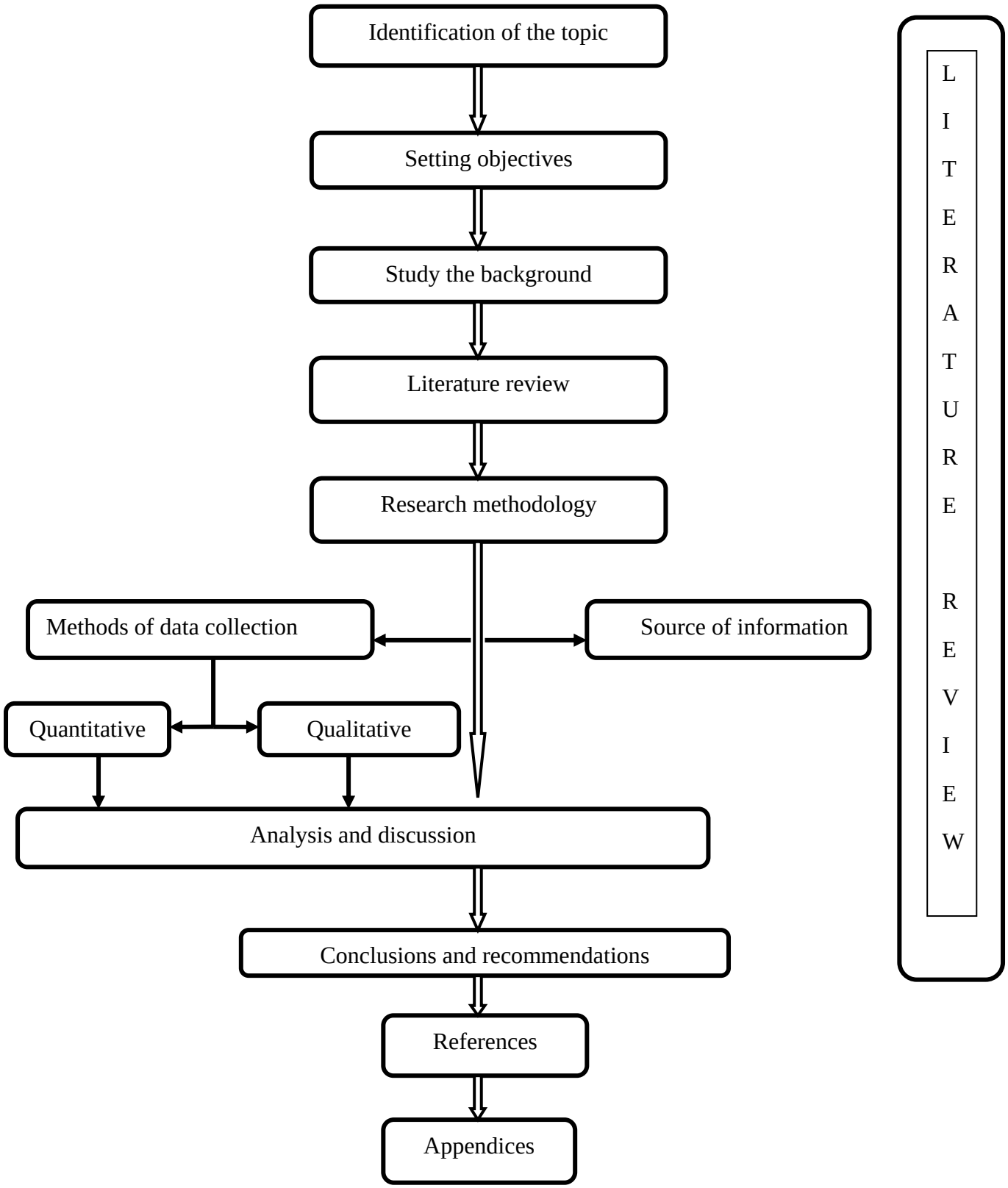
A Pearson correlation test was run on the results to verify the correlation between the research trend rankings and construction industry rankings. The Pearson correlation function from Microsoft Excel was used to determine the correlation coefficient. Results were then graphed to show the linear dependence of the industry and research ranking.

The Pearson correlation coefficient is a measure of the correlation or linear dependence between two variables X and Y, giving a value between +1 and −1 inclusive (Graham 2010). The correlation coefficient is a measure of the strength of the straight-line or linear relationship between two variables (Ratner 2009).

The following values of r are the accepted guidelines for interpreting the correlation coefficient (Ratner 2009):

1. 0 indicates no linear relationship.
2. +1 indicates a perfect positive linear relationship, as one variable increases in its values; the other variable also increases in its values through an exact linear rule.
3. −1 indicates a perfect negative linear relationship, as one variable increases in its values, the other variable decreases in its values through an exact linear rule.
4. Values between 0 and 0.3 indicate a weak positive linear relationship through a shaky linear rule.
5. Values between 0 and −0.3 indicate a weak negative linear relationship through a shaky linear rule.
6. Values between 0.3 and 0.7 indicate a moderate positive linear relationship through a fuzzy-firm linear rule.
7. Values between −0.3 and −0.7 indicate a moderate negative linear relationship through a fuzzy-firm linear rule.
8. Values between 0.7 and 1.0 indicate a strong positive linear relationship through a firm linear rule.
9. Values between −0.7 and −1.0 indicate a strong negative linear relationship through a firm linear rule.

3.12 Flow chart of research



4. DATA ANALYSIS AND DISCUSSIONS

4.1 Introduction

In this part of the thesis, data which were collected from sample respondents are presented, analyzed, interpreted and evaluated. The data's have been collected and processed according to the research methodology described in the previous chapter and address the research problems posed in the first chapter of this study.

The data were obtained through questionnaires. The questionnaires were distributed to different contractors (local and foreign), consultants and real estate developers, Ethiopian Roads Authority (ERA) North, West, South, East, and Central region offices; Express way project office; ERA Design Bid department; and Addis Ababa City Roads Authority (AACRA).

The questions asked were close ended and some open ended questions were also included. The open ended questions were used to gather respondent's opinion which provides in depth understanding of the issue of the study.

The questionnaire which is attached in Appendix - A used for data collection comprises of seven sections:

i. The first section deals with personal and organizational profile of respondent.
ii. The second section is concerned with general questions of the construction research and construction industry.
iii. The third section involves the rank of the construction research topics in which the construction industry is required to rank the research topic areas by their importance to the industry.
iv. Benefits of university industry linkages were covered in the fourth section of the questionnaire.
v. The fifth section covers the methods to enhance the university industry relationship.
vi. Factors which contribute for the lack involvement of construction research in the industry were part of the questionnaire in section six.
vii. The last section deals with additional research topics suggestions from the industry.

4.2 Questionnaire survey response rate and respondent profile

The questionnaire was distributed to contractors (local and foreign), consultants, real estate developers, ERA and AACRA professionals. Before analyzing the questionnaires, returned questionnaires were checked for their reliability and the valid responses shown in Table 4.1 and Figure 4.1 were analyzed.

Table 4.1 - Questionnaire response rate

Questionnaire response rate					
No.		**Distributed**	**Returned**	**Valid response**	**Response rate**
1.	**Clients**				
	• **ERA**	21	20	19	90%
	• **AACRA**	17	16	16	94%
	• **Real estate**	18	16	13	72%
2.	**Contractors**				
	• **Local**	24	21	19	79%
	• **Foreign**	6	6	5	83%
3.	**Consultants**	22	20	18	82%
	Total	108	99	90	83%

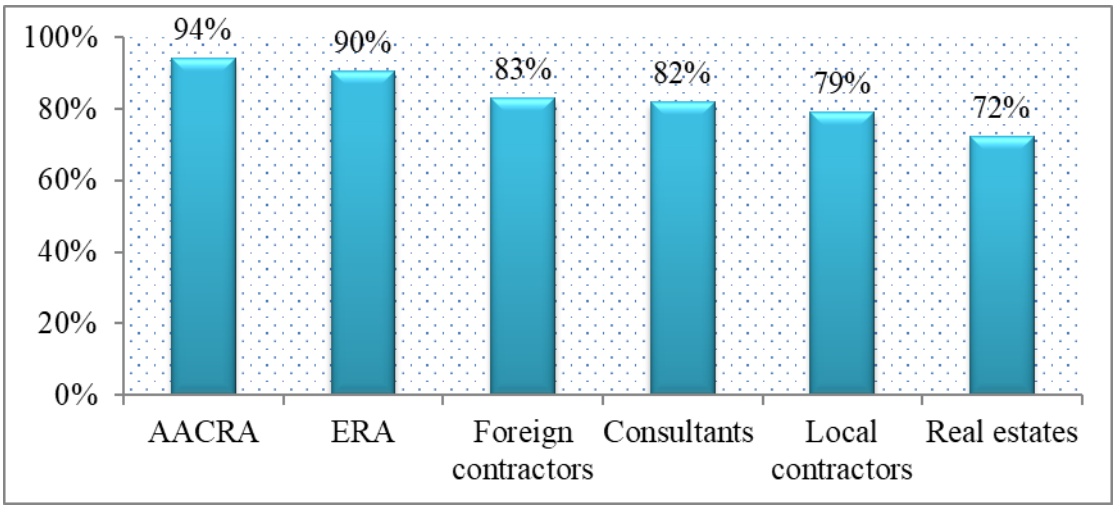


Figure 4.1 - Questionnaire response rate

Table 4.2 and Figure 4.2 shows that eleven percent of respondents were site engineers, another eleven percent were office engineers, thirteen percent were project manager, three percent were architects, fourteen percent of respondents were resident engineer, ten percent were contract administrator, six percent were lead engineer, seventeen percent were senior engineers, and the last fourteen percent were project engineers.

Table 4.2 - Respondents current working positions

Respondents current working position			
No.	**Position**	**No.**	**Percentage**
1.	**Site Engineer**	10	11%
2.	**Office Engineer**	10	11%
3.	**Project Manager**	12	13%
4.	**Architect**	3	3%
5.	**Resident Engineer**	13	14%
6.	**Contract Administrator**	9	10%
7.	**Lead Engineer**	5	6%
8.	**Senior Engineer**	15	17%
9.	**Project Engineer**	13	14%

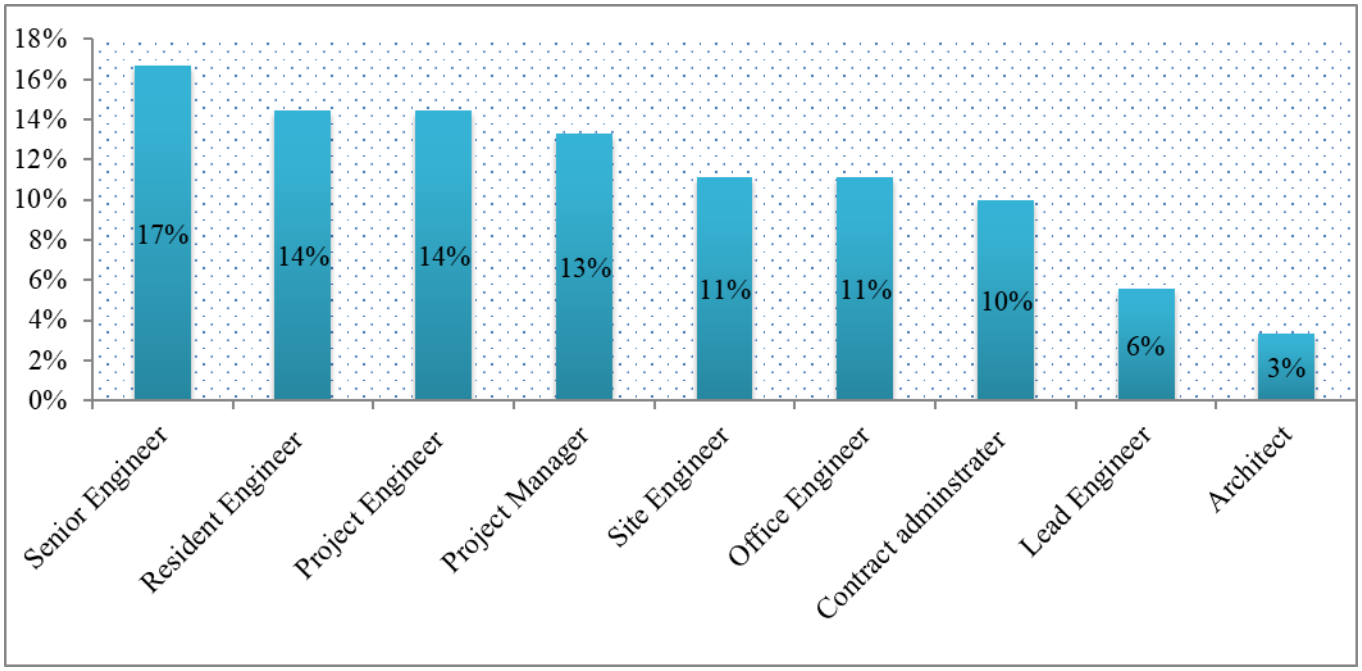


Figure 4.2 - Respondents current working positions

The following Table 4.3 shows the respondents experience in their current working position, experience in the construction industry, and level of education.

Table 4.3 – Respondent profile

No.	Respondent profile		
1.	**Respondents experience in current working position**		
	Years	No.	Percentage
	0 to 2	65	72%
	3 to 4	25	28%
	Above 5	0	0
2.	**Respondents experience in the construction industry**		
	Years	No.	Percentage
	0 to 5	21	23%
	6 to 10	33	36%
	11 to 15	24	27%
	16 to 20	7	8%
	21 to 25	5	6%
	Above 26	0	0%
3.	**Respondents level of education**		
	Years	No.	Percentage
	Diploma	0	0%
	Bachelor	63	70%
	Masters	27	30%

4.3 Analysis of respondents

Analysis and processing of research involves examining, categorizing, tabulating, testing or otherwise combining mixed evidences to address the initial problem statement. The analysis of the data depends on the specific research problem and objectives. The research instruments were designed properly to ease examining, categorizing and tabulating the research responses. The research questions are given weightings for the different responses of the questionnaire and it is presented in Table 4.4.

Table 4.4 – Weight of different responses

Type of Instrument	Weight of the different responses			
	Very often / always / very important	Often / usually / important	Sometimes or somehow important	None / never / not important
Questionnaire	6	4	2	1

Source: Adopted from Borcherding and Jhon.D, 1999 cited in Tewodros Alemu, 2006

Responses for similar questions are aggregated by the following formula considering the above weightings (Borcherding and Jhon.D, 1999 cited in Tewodros Alemu, 2006).

$$MSV = \frac{6(Von)+4(On)+2(Stn)+1(Non)}{Von+On+Stn+Non} \quad \text{..... [Eq. 4.1]}$$

Where; MSV = Mean Score Value;

Von = Number of respondents selecting very often or always or very important

On = Number of respondents selecting often or usually or important

Stn = Number of respondents selecting sometimes or somehow important

Non = Number of respondents selecting none or never or not important

The mean score of responses obtained by the above method are again classified based on the following criteria for interpretation:

Average score ranging: $0 \leq MSV < 2$; Poor performance

$2 \leq MSV < 4$; Low performance (Unsatisfactory)

$4 \leq MSV < 5$; Satisfactory performance

$5 \leq MSV \leq 6$; Good performance

where; MSV = Mean score value of the subtitle being analyzed in the discussion report and the numbers are score values.

The average score range description can differ according to the questions that are asked.

Score range description for the different questions were:

- $0 < MSV < 2$; Not applied, very low consideration, very low performance, never, no problem or not affected
- $2 \leq MSV < 4$; slightly applied, unsatisfactory, low consideration, low performance, sometimes, low problem or less affected

- $4 \leq MSV < 5$; applied, considered, good performance, usually, problem or affected
- $5 \leq MSV \leq 6$; highly applied, highly considered, very good performance, always, high problem or highly affected

4.3.1 Analysis of general questions

As shown in Table 4.5 and Figure 4.3, the overall trend of using a construction research papers from universities to solve problems faced on different stakeholders of the construction industry falls below two mean score value, which represent the use of the construction research papers by the industry is not applied meanwhile depending the individual mean score value for the trend of using construction research papers by ERA professionals was slightly applied. According to the data collected, ERA professionals are better users of construction research papers from universities.

Table 4.5 – Responses of general questions

No.	General questions	Scale				MSV
		Always	Usually	Sometimes	Never	
1.	Trend of using research papers	2	11	32	45	1.83
2.	Belief of those research papers have benefits	15	17	35	23	2.79
3.	Belief of strong university industry relationships for better basic research innovation	38	35	6	11	4.34
4.	Importance of advisory committee for the construction industry and for the needs in company	43	31	10	6	4.53
5.	Role of education and research is to make the concepts and practices	54	30	4	2	5.04

	known and useable					
6.	Collaboration between university industry to increase the tendency of firms to introduce new products	37	37	9	7	4.39
7.	Industry finds university graduates to be too theoretical and unable to make transition to the more applied orientation of industrial research	34	42	10	4	4.40

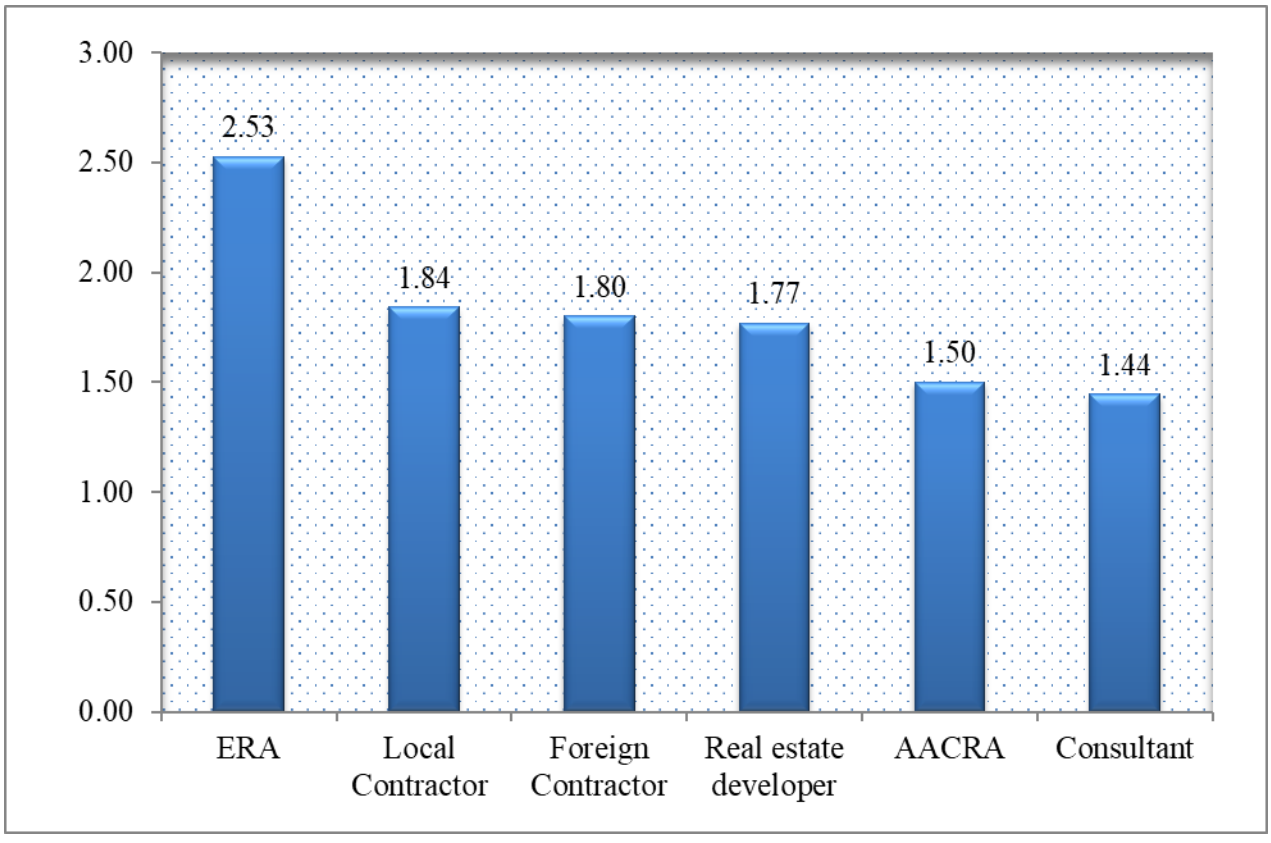


Figure 4.3 – MSV for trend of using research papers by the construction industry

From the Table 4.5, it can be referred that the overall construction industry has a low consideration on the belief of the benefits of the construction research papers for their companies. The mean score value was 2.79. It was obvious that the construction industry has a lower consideration since they have a very poor trend of using construction research papers.

A belief on the strong university industry relationship which can bring the improvement of the basic research innovation on average falls on the second best having a mean score value of 4.34, which means it has been considered that the strong university industry relationship is essential for the basic research innovation. Below On the Figure 4.4, the individual mean score value for the raised issue is presented.

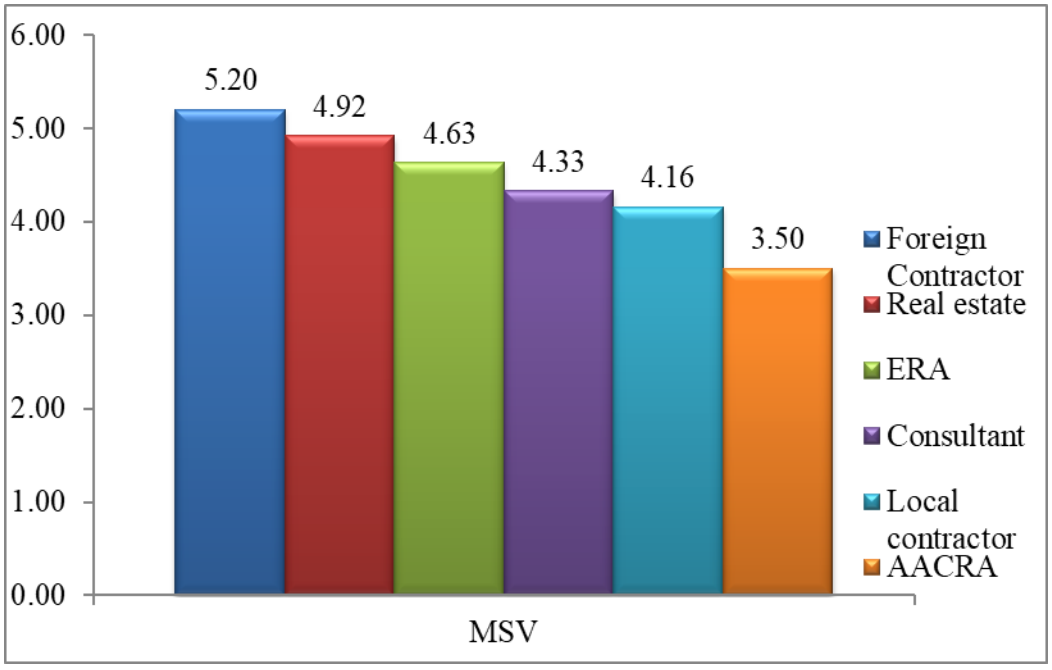


Figure 4.4 – MSV for the belief of strong university – industry relationships

It can be see that the foreign contractors have got the highest mean score value of 5.20, it means that they highly consider that the strong university industry relationships can enhance the basic research innovation.

According to Table 4.5, the mean score value of the entire construction industry was 4.53 for the importance of an advisory committee or research council made up of professionals and executives in the construction industry, which indicates they have a better

consideration on the importance of this advisory committee or research council. These professionals and executives of the committee will inform on current changes in the construction industry and on the needs in organizations. Below in Figure 4.5, the individual mean score value is presented;

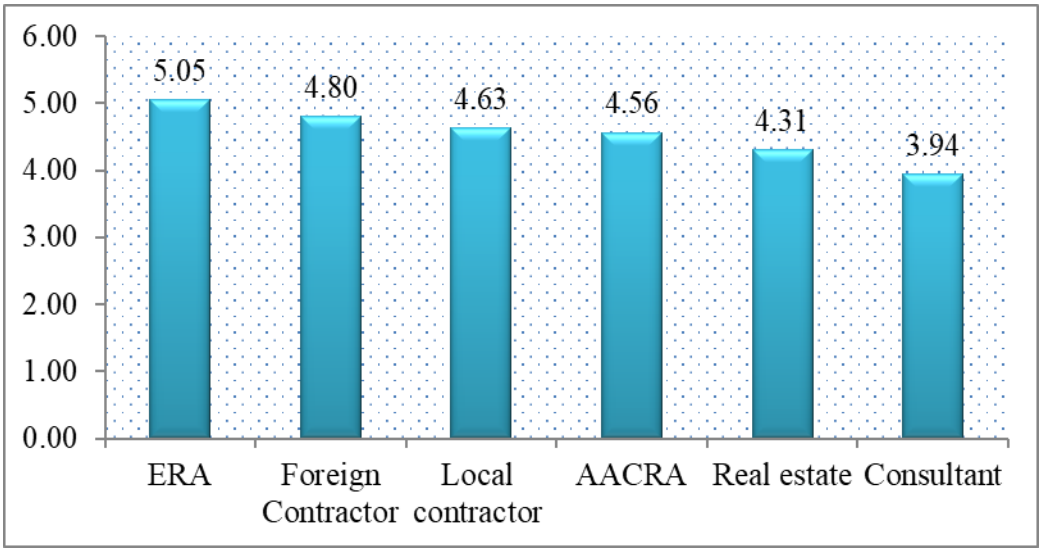


Figure 4.5 – MSV for the importance of an advisory committee

Relating to the role of education and research, the overall respondents believe that the education and research will make the concepts and practices known and useable. The mean score value for the above issue was 5.04, which means the capacity of education and research on making the thoughts and practices recognized and operational was highly considered in the entire construction industry.

Average 4.39 mean score value represent for the issue raised for respondents relating to the collaboration between universities – industry which could substantially increase the tendency of firms to introduce new products. This means they have considered that the partnership among academies and industry is the key for significantly raise the trend of firms to familiarize new products and technology. The individual mean score value for ERA, AACRA, real estate developers, foreign contractors, consultants and local contractors were 4.58, 3.81, 4.77, 5.2, 4.22 and 4.37 respectively.

According to the collected data in Figure 4.6, the industry finds university graduates to be too theoretical and unable to make the transition to the more applied orientation of industrial research. The mean score value was 4.40, meaning the industry usually finds

university graduate to be more hypothetical and unfamiliar with applied orientation of industrial works.

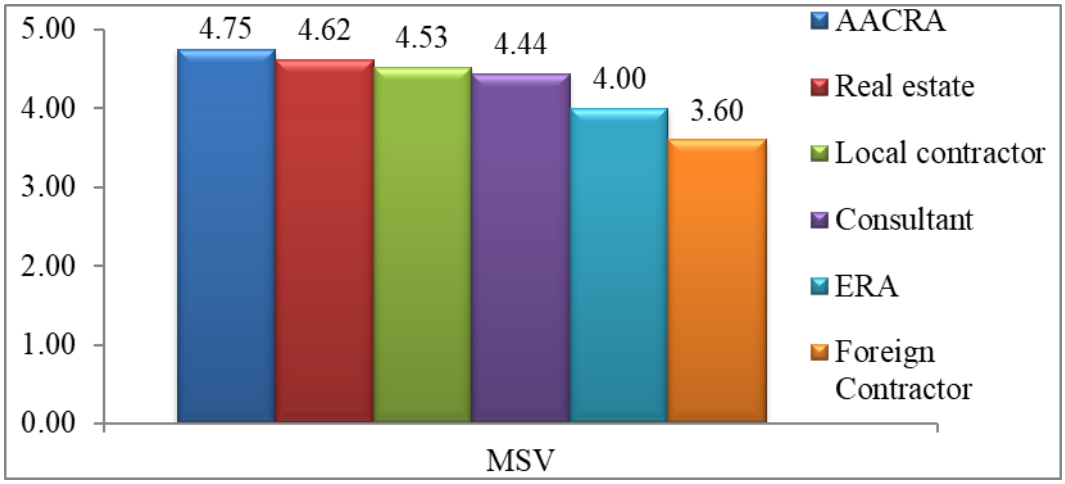


Figure 4.6 – MSV for the outlook of the industry on university graduates

Also for the question raised if that the academic research community need the construction industry or if that the construction industry need the research community, there is a high belief that there is a mutual benefit between the research and the industry. All of the respondents agree that the academic research community and the construction industry need one another.

4.3.2 Rank of the construction research topic areas

Based on the rank which is given by the construction industry various sectors and research trends, a Pearson correlation test was done on the ranking results, in order to see if any correlation existed between the construction industry ranking and research ranking. The evaluation was done within individual construction industry sectors and considering the entire construction industry.

The Pearson correlation coefficient is a measure of the correlation or linear dependence between two variables X and Y, giving a value between +1 and −1 inclusive (Graham 2010). The correlation coefficient, denoted by *r*, is a measure of the strength of the straight-line or linear relationship between two variables (Ratner 2009).

The following values of r are the accepted guidelines for interpreting the correlation coefficient (Ratner 2009):

1. 0 indicates no linear relationship.
2. +1 indicates a perfect positive linear relationship, as one variable increases in its values; the other variable also increases in its values through an exact linear rule.

3. −1 indicates a perfect negative linear relationship, as one variable increases in its values, the other variable decreases in its values through an exact linear rule.
4. Values between 0 and 0.3 indicate a weak positive linear relationship through a shaky linear rule.
5. Values between 0 and −0.3 indicate a weak negative linear relationship through a shaky linear rule.
6. Values between 0.3 and 0.7 indicate a moderate positive linear relationship through a fuzzy-firm linear rule.
7. Values between −0.3 and −0.7 indicate a moderate negative linear relationship through a fuzzy-firm linear rule.
8. Values between 0.7 and 1.0 indicate a strong positive linear relationship through a firm linear rule.
9. Values between −0.7 and −1.0 indicate a strong negative linear relationship through a firm linear rule.

Legends for the graph under section 4.3.2 Rank of the construction research topic areas

No.	Topic area	No.	Topic area
1.	Alternate Dispute Resolution	**13.**	Insurance
2.	Change orders / Variation	**14.**	Legal/Contracts
3.	Computer systems / Expert systems	**15.**	Material and equipment management
4.	Concrete technology	**16.**	Performance
5.	Constructability	**17.**	Price escalation
6.	Delay and cost overrun	**18.**	Procurement
7.	Demolition	**19.**	Productivity
8.	Economics / Cost control	**20.**	Quality Management
9.	Estimating / Bidding	**21.**	Risk management
10.	Facility Management	**22.**	Scheduling
11.	Health and safety	**23.**	Sustainability
12.	Industry Overview	**24.**	Technology/Innovation

i. Rank of the construction research topic areas by the construction industry respondents

The following Table 4.6 contains the topic areas which are given a rank according to their importance to the Ethiopian construction industry by different construction sector participants.

Table 4.6 – Rank of topic areas by the construction industry respondents

No.	Construction research topics	All in one Rank	Research Rank
1.	Alternate Dispute Resolution	14	19
2.	Change orders / Variation	7	5
3.	Computer systems / Expert systems	6	10
4.	Concrete technology	20	1
5.	Constructability	13	3
6.	Delay and cost overrun	2	10
7.	Demolition	23	23
8.	Economics / Cost control	1	10
9.	Estimating / Bidding	4	10
10.	Facility Management	18	19
11.	Health and safety	15	23
12.	Industry Overview	24	2
13.	Insurance	21	19
14.	Legal/Contracts	16	5
15.	Material and equipment management	9	16
16.	Performance	12	5
17.	Price escalation	8	10
18.	Procurement	19	4
19.	Productivity	3	16
20.	Quality Management	17	10
21.	Risk management	11	8
22.	Scheduling	10	8
23.	Sustainability	22	19

No.	Construction research topics	All in one Rank	Research Rank
24.	Technology/Innovation	5	16

The most required topic areas for construction industry respondents are economics / cost control, delay and cost overrun, productivity, estimating / bidding, and technology / innovation having a research ranking position of 10, 10, 16, 10 and 16 respectively.

Instead the topic areas such as concrete technology, industry overview and constructability have got the top three positions from research trend ranking. But according to construction industry professionals ranking concrete technology, industry overview and constructability have got the 20, 24 and 13 ranking position respectively. The individual rank of the topic areas is presented below in Figure 4.7.

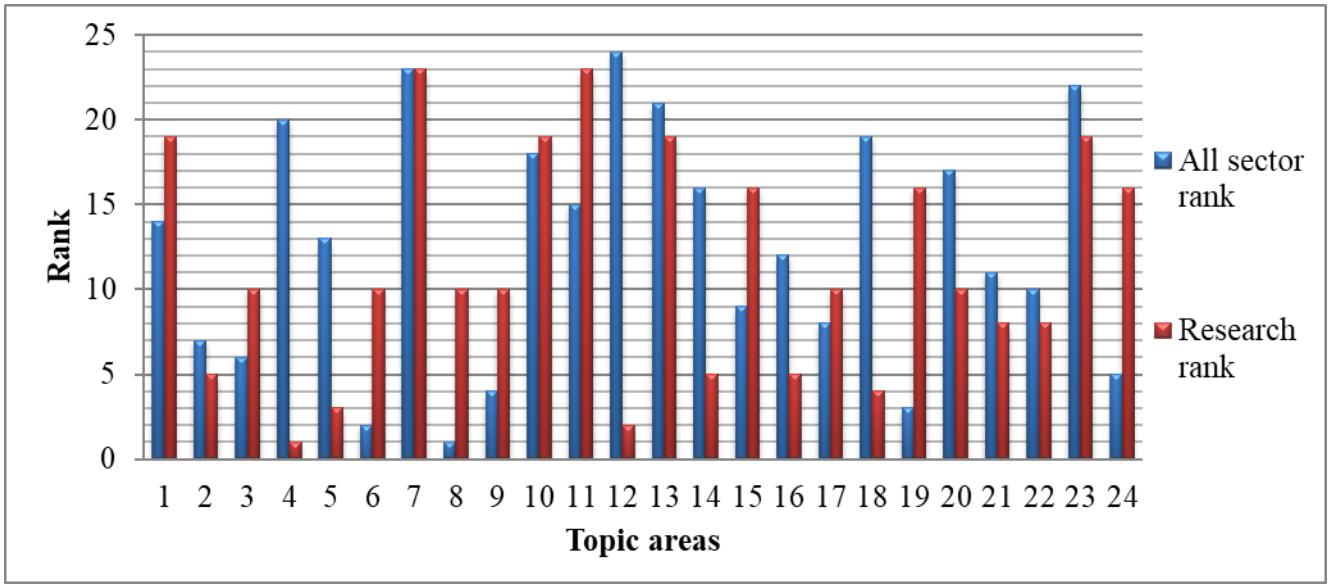


Figure 4.7 - All construction sector and research trend ranking

The data from Table 4.6, showed the correlation between all construction sectors and the research trend is no linear relationship with the correlation coefficient value of 0.08 which is approximately zero and the correlation graph is presented in Figure 4.8. This value may indicate that the construction industry professionals believe that concrete technology, industry overview and constructability are being sufficiently studied and the findings might be acknowledged. But more research on these topic areas is not the necessity for the recent construction industry. On the other hand, great efforts shall be made on current demands of the construction industry in order to generate numerous outcomes. And this correlation coefficient only reflects the current demand of the research participant.

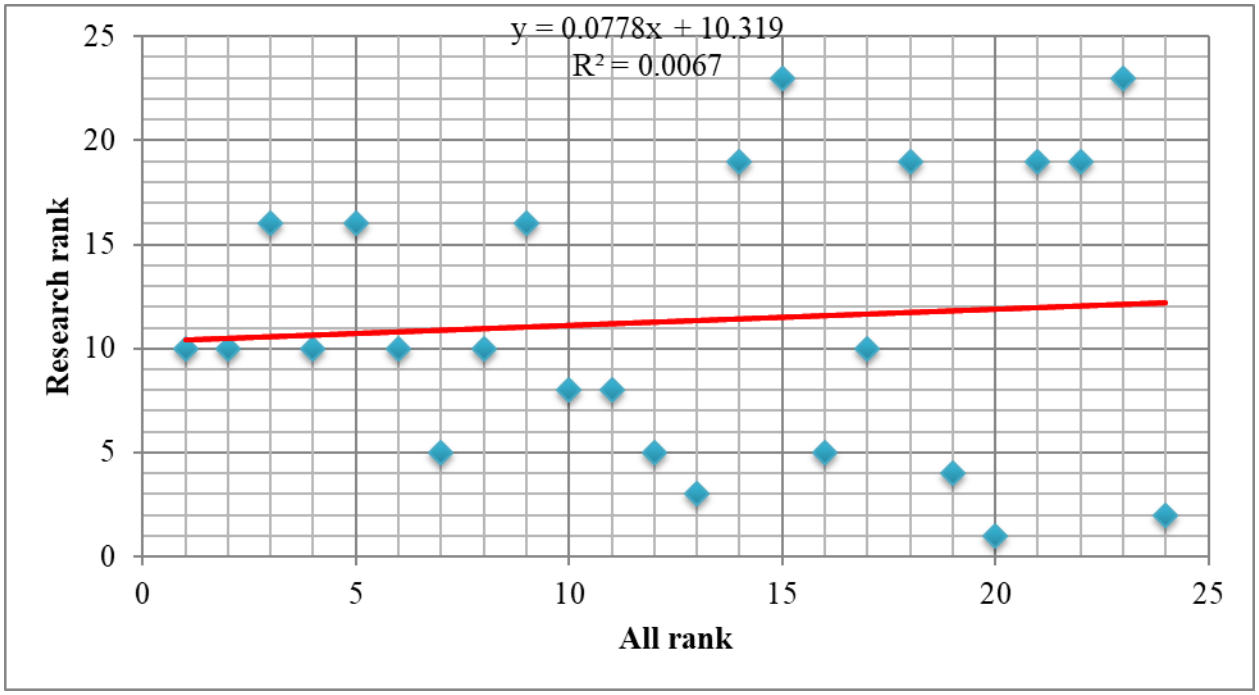


Figure 4.8 - Pearson correlation graph for research trend and all construction sector rankings

ii. Rank of the construction research topic areas by Ethiopian Roads Authority

On the following Table 4.7, it contains topic areas which are given a rank according to their importance to the Ethiopian construction industry by Ethiopian Roads Authority professionals.

Table 4.7 – Rank of topic areas by ERA

No.	Construction research topics	ERA Rank	Research Rank
1.	Alternate Dispute Resolution	16	19
2.	Change orders / Variation	8	5
3.	Computer systems / Expert systems	14	10
4.	Concrete technology	17	1
5.	Constructability	18	3
6.	Delay and cost overrun	3	10
7.	Demolition	24	23
8.	Economics / Cost control	2	10
9.	Estimating / Bidding	4	10
10.	Facility Management	23	19

No.	Construction research topics	ERA Rank	Research Rank
11.	Health and safety	10	23
12.	Industry Overview	22	2
13.	Insurance	19	19
14.	Legal/Contracts	15	5
15.	Material and equipment management	11	16
16.	Performance	12	5
17.	Price escalation	13	10
18.	Procurement	7	4
19.	Productivity	1	16
20.	Quality Management	21	10
21.	Risk management	6	8
22.	Scheduling	5	8
23.	Sustainability	20	19
24.	Technology/Innovation	9	16

The most essential topic areas for Ethiopian Roads Authority are productivity, economics / cost control, delay and cost overrun, estimating/ bidding and scheduling having a research ranking position of 16, 10, 10, 10 and 8 respectively.

And the topic areas such as concrete technology, industry overview and constructability have got the top three positions from research trend ranking. But according to ERA professionals ranking concrete technology, industry overview and constructability have got the 17, 22 and 18 ranking position respectively. The individual rank of the topic areas is presented in Figure 4.9.

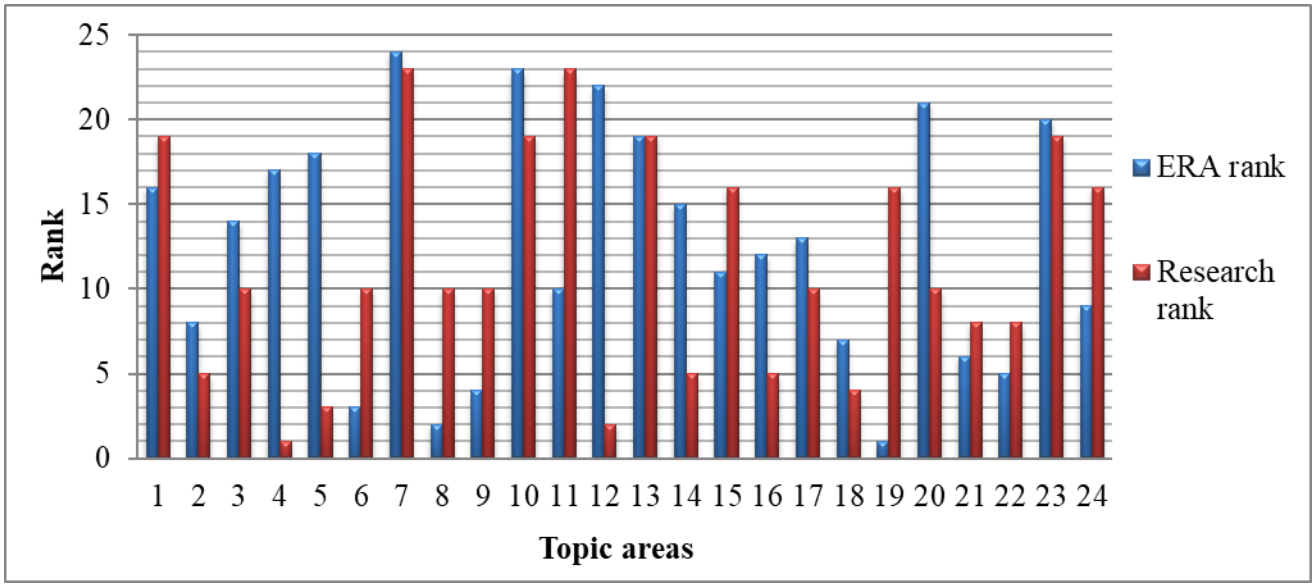


Figure 4.9 – ERA and research trend ranking

The facts from Table 4.7, indicated the correlation between ERA and the research trend ranking is a weak positive linear relationship through a shaky linear rule with the correlation coefficient value of 0.17. The correlation graph for the research and ERA rank is presented in Figure 4.10.

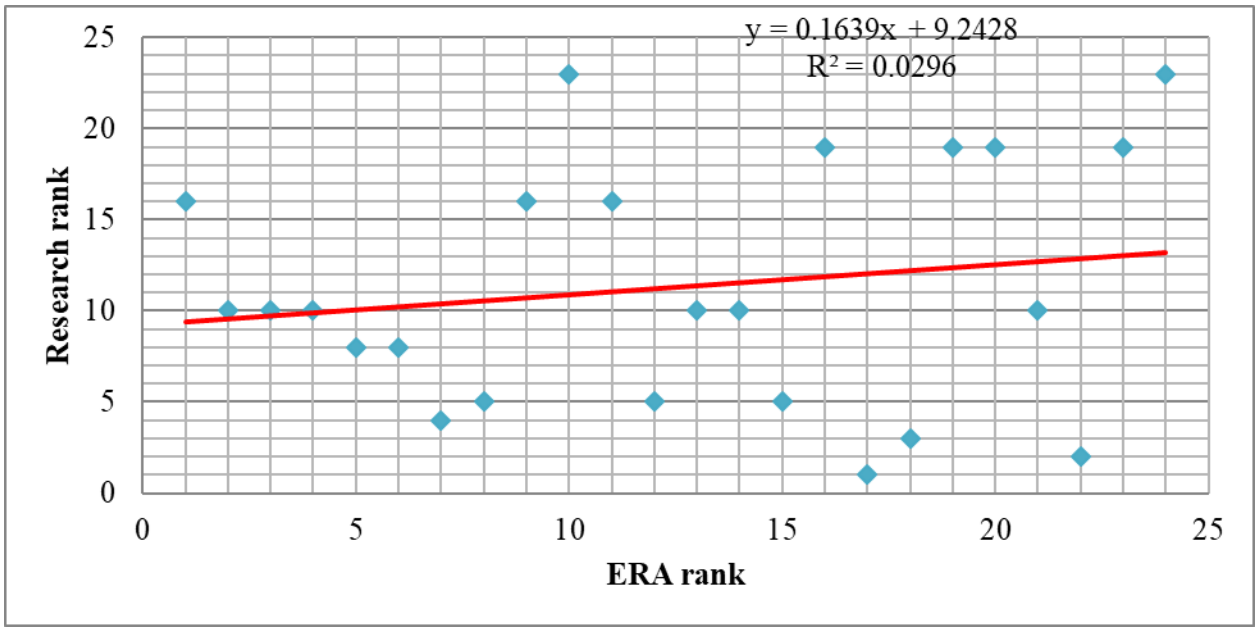


Figure 4.10 – Pearson correlation graph for research trend and ERA rankings

iii. Rank of the construction research topic areas by Addis Ababa City Roads Authority

The following Table 4.8 includes the topic areas which are given a rank according to their importance to the Ethiopian construction industry by AACRA professionals.

Table 4.8 – Rank of topic areas by AACRA

No.	Construction research topics	AACRA Rank	Research Rank
1.	Alternate Dispute Resolution	14	19
2.	Change orders / Variation	2	5
3.	Computer systems / Expert systems	7	10
4.	Concrete technology	21	1
5.	Constructability	19	3
6.	Delay and cost overrun	1	10
7.	Demolition	23	23
8.	Economics / Cost control	5	10
9.	Estimating / Bidding	3	10
10.	Facility Management	10	19
11.	Health and safety	20	23
12.	Industry Overview	24	2
13.	Insurance	17	19
14.	Legal/Contracts	18	5
15.	Material and equipment management	8	16
16.	Performance	11	5
17.	Price escalation	6	10
18.	Procurement	13	4
19.	Productivity	4	16
20.	Quality Management	16	10
21.	Risk management	12	8
22.	Scheduling	15	8
23.	Sustainability	22	19
24.	Technology/Innovation	9	16

The most required topic areas for Addis Ababa Roads Authority are delay and cost overrun, change orders / variation, estimating/ bidding, productivity, and economics / cost control having a research ranking position of 10, 5, 10, 16 and 10 respectively.

On the other hand the topic areas such as concrete technology, industry overview and constructability have got the top three positions from research trend ranking. But according to AACRA professionals ranking concrete technology, industry overview and constructability have got the 21, 24 and 19 ranking position respectively. The individual rank of the topic areas is presented in Figure 4.11.

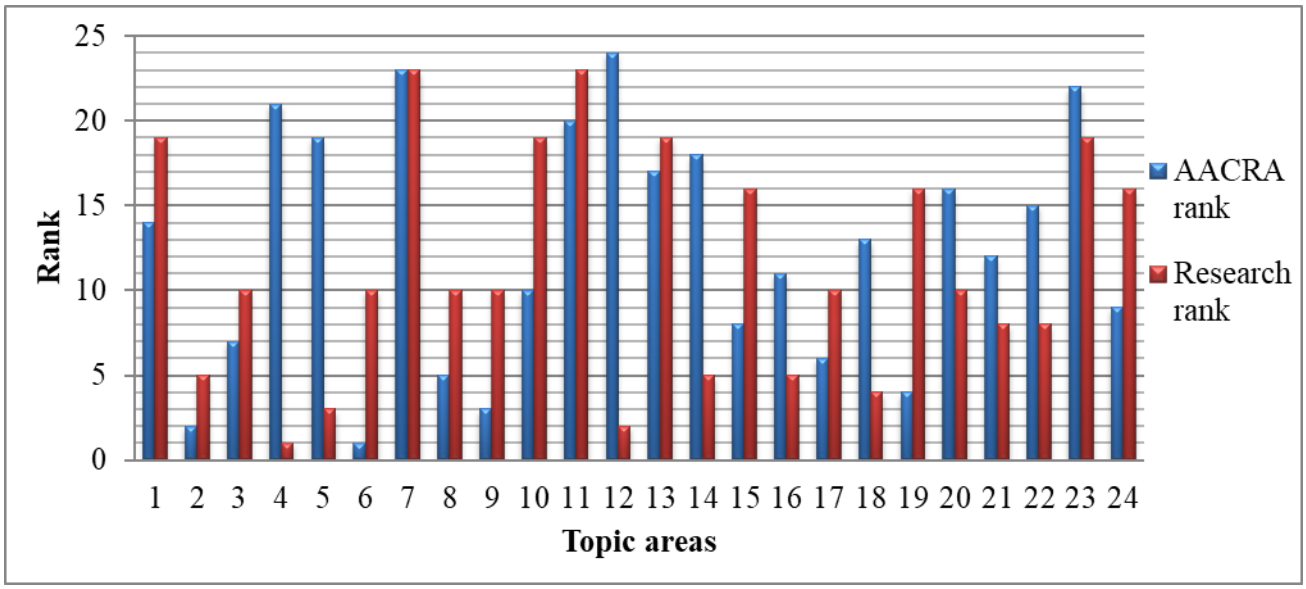


Figure 4.11 - AACRA and research trend ranking

The result from Table 4.8, showed the correlation between AACRA and the research trend ranking is no linear relationship with the correlation coefficient value of 0.06 which is approximately zero and the correlation graph for the topic areas ranking is presented in Figure 4.12.

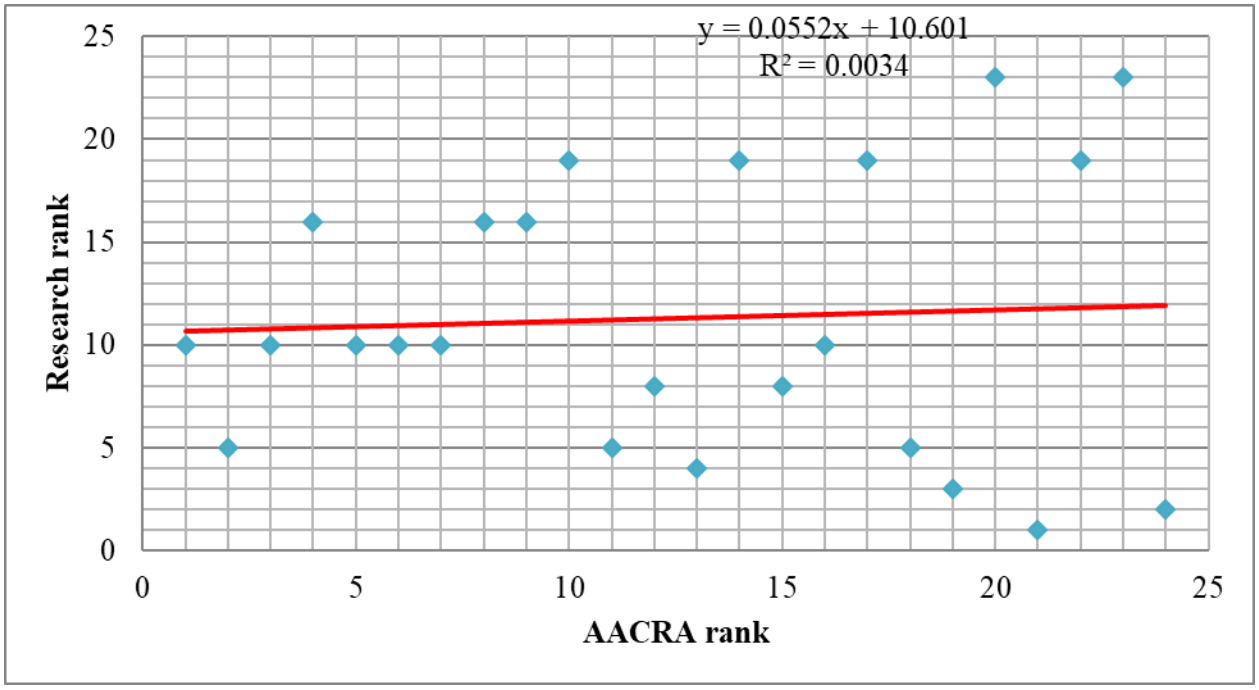


Figure 4.12 – Pearson correlation graph for research trend and AACRA rankings

iv. Rank of the construction research topic areas by real estate developers

The succeeding Table 4.9 includes the topic areas which are given a rank according to their importance to the Ethiopian construction industry by different real estate developers' professionals.

Table 4.9 – Rank of topic areas by real estate developers

No.	Construction research topics	Real estate Rank	Research Rank
1.	Alternate Dispute Resolution	17	19
2.	Change orders / Variation	10	5
3.	Computer systems / Expert systems	3	10
4.	Concrete technology	12	1
5.	Constructability	1	3
6.	Delay and cost overrun	5	10
7.	Demolition	20	23
8.	Economics / Cost control	2	10
9.	Estimating / Bidding	9	10
10.	Facility Management	18	19
11.	Health and safety	23	23

No.	Construction research topics	Real estate Rank	Research Rank
12.	Industry Overview	24	2
13.	Insurance	19	19
14.	Legal/Contracts	16	5
15.	Material and equipment management	6	16
16.	Performance	8	5
17.	Price escalation	4	10
18.	Procurement	15	4
19.	Productivity	11	16
20.	Quality Management	22	10
21.	Risk management	13	8
22.	Scheduling	14	8
23.	Sustainability	21	19
24.	Technology/Innovation	7	16

The most required topic areas for real estate developers are constructability, economics / cost control, computer systems / expert systems, price escalation, and delay and cost overrun, having a research ranking position of 3, 10, 10, 10 and 10 respectively.

And the topic areas such as concrete technology, industry overview and constructability have got the top three positions from research trend ranking. But according to real estate developer professionals ranking concrete technology, industry overview and constructability have got the 12, 24 and 1 ranking position respectively. The individual rank of the topic areas is presented in Figure 4.13.

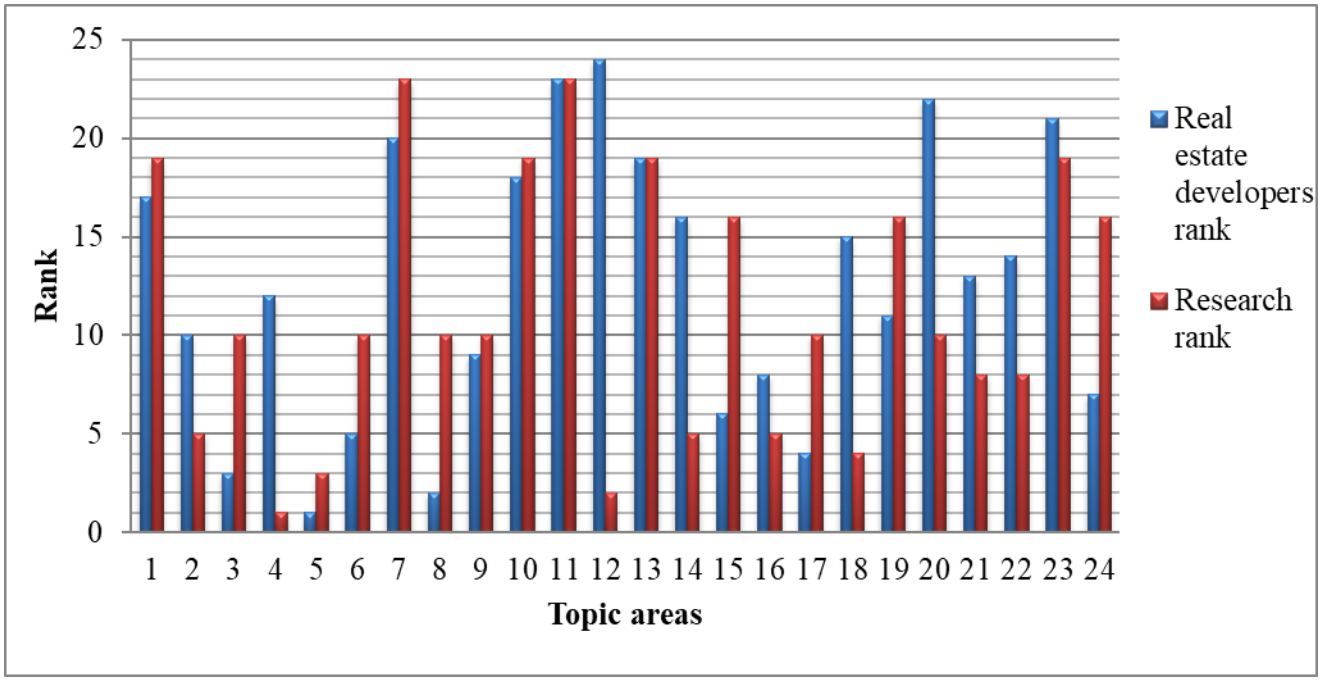


Figure 4.13 – Real estate developers and research trend ranking

The data from Table 4.9, indicated the correlation between real estate developers and the research trend ranking is a moderate positive linear relationship through a fuzzy-firm linear rule with the correlation coefficient value of 0.34. The correlation graph for the topic areas ranking is presented below in Figure 4.14.

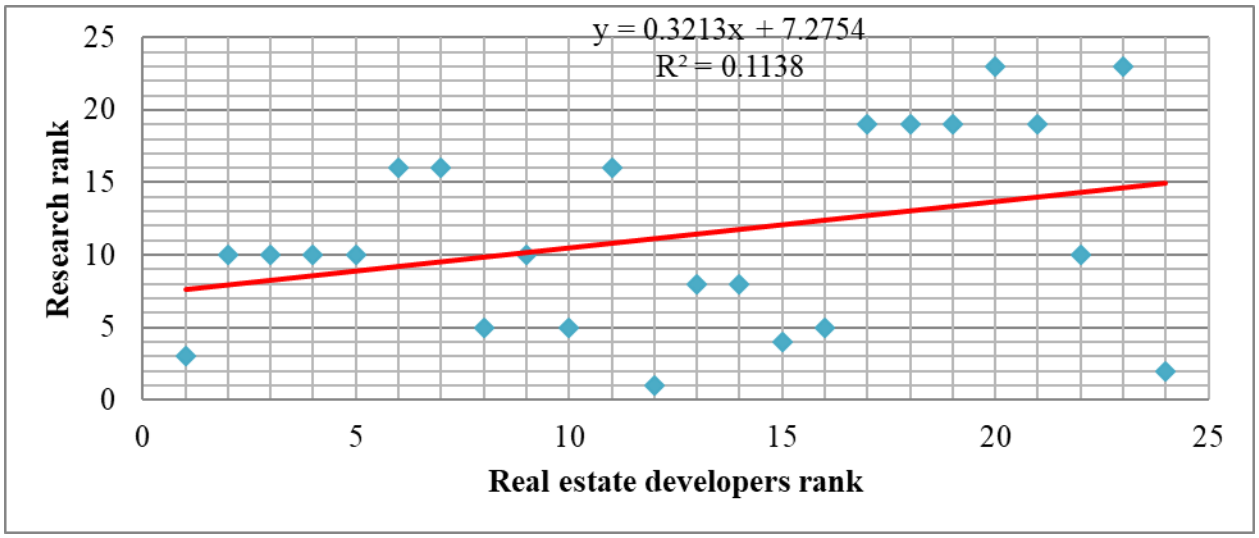


Figure 4.14 – Pearson correlation graph for research trend and real estate developers rankings

v. Rank of the construction research topic areas by foreign contractors

The following Table 4.10 contains the topic areas which are given a rank according to their importance to the Ethiopian construction industry by foreign contractors.

Table 4.10 – Rank of topic areas by foreign contractors

No.	Construction research topics	Foreign contractors Rank	Research Rank
1.	Alternate Dispute Resolution	12	19
2.	Change orders / Variation	19	5
3.	Computer systems / Expert systems	11	10
4.	Concrete technology	22	1
5.	Constructability	2	3
6.	Delay and cost overrun	17	10
7.	Demolition	21	23
8.	Economics / Cost control	8	10
9.	Estimating / Bidding	15	10
10.	Facility Management	3	19
11.	Health and safety	4	23
12.	Industry Overview	24	2
13.	Insurance	13	19
14.	Legal/Contracts	16	5
15.	Material and equipment management	20	16
16.	Performance	14	5
17.	Price escalation	18	10
18.	Procurement	23	4
19.	Productivity	6	16
20.	Quality Management	5	10
21.	Risk management	7	8
22.	Scheduling	10	8
23.	Sustainability	9	19
24.	Technology/Innovation	1	16

The most required topic areas for foreign contractors are Technology / innovation, constructability, facility management, health and safety, and quality management having a research ranking position of 16, 3, 19, 23 and 10 respectively.

On the other hand the topic areas such as concrete technology, industry overview and constructability have got the top three positions from research trend ranking. But according to foreign contractor professionals ranking concrete technology, industry overview and constructability have got the 22, 24 and 2 ranking position respectively. The individual rank of the topic areas is presented in Figure 4.15.

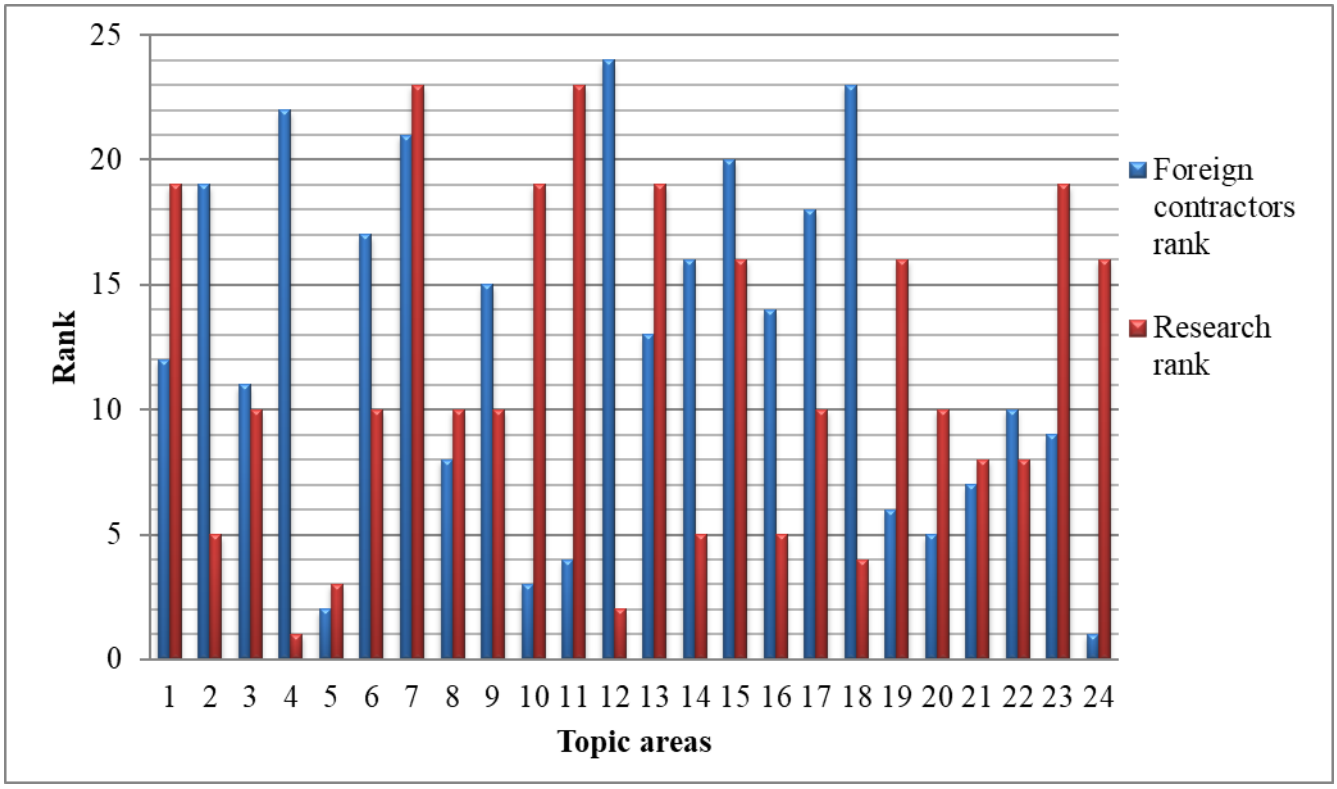


Figure 4.15 – Foreign contractors and research trend ranking

The data from Table 4.10, indicated the correlation between foreign contractors and the research trend ranking is a moderate negative linear relationship through a fuzzy-firm linear rule with the correlation coefficient value of -0.35 and the correlation graph for the individual ranking is presented below in Figure 4.16.

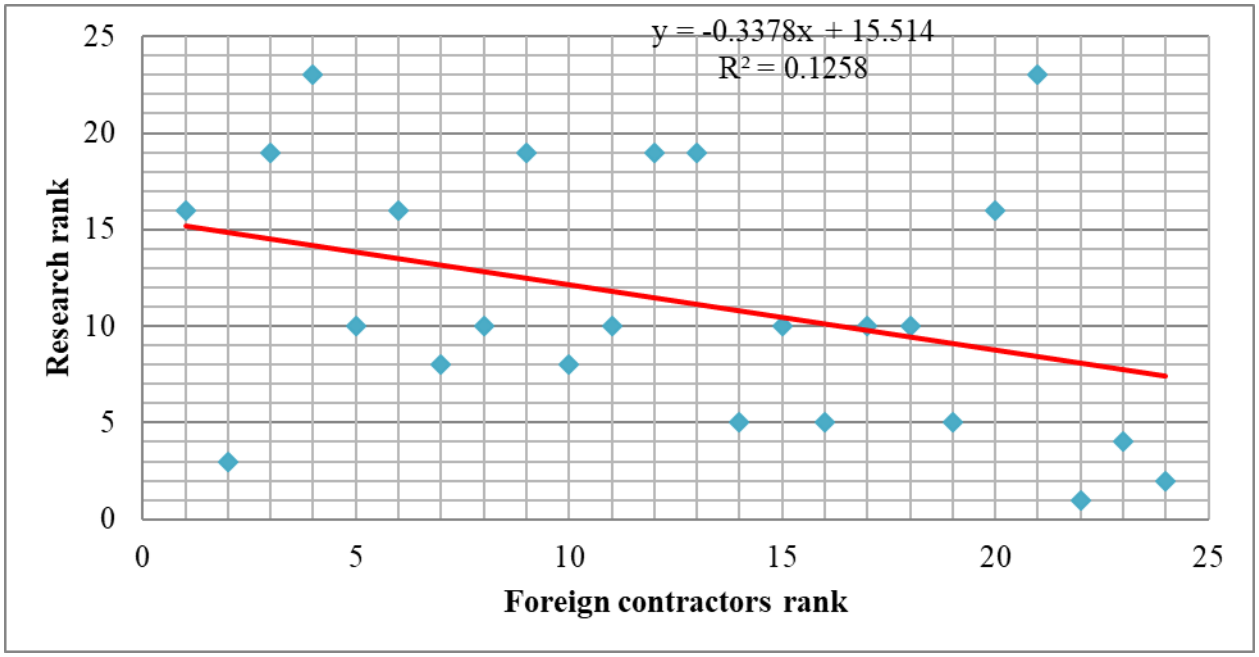


Figure 4.16 – Pearson correlation graph for research trend and foreign contractors rankings

vi. Rank of the construction research topic areas by consultants

The following Table 4.11 includes the topic areas which are given a rank according to their importance to the Ethiopian construction industry by various consultants.

Table 4.11 – Rank of topic areas by consultants

No.	Construction research topics	Consultants Rank	Research Rank
1.	Alternate Dispute Resolution	10	19
2.	Change orders / Variation	14	5
3.	Computer systems / Expert systems	3	10
4.	Concrete technology	21	1
5.	Constructability	19	3
6.	Delay and cost overrun	8	10
7.	Demolition	23	23
8.	Economics / Cost control	9	10
9.	Estimating / Bidding	5	10
10.	Facility Management	6	19
11.	Health and safety	11	23

No.	Construction research topics	Consultants Rank	Research Rank
12.	Industry Overview	24	2
13.	Insurance	18	19
14.	Legal/Contracts	13	5
15.	Material and equipment management	17	16
16.	Performance	12	5
17.	Price escalation	7	10
18.	Procurement	22	4
19.	Productivity	1	16
20.	Quality Management	20	10
21.	Risk management	15	8
22.	Scheduling	4	8
23.	Sustainability	16	19
24.	Technology/Innovation	2	16

According to Table 4.11, the most required topic areas for consultants are productivity, technology / innovation, computer systems / expert systems, scheduling, and estimating / bidding having a research ranking position of 16, 16, 10, 8 and 10 respectively.

On the other hand the topic areas such as concrete technology, industry overview and constructability have got the top three positions from research trend ranking. But according to consultant professionals ranking concrete technology, industry overview and constructability have got the 21, 24 and 19 ranking position respectively. The individual ranking of the topic areas is presented in Figure 4.17.

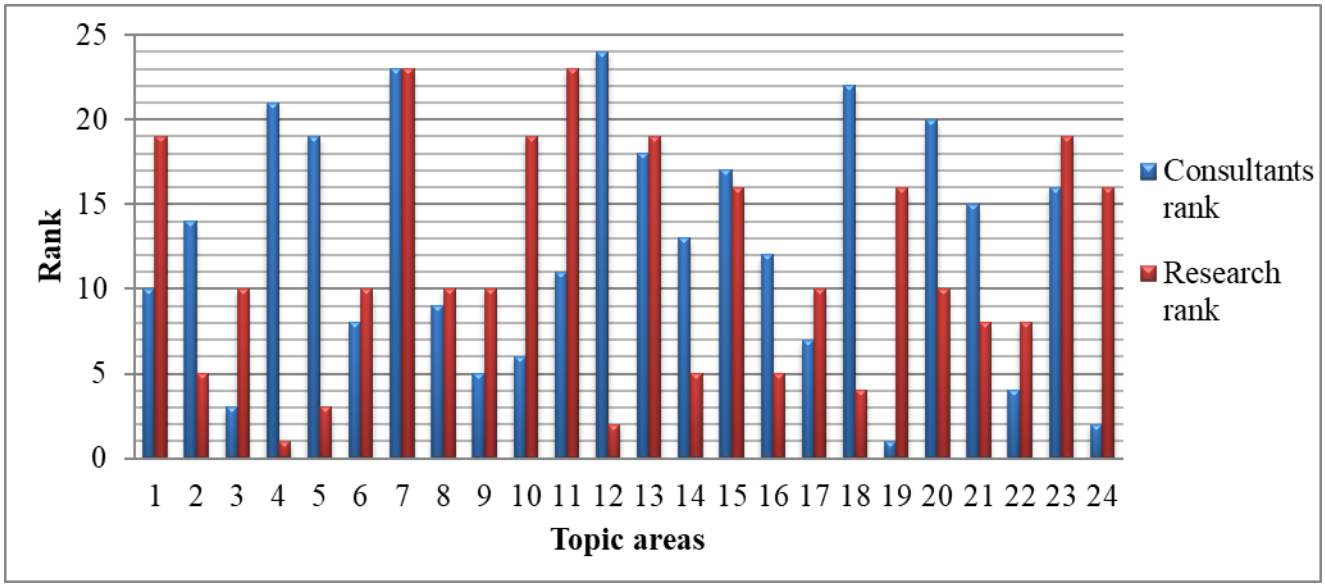


Figure 4.17 – Consultants and research trend ranking

The result of the analysis specified the correlation between consultants and the research trend ranking is a weak negative linear relationship through a shaky linear rule with the correlation coefficient value of -0.23 and the correlation graph of the individual topic areas in presented in Figure 4.18.

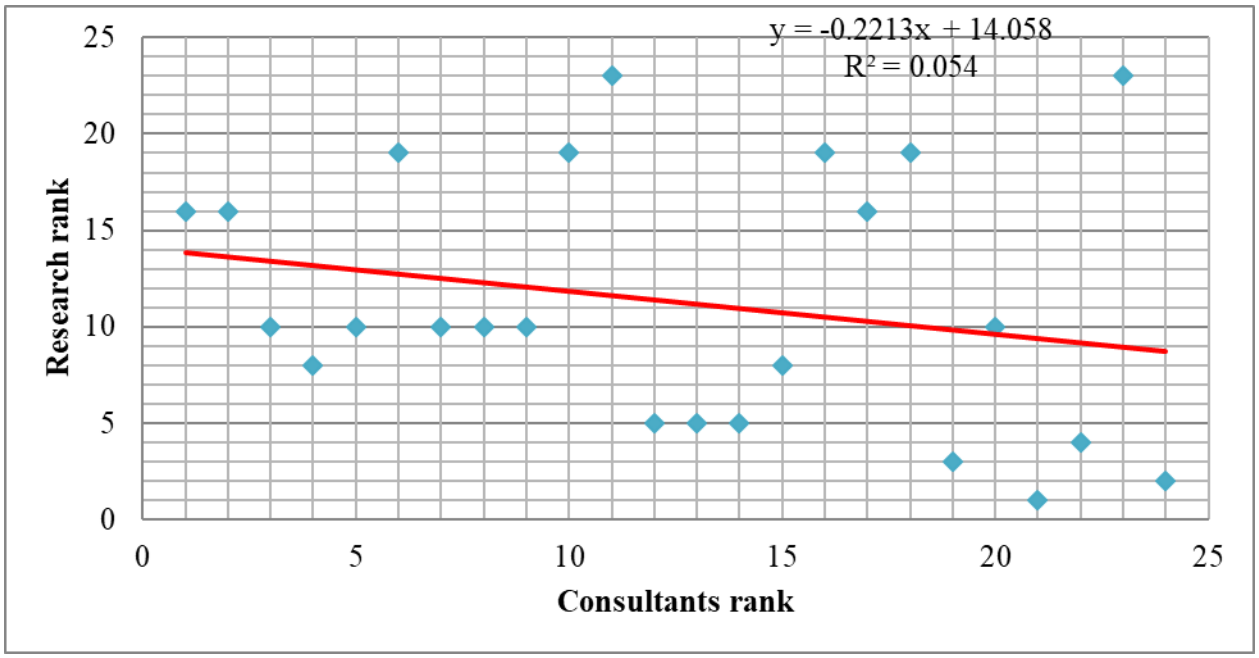


Figure 4.18 – Pearson correlation graph for research trend and consultants rankings

vii. Rank of the construction research topic areas by local contractors

The following Table 4.12 includes the topic areas which are given a rank according to their importance to the Ethiopian construction industry by local contractors.

Table 4.12 – Rank of topic areas by local contractors

No.	Construction research topics	Local contractors Rank	Research Rank
1.	Alternate Dispute Resolution	16	19
2.	Change orders / Variation	11	5
3.	Computer systems / Expert systems	6	10
4.	Concrete technology	9	1
5.	Constructability	7	3
6.	Delay and cost overrun	3	10
7.	Demolition	22	23
8.	Economics / Cost control	5	10
9.	Estimating / Bidding	2	10
10.	Facility Management	20	19
11.	Health and safety	15	23
12.	Industry Overview	23	2
13.	Insurance	21	19
14.	Legal/Contracts	18	5
15.	Material and equipment management	4	16
16.	Performance	12	5
17.	Price escalation	8	10
18.	Procurement	17	4
19.	Productivity	19	16
20.	Quality Management	1	10
21.	Risk management	14	8
22.	Scheduling	13	8
23.	Sustainability	24	19
24.	Technology/Innovation	10	16

The most required topic areas for local contractors are quality management, estimating / bidding, delay and cost overrun, material and equipment management, and

economics / cost control having a research ranking position of tenth place except the material and equipment management scoring the sixteenth place.

On the other hand the topic areas such as concrete technology, industry overview and constructability have got the top three positions from research trend ranking. But according to local contractors professionals ranking concrete technology, industry overview and constructability have got the 9, 23 and 7 ranking position respectively. The individual ranking of the topic areas is presented in Figure 4.19.

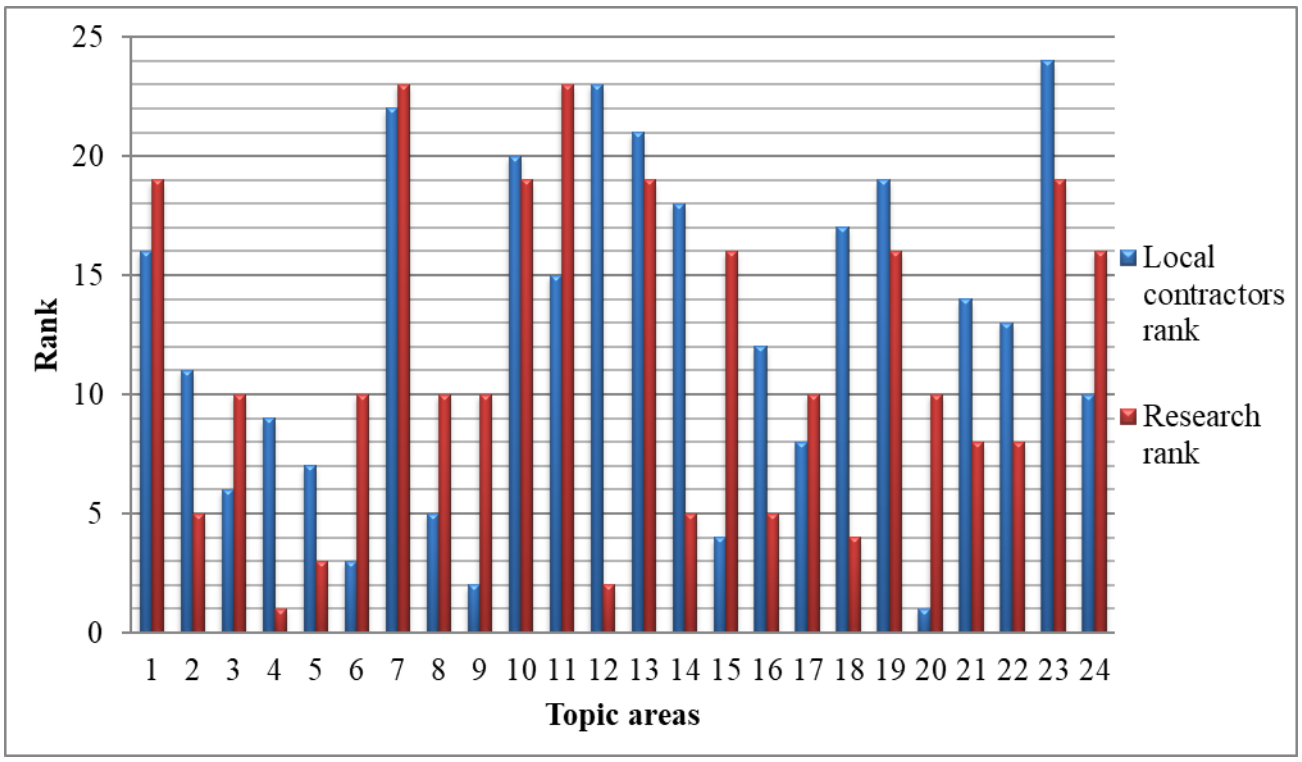


Figure 4.19 – Local contractors and research trend ranking

The data from Table 4.12, showed the correlation between local contractors and the research trend is moderate positive linear relationship through a fuzzy-firm linear rule with the correlation coefficient value of 0.32. The correlation graph for the topic areas individual ranking is presented in Figure 4.20.

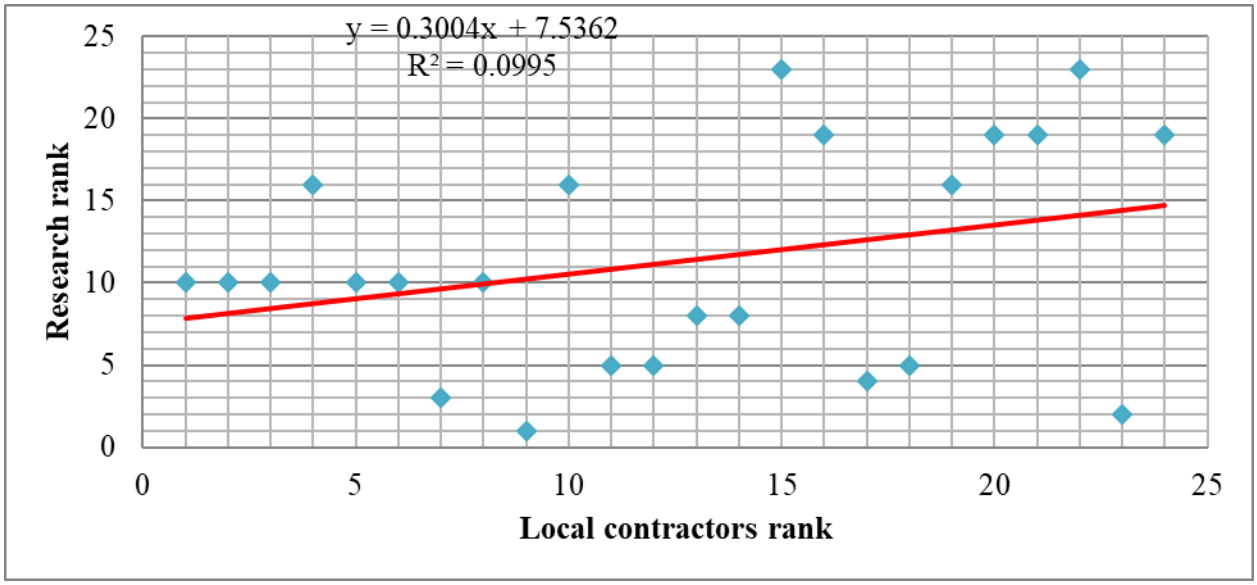


Figure 4.20 – Pearson correlation graph for research trend and local contractors rankings

4.3.3 Benefits of university – industry linkages

Enhancing new technology and innovation is one of the benefits of university – industry linkages. Once the university – industry get closer to each other the enhancement of new technology, approach, methodology and innovation will increase. There is a strong and high belief in the overall benefit of the university – industry linkages for improving innovative technology. The mean score value for enhancing new technology and innovation was 5.06 which represents that it has a high consideration among the construction industry participants regarding to the raised fact. Mean score value for the probable benefits of university industry linkages is presented in Table 4.13and Figure 4.21.

Table 4.13 – Benefits of university – industry linkages

No.	Probable benefits of university industry linkages	Scale				MSV
		Very important	Important	Somehow Important	Not important	
1.	Enhancing new technology and innovation	56	26	7	1	5.06
2.	Solving urgent problems	33	30	20	7	4.06
3.	Developing current and future construction industry research needs	38	38	11	3	4.50
4.	Making the industry more competitive	30	47	13	0	4.38

No.	Probable benefits of university industry linkages	Scale				MSV
		Very important	Important	Somehow Important	Not important	
5.	Developing relevant research topics	43	39	7	1	4.77
6.	Coordinate R&D agendas	53	33	4	0	5.09
7.	Avoid duplications	34	31	19	6	4.13
8.	Stimulate additional private R&D investment	31	49	9	1	4.46
9.	Exploit synergies	31	40	17	2	4.24
10.	Exploit complementarities of scientific and technological capabilities	39	35	9	7	4.43

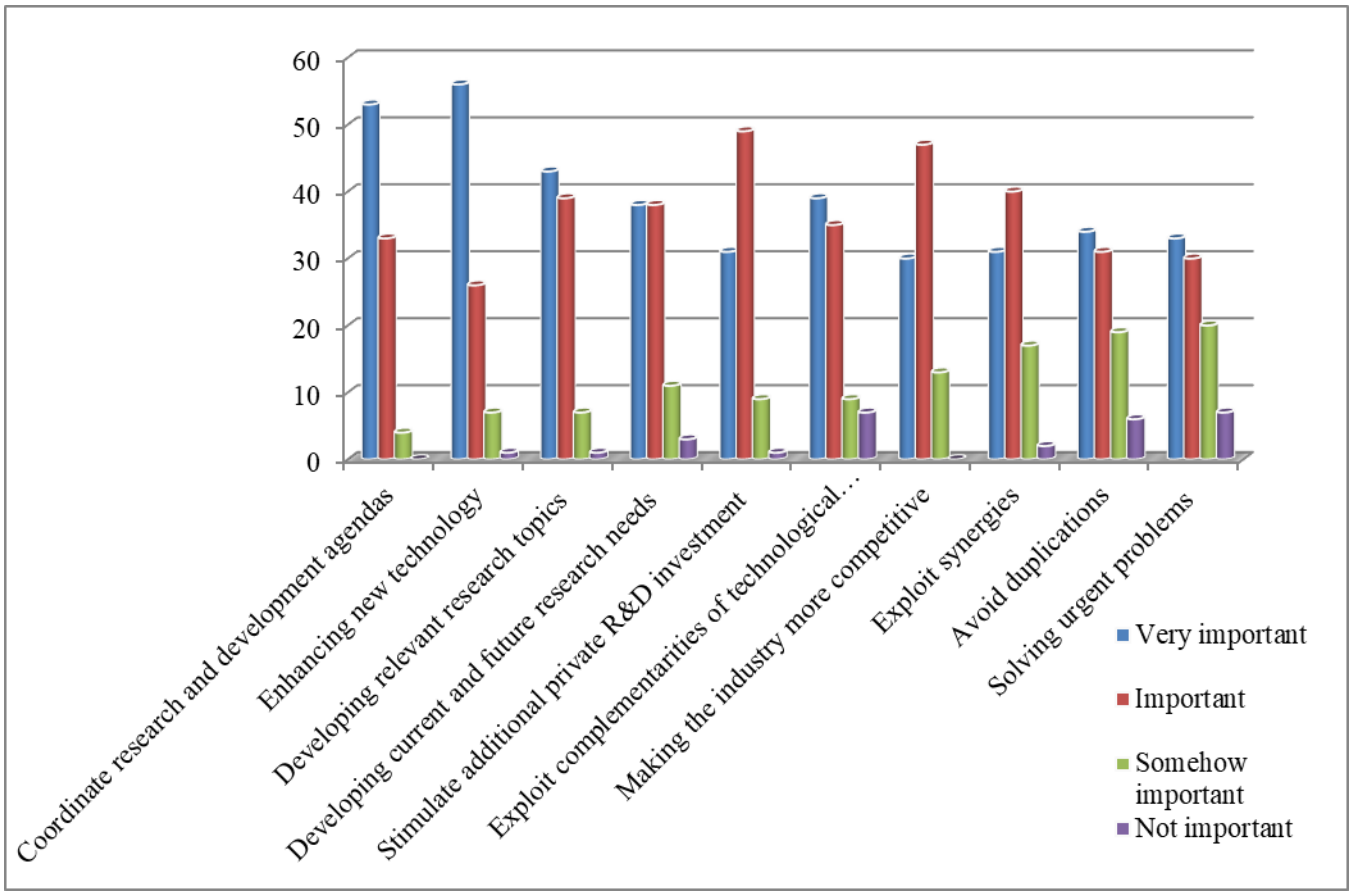


Figure 4.21 - Benefits of university – industry linkages

The other probable benefit of university – industry linkages is to solve urgent problems; however, there are some conflicts between groups that are saying solving urgent problems will be somehow difficult because it must go through every step to find the solution even if there is a linkage between university and industry. And the other group believes if the strong university – industry linkages has been created those urgent problems will get solutions. The mean score value for this issue falls in the range between four and five, which means that it is important to have a better university – industry in order to solve those urgent problems. The individual mean score value of the construction industry is presented in Figure 4.22.

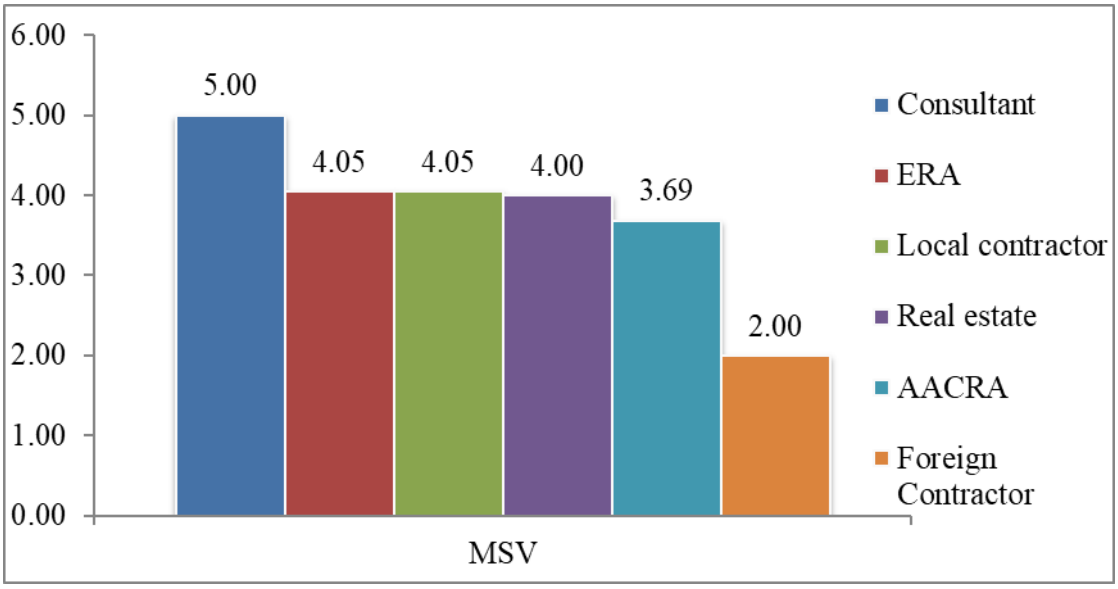


Figure 4.22 - MSV of university – industry linkages for solving urgent problems

One of the benefits of university – industry linkages is that developing current and future construction industry research needs. The mean score value for rising present and upcoming construction industry research desires was 4.5, which means it is considered or it is one of the important benefit of university – industry relationships. The mean score value for ERA, AACRA, real estate developers, foreign contractors consultants and local contractors was 4.31, 4.81, 4.23, 4.40, 5.22 and 3.94, respectively.

According to the results from the analysis making the industry more competitive was believed to be one of the benefits of the university – industry linkages. The mean score value was 4.38 which represent that it is important for making the industry further good. The individual mean score value is presented in Figure 4.23:

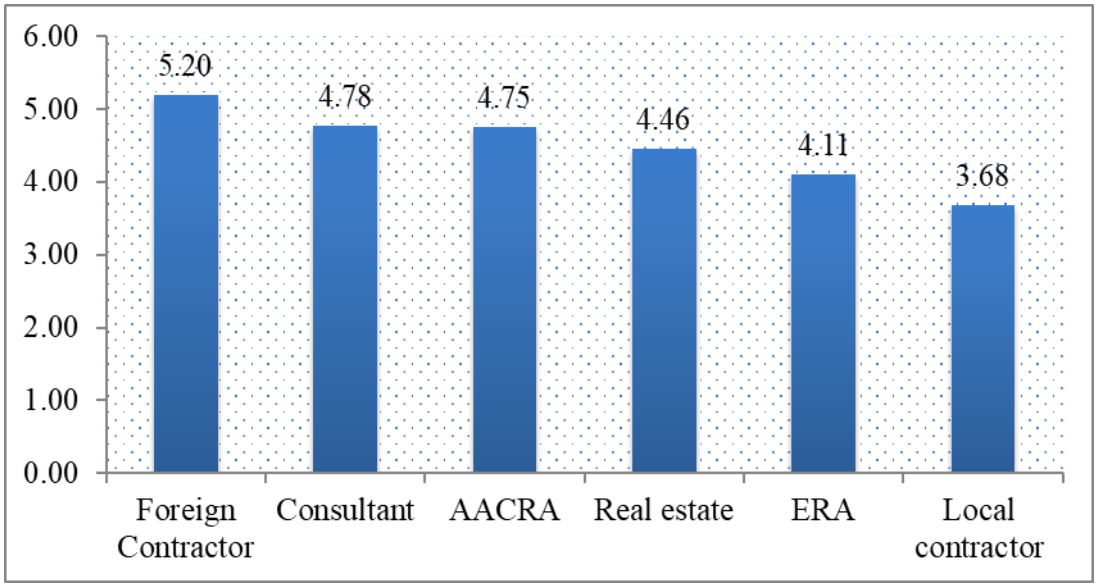


Figure 4.23 - MSV for making the industry more competitive

Developing relevant research topics which are worthy for the industry by students is one the most difficulties nowadays in universities. Meanwhile the industry believes that if there is a strong university – industry linkages developing relevant research topics will be somehow easier. The mean score value was 4.77 for developing relevant research topics. The individual mean score is presented in Figure 4.24;

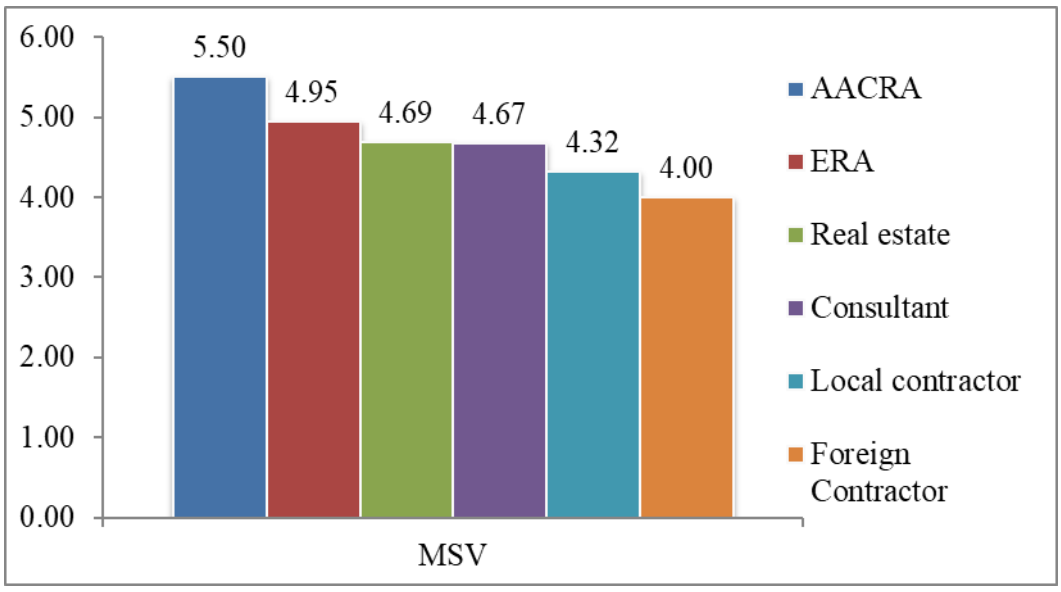


Figure 4.24 - MSV for developing relevant research topics

According to Table 4.13 the mean score value for one of the benefit of university – industry relationships which is coordinating research and development agendas was 5.09. It means it is very important that the university – industry linkages is formed in communicable

way in order to manage research and development programs for the construction industry. The individual mean score value is presented as follows in Figure 4.25;

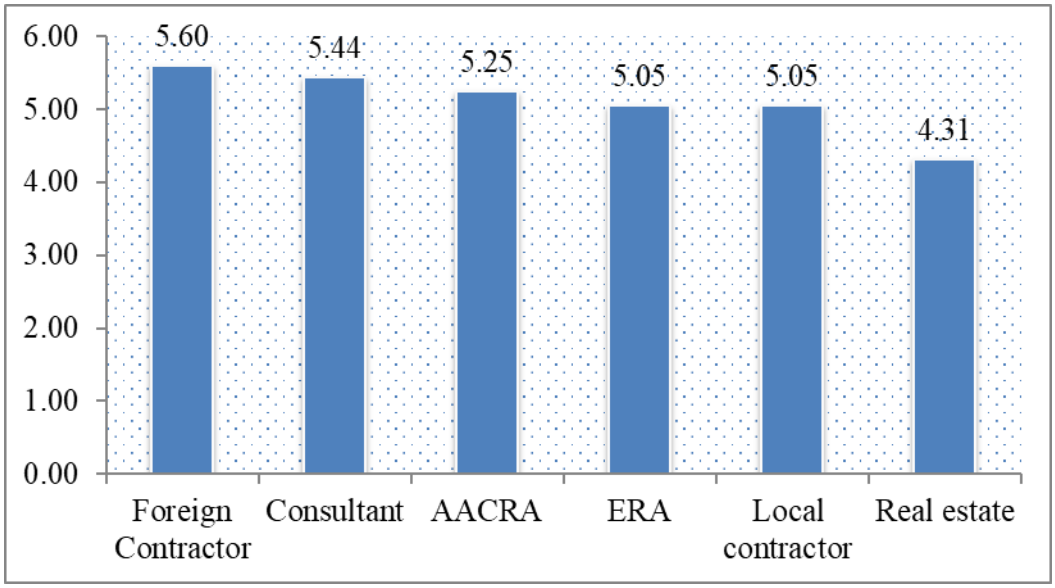


Figure 4.25 - MSV for coordinating research and development agendas

The additional advantage of the university – industry linkages is to avoid duplications of research works. Many of the respondents agree that these duplications of research papers can be minimized by strong and active university – industry relationships. The mean score value for this fact was 4.13 and individual mean score value of individuals for ERA, AACRA, real estate developers, foreign contractors, consultants and local contractors was 4.21, 4.63, 3.69, 4.40, 4.94 and 3.10 respectively.

One the other hand the university – industry linkages will also increase the stimulation of additional private R&D investment because the industry will be eager to find solutions for its day to day construction difficulties. The mean score value for the fact was 4.46 it means it is important to have strong university – industry linkages in order to inspire supplementary private R&D investments by the industry for further enhancement of the research trend. The other benefits of the university – industry linkages are that it exploits synergies and collaborations. The mean score value for the exploits synergies was 4.24, that means it is important. The individual mean score value for ERA, AACRA, real estate developers, foreign contractors, consultants and local contractors was 3.58, 4.75, 4, 4.8, 4.44 and 4.32 respectively.

The additional benefit of university – industry linkages is that it exploits complementarities of scientific and technological capabilities for the industry. The mean score value for this issue was 4.43, which falls in the important category. The individual mean score value is somehow different among the stakeholders and it is presented as follows in Figure 4.26;

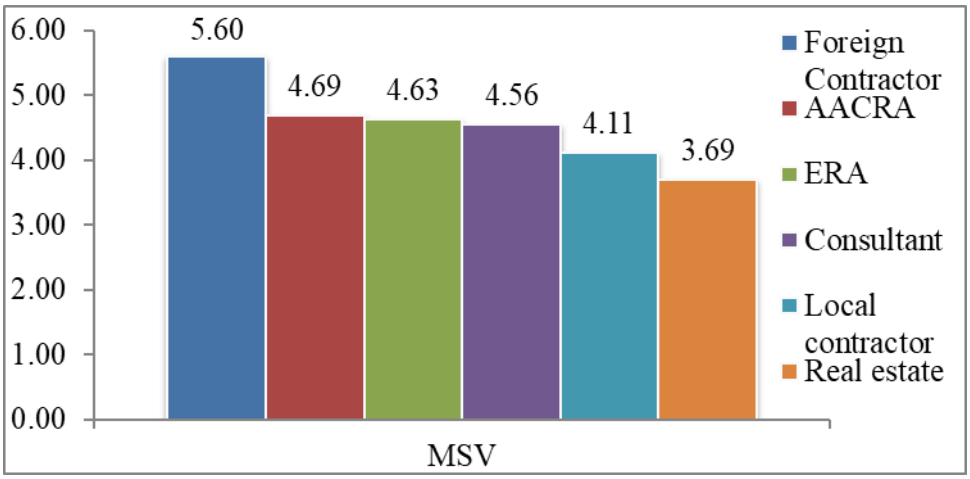


Figure 4.26 - MSV for exploits complementarities of scientific and technological capabilities for the industry

Therefore according to the mean score value the most important benefits of university – industry linkages are to coordinate R&D agendas and to enhance new technology and innovation. The development of relevant research topics and the development of current and future construction industry research needs and making the industry more competitive will follow.

4.3.4 Methods to enhance the university – industry relationship

This section will show the results of the analysis on methods to enhance the university industry relationships and the results are presented in Table 4.14.

Table 4.14 – Methods to enhance the university – industry relationship

No.	Probable methods to enhance the university industry relationship	Scale				MSV
		Very important	Important	Somehow important	Not important	
1.	R&D incentives and grants	53	29	8	0	5
2.	Performance based funding of universities and reward systems for researchers	31	42	17	0	4.31

3.	Country's technological and institutional donations	31	46	11	2	4.38
4.	Intellectual property rights management and technology transfer offices	38	35	14	3	4.43
5.	Involving government to create specific programs designed to stimulate contacts and substantive interaction	36	39	11	4	4.42
6.	Accelerating contacts between university administrators and scientists and their industrial counterparts	35	41	13	1	4.46
7.	Science parks, spin-offs and business incubators	32	42	14	2	4.33
8.	Application of IT to improve the link between construction industry and academics to easily access information	51	34	5	0	5.02
9.	Consulting and involving the key stakeholders of the construction.	43	35	10	2	4.67
10.	Increasing partnership between the research community and the industry	57	27	5	1	5.12
11.	Growing emphasis on integrated topics and approaches in research	42	36	11	1	4.66
12.	Internationalization of competition and collaboration in the research community	25	46	12	7	4.06
13.	Education and training	54	31	5	0	5.09
14.	Globalization and international university industry collaboration	43	37	7	2	4.69

One of the methods to enhance the university – industry relationship is that the R&D incentives and grants for researchers. The mean score value for R&D incentives and grants was above 5 which means it is very important method to enhance the university – industry relationship in which the researcher is interested and motivated. The mean score of individual sectors for R&D incentives and grants is presented in Figure 4.27;

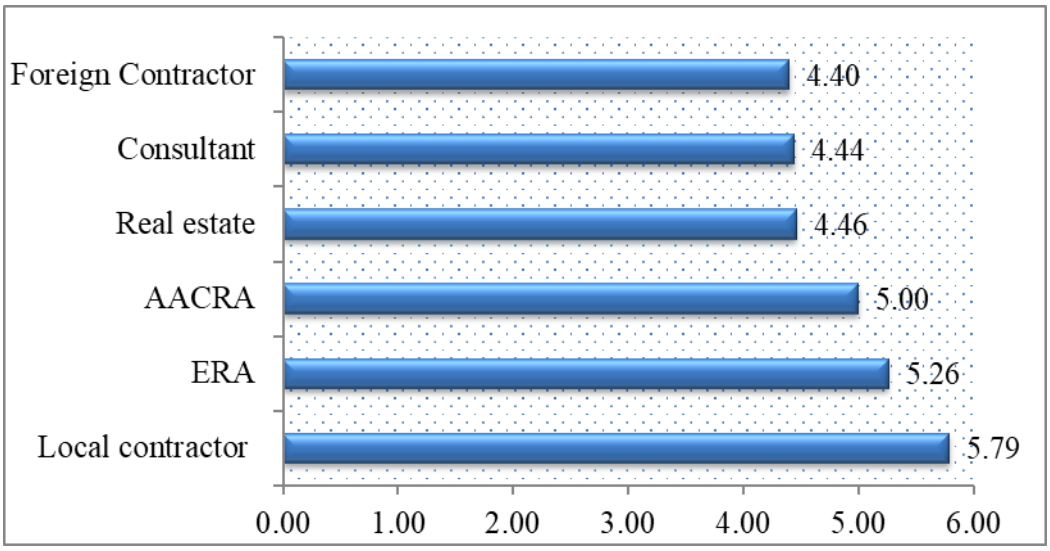


Figure 4.27 - MSV for research and development incentives and grants

Performance based funding of universities and reward systems for researchers are the other way to enhance the university – industry relationships. The mean score value was 4.31 for the overall construction industry. In addition they all fall under the important category while we try to see them individually. Figure 4.28 shows the individual mean score value of performance based funding.

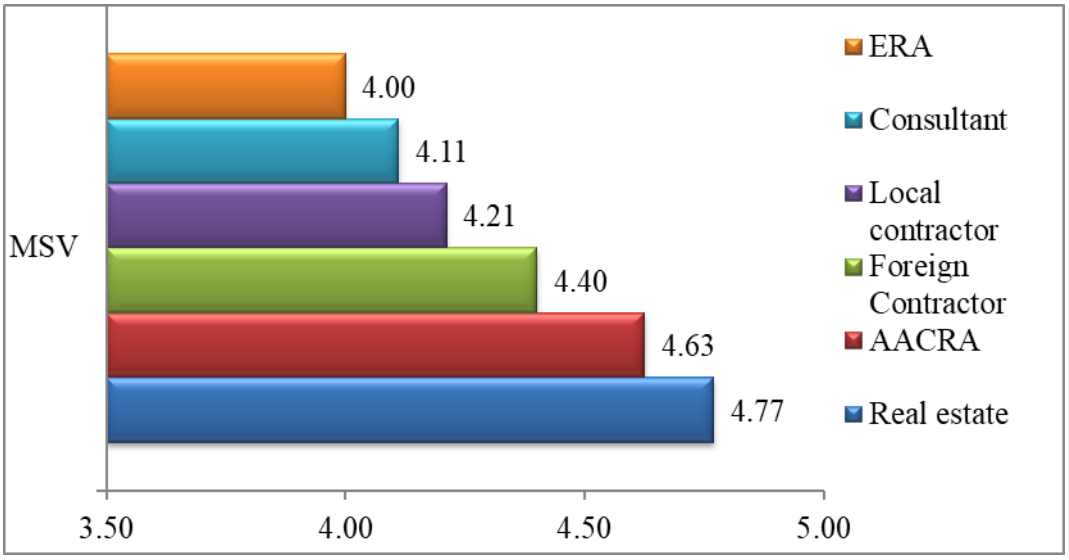


Figure 4.28 - MSV for performance based funding

Country's technological and institutional donations are also essential to enhance the relationship of university – industry. The mean score value for country's technological and institutional donations was 4.38, which falls under the important category. The individual mean score value for ERA, AACRA, real estate developers, foreign contractors, consultants and local contractors was 4.58, 4, 4.15, 4.8, 4.17 and 4.73 respectively. Therefore, from the individual MSV results stated above, it can be summarized as all of the selected construction sectors rely on the need of technological and institutional contributions.

The mean score value for intellectual property rights management and technology transfer offices was 4.43 which implies that it is important for the enhancement of the university – industry relationships. The individual mean score is presented as follows in Figure 4.29;

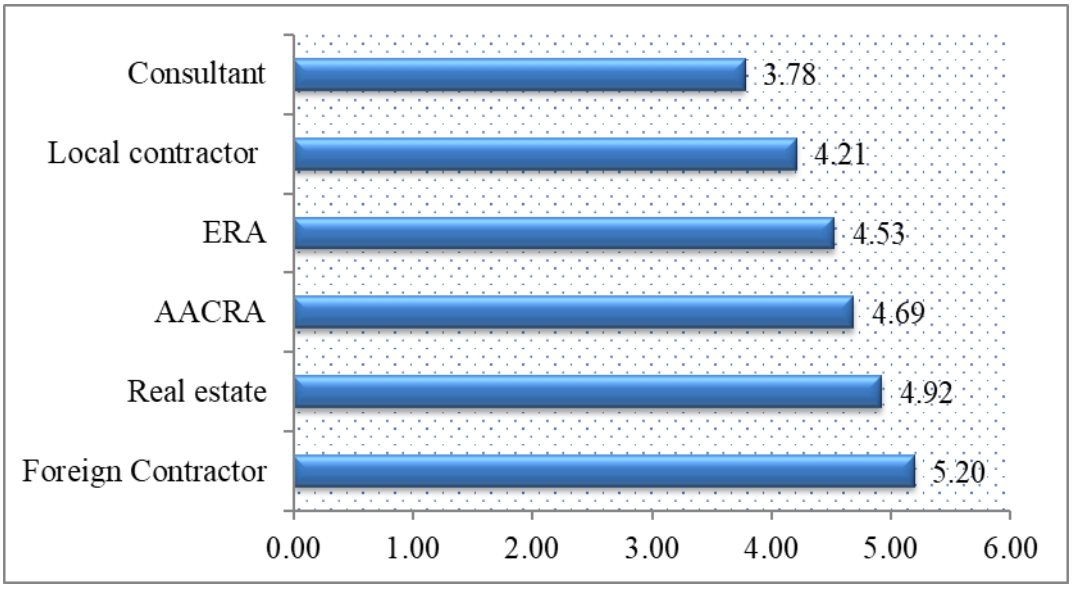


Figure 4.29 - MSV for the need of intellectual property rights management and technology transfer offices

Involving government to create specific programs designed to stimulate contacts and substantive interaction between the university and industry is one of the essential ways to improve the university – industry relationships. The mean score value for this issue is 4.42. The individual mean score for ERA, AACRA, real estate developers, foreign contractors, consultants and local contractors was 3.84, 4.44, 4.69, 4.40, 4.67 and 4.58 respectively.

The other method to improve the relationship between the universities – industry is to accelerate contacts between university administrators and scientists and their industrial

counterparts. The mean score for this fact was 4.46 which show that it is important to apply for better connection among the industry and universities. As a result, using the information from the collected data all the sectors choice falls between four and five mean score value except the foreign contractor mean score value was 5.6.

Science parks, spin-offs and business incubators are methods which are believed to enhance the university – industry relationship. This approach has got a 4.33 mean score value, which tells us that it is important to consider these science parks, spin-offs and business incubators for better relationship among university – industry. The individual mean score value for ERA, AACRA, real estate developers, foreign contractors, consultants and local contractors was 4.21, 4.56, 4.62, 4.4, 4.17 and 4.21 respectively.

The other main method to enhance the university – industry relationship is the application of IT to improve the link between construction industry and academics in order to easily access information. Here the mean score value was 5.02 which implies that it is very important technique for the strong university – industry relationship. The individual mean score value is presented in Figure 4.30;

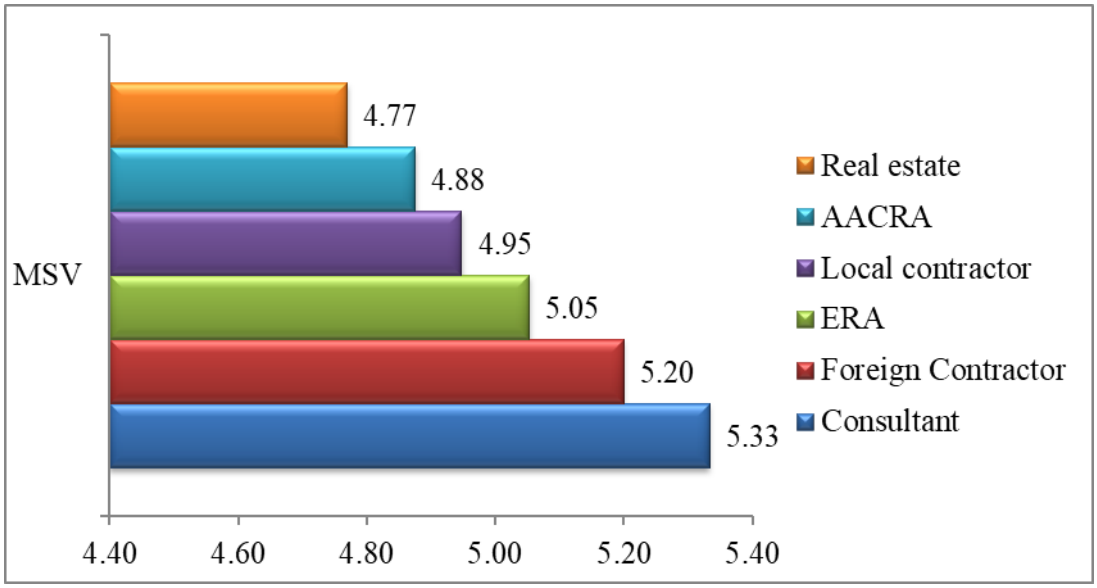


Figure 4.30 - MSV for application of IT

One of the methods to improve the university – industry relationship is that to consult and involve the key stakeholders of the construction. The mean score value of this fact was 4.67 that falls in the important category. The individual mean score value for ERA, AACRA, real estate developer, foreign contractor, consultants and local contractors was 5.05, 4.88, 5.31, 5.20, 4.28 and 3.89 respectively. In addition increasing partnership between the

research community and the industry is the other way to enhance the university – industry relationship. The mean score value for increasing partnership between the research community and the industry was 5.12 which implies that it is a very important technique. Most of the individual mean score value also lies above mean score value of 5.

The other method to improve the university – industry relationship is that the growing emphasis on integrated topics and approaches in research is found to be essential. The mean score value falls between four and five which implies that it is important issue. The individual mean score value is presented in Figure 4.31;

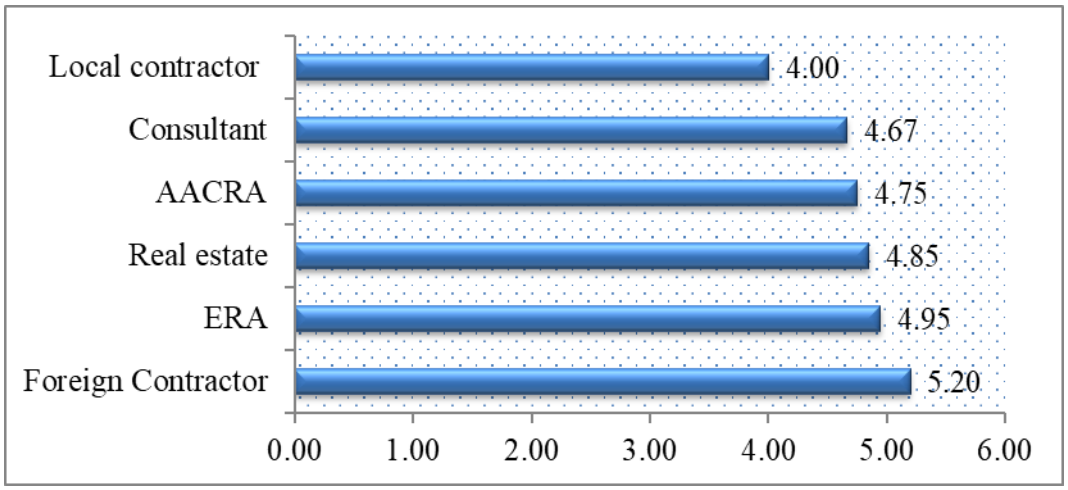


Figure 4.31 - MSV for growing emphasis on integrated topics and approaches in research

The belief for the improvement of the university – industry relationship by internationalization of competition and collaboration in the research community was mainly supported by the foreigner contractors. The overall mean score value for the raised issue was 4.06 which lie on the important range. However the mean score of foreign contractors was 5.6 which mean they mostly agree with this method for the enhancement of university – industry relationship.

The major technique to enhance the university – industry relationship is education and training. Most of the construction sectors said that it is a very important way to improve the relationship among the university and the construction industry. The overall mean score value was 5.09 and the individual mean score value is presented in Figure 4.32;

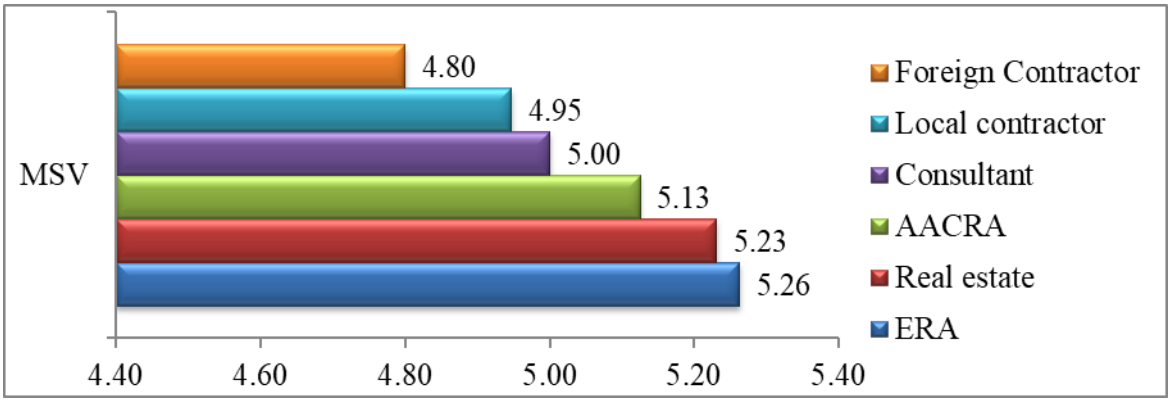


Figure 4.32 - MSV for education and training

Globalization and international university industry collaboration is the other main method to enhance the university – industry relationship. The mean score value was 4.69 which implies that it is in the important category. The individual mean score value for ERA, AACRA, real estate developers, foreign contractors, consultants and local contractors was 4.79, 4.69, 5.23, 5.20, 4.56 and 4.21 respectively.

Therefore according to the above analysis increasing partnership between the research community and the industry is the most important method to enhance the university – industry relationship, then education and training, application of IT which can improve the link between construction industry and academics in order to easily access information and R&D incentives and grants will follow.

4.3.5 Factors which contributes for the less involvement of construction research in the industry

This section of the analysis part presents the results from the respondents regarding the possible causes for the less involvement of construction research in the industry and the results are presented in Table 4.15 and Figure 4.33.

Table 4.15 - Causes for the less involvement of construction research in the industry

No.	Possible causes for the less involvement of construction research in the industry	Scale				MSV
		Very often	Often	Sometimes	None	
1.	Quality of the thesis works and research papers	34	37	19	0	4.33
2.	Lack of proper communication and coordination among universities and	52	32	5	1	5.01

No.	Possible causes for the less involvement of construction research in the industry	Scale				MSV
		Very often	Often	Sometimes	None	
	construction industry					
3.	Accessibility of thesis works and research papers	22	50	14	4	4.04
4.	Duplication of thesis works and research papers	39	29	22	0	4.38
5.	Lack of knowledge or information of available resources	53	29	8	0	5
6.	The disconnect between academic research from perceived industrial needs	39	31	19	1	4.41
7.	The decreased interest among university graduates in industrial research careers	29	44	17	0	4.27
8.	Industry's diminishing role in basic research	32	40	18	0	4.31
9.	Inherent mismatch between the research orientations of firms and universities	35	30	25	0	4.22
10.	Usual interest of firms in how quickly new patents or new products can be obtained	24	45	16	5	4.01
11.	Difficulties finding contact persons and transaction costs	21	37	28	4	3.71
12.	Lack of financial and human resources	52	31	7	0	5
13.	Low interest in technological innovation	34	34	19	3	4.23

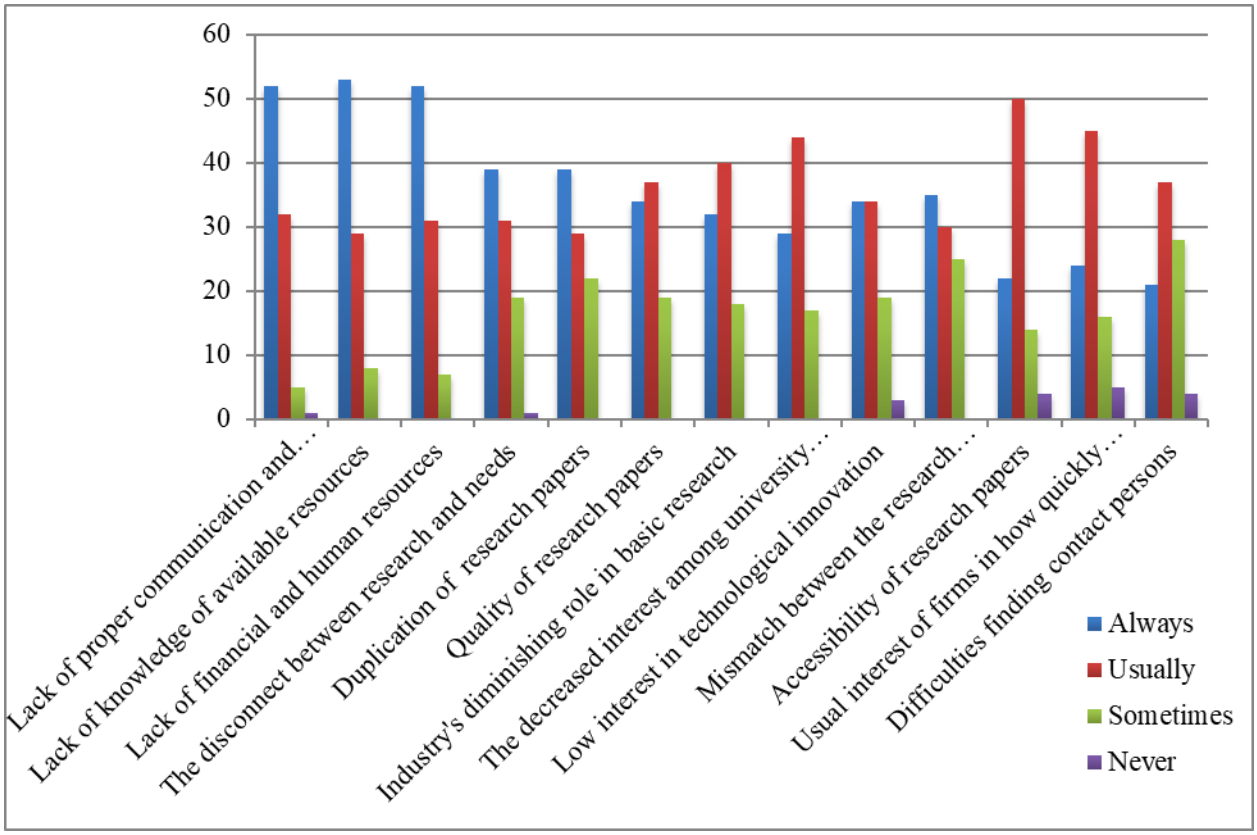


Figure 4.33 - Possible causes for the less involvement of construction research in the industry

One of the causes for the less involvement of construction research is the quality of the thesis works and research papers. The mean score value for value of the research papers was 4.33. And individual mean score value is presented in Figure 4.34;

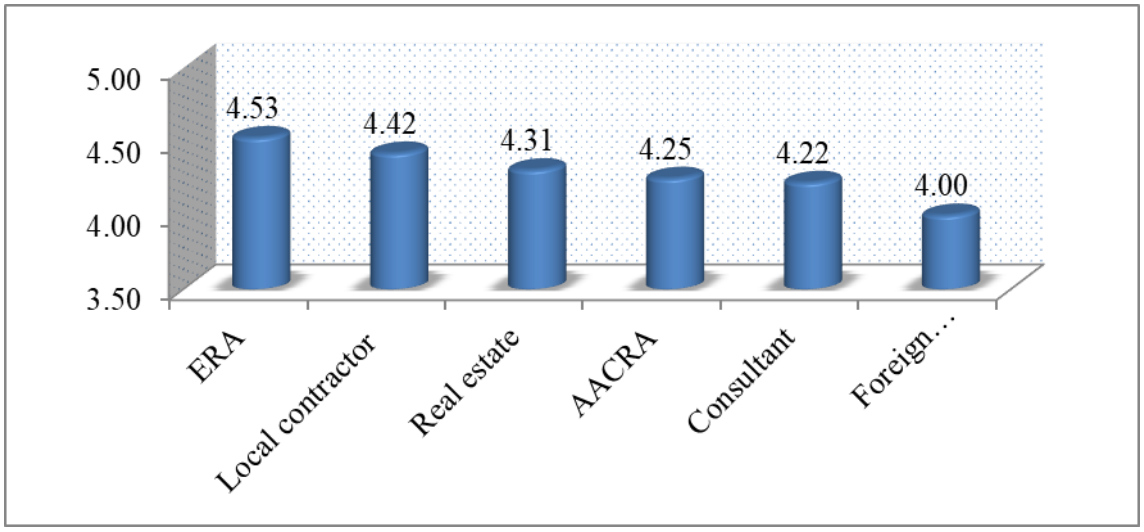


Figure 4.34 - MSV for quality of thesis works and research papers

Lack of proper communication and coordination among universities and construction industry is also a factor for the less involvement of research papers in the industry. The overall mean score was 5.01 which imply that it is the most important factor for the less involvement of the research papers in the industry. The individual mean score value is presented Figure 4.35;

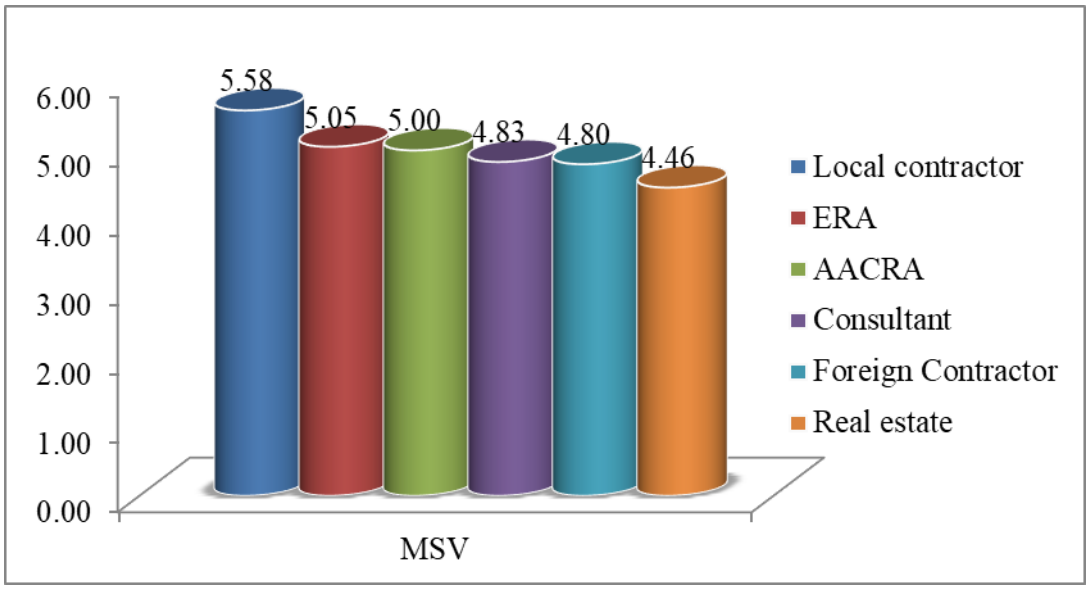


Figure 4.35 - MSV for lack of proper communication and coordination

The other factor is that the accessibility of thesis works and research papers. Here the collected data shows that the research papers accessibility falls between four and five. The mean score value was 4.04. And the individual mean score for ERA, AACRA, real estate developers, foreign contractors, consultants and local contractors was 3.42, 3.75, 4.46, 4.40, 5.11 and 3.53 respectively. The additional key cause for the less involvement of research paper in the industry is that the duplication of thesis works and research papers mainly in the BSc programs. The mean score value was 4.38.

Here is one of the main gaps between the researcher and industry because there is a lack of knowledge or information of available resources among the industry. The mean score value was 5 which lies in a very often category that implies it is a major factor for the less involvement of research papers in the industry. The individual mean score value is presented in Figure 4.36;

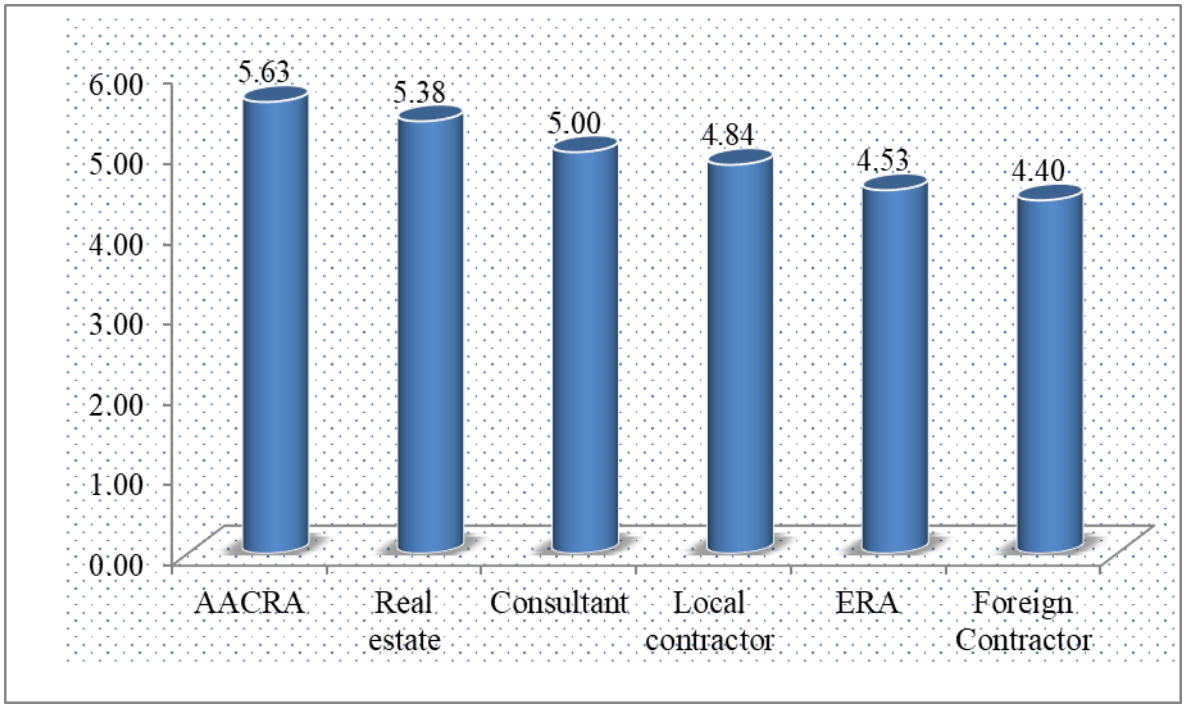


Figure 4.36 - MSV for lack of knowledge or information of available resources

The disconnection between academic researchers from perceived industrial needs is also a factor for the less involvement of research papers in the industry. The mean score value was 4.41; it means the disconnected between academic researchers from perceived industrial needs is one of the major factor for the fewer participation of construction research in the industry. And the individual mean score for ERA, AACRA, real estate developers, foreign contractors, consultants and local contractors was 4.84, 5, 4.46, 3.60, 3.94 and 4.10 respectively.

The other factor is the decreased interest among university graduates in industrial research careers and this got a mean score value of 4.27 which implies that it is often factor for the less involvement of research papers in the industry. The individual mean score value is presented in Figure 4.37;

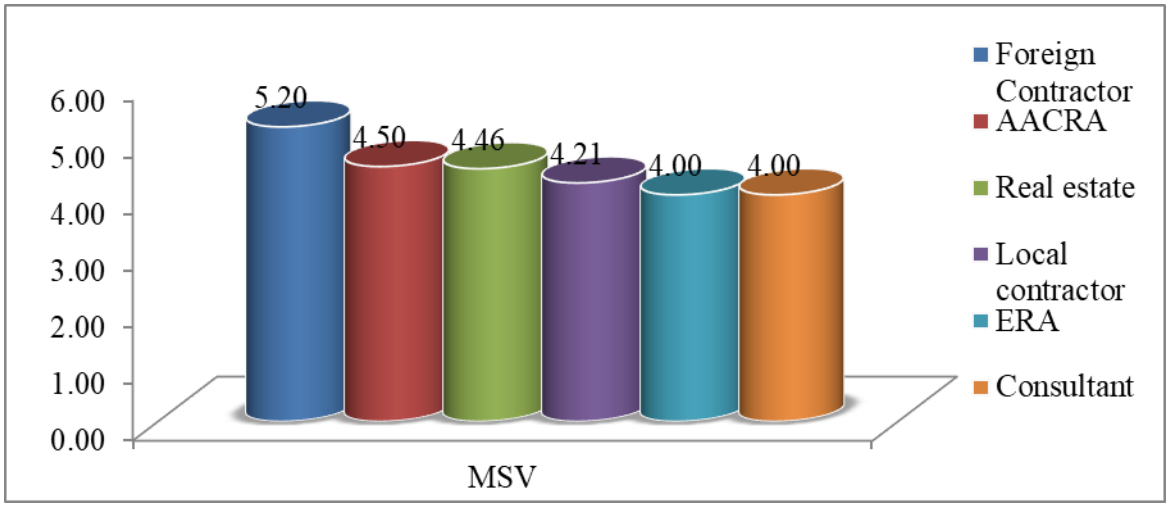


Figure 4.37 - MSV for decreased interest among university graduates in industrial research careers

The other factor is that the industry's diminishing role in basic research. The mean score value was 4.31 which implies that it is often factor for the less involvement of research papers in the industry. The individuals mean score value is presented in Figure 4.38;

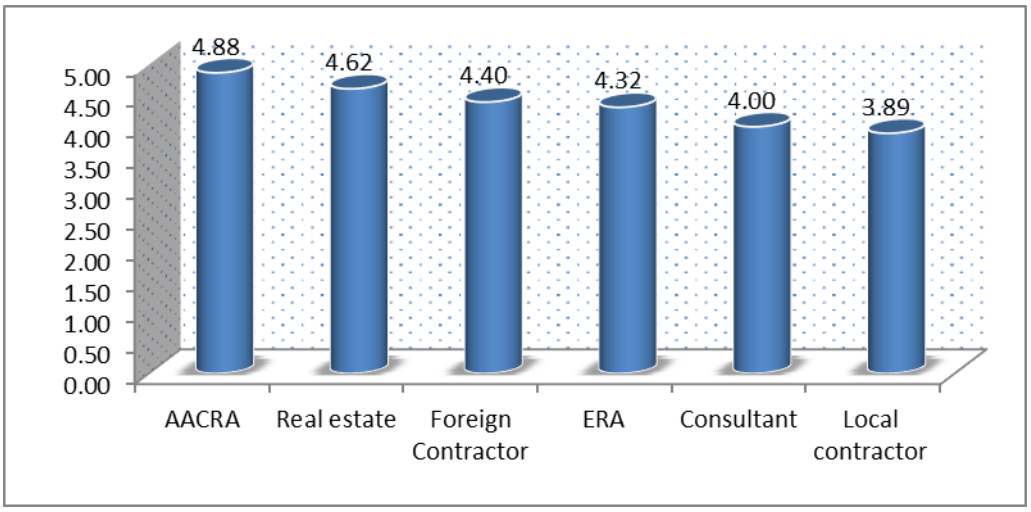


Figure 4.38 - MSV for industry diminishing role in the basic research

The inherent mismatch between the research orientations of firms and universities is also a factor for the less involvement of research papers in the industry. The mean score value was 4.22 which implies that it is one of the main factors. The individual mean score value for ERA, AACRA, real estate, foreign contractors, consultants and local contractors was 4.11, 4.75, 4.00, 4.00, 4.00 and 4.32 respectively. The other factor for the less involvement of research papers is the usual interest of firms in how quickly new patents or new products can be obtained and this is somehow difficult to satisfy the industry. The mean score value was 4.01 which implies that it is often a factor for the less involvement of research papers in the industry. And also difficulties of finding contact persons and transaction costs were found to

have a little impact for the less involvement of research papers in the industry. The overall mean score value was 3.71 which imply that it is sometimes a reason.

One of the major factors for the less involvement of research papers in the industry is that the lack of financial and human resources. Many of the respondents agree on this factor. The mean score value was 5 which lies on the very often range. The individual mean score is presented in Figure 4.39;

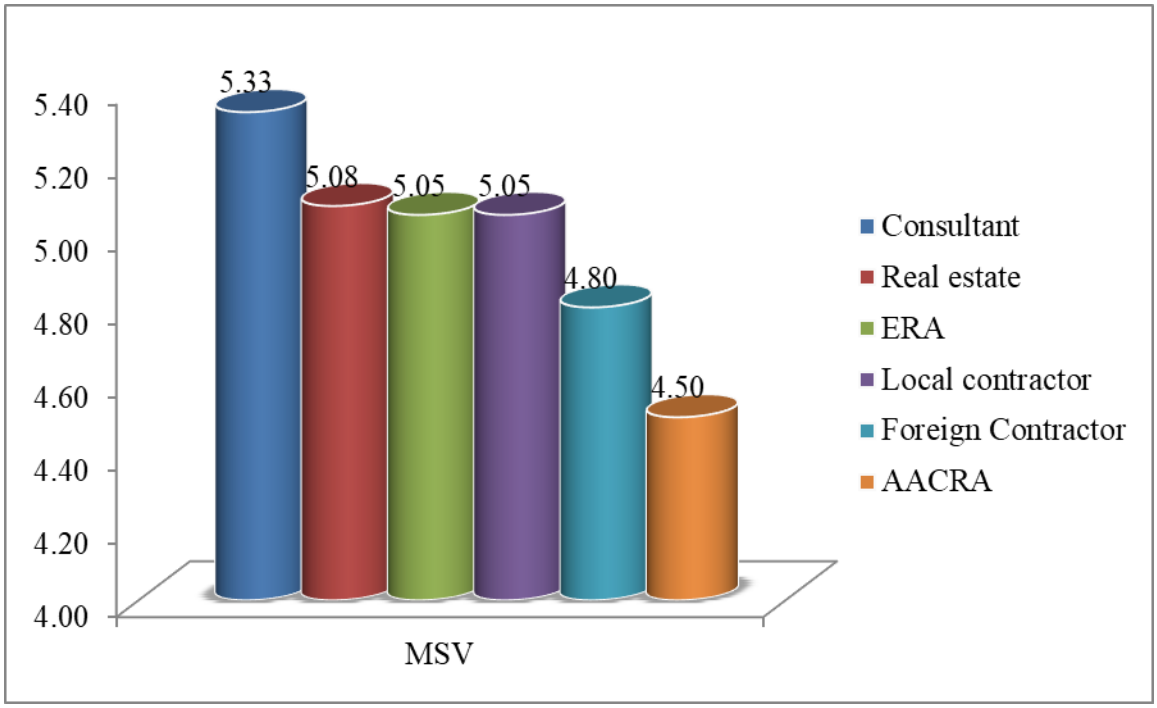


Figure 4.39 - MSV for lack of financial and human resources

The other factor for the less involvement of construction research in the industry is the low interest in technological innovation and this factor has got a mean score value of 4.23. And the individual mean score value is presented in Figure 4.40;

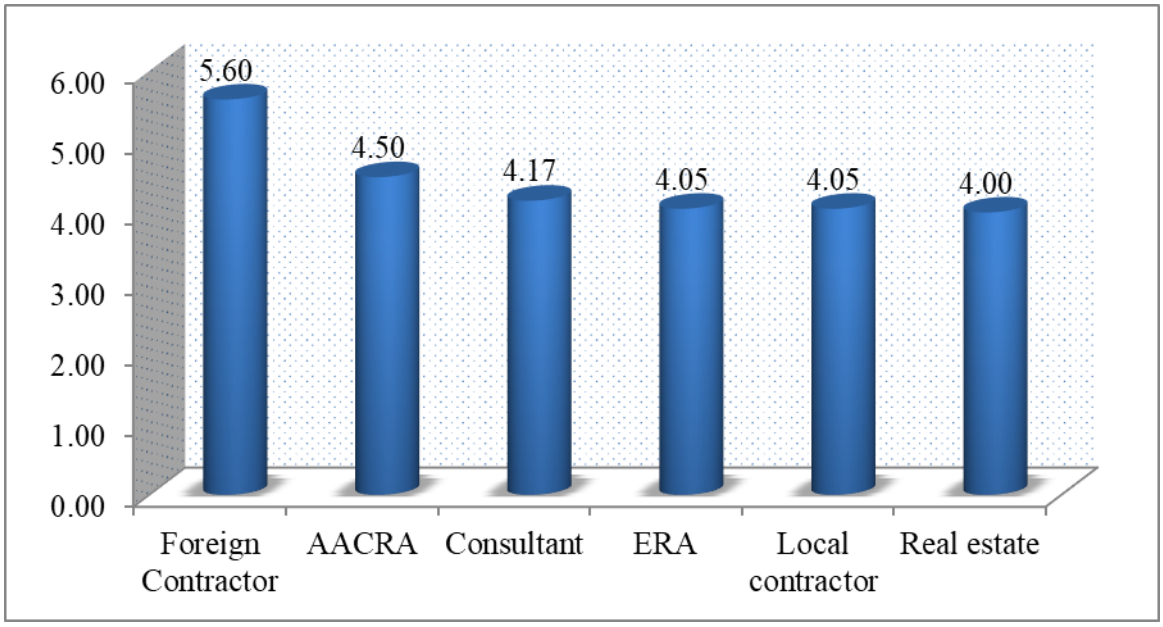


Figure 4.40 - MSV for low interest in technological innovation

From the above analysis the lack of proper communication and coordination among universities and construction industry, lack of knowledge or information of available resources and lack of financial and human resources has been the major reasons for the less involvement of research papers in the industry.

4.3.6 Proposed additional research topics

The following topic areas are suggested by the industry professional and they can be basic starting topics which might require modifications based on the research context;

- Design solutions for time and cost overrun in the federal road projects.
- Alternative construction delivery systems based on time and cost.
- A study on policy measures for promoting railway use in freight transportation; a case study on Djibouti – Addis Ababa railway project.
- Study on Management Information System (MIS) for planning and schedule control of construction projects.
- Study on contract vagueness of design and bid road contracts in Ethiopia.
- Effects of poor design and specification and their impacts on bidding and construction process.
- Study on the efficient communication system between the designer and contractor for better construction output.

- Study on the advantages and disadvantages of rigid pavement in hot areas of the country.
- The impact of lack of using efficient work methods and technologies by local contractors.
- Study the effect of supply chain management on the quality of construction works.
- Case study on road traffic management in Addis Ababa.
- Data base management system in the construction industry.
- Study on the evaluation system model for road projects.
- Study on the first few years of the performance of graduating students in the construction industry.
- Investigation of optimal management solution of cost estimation of road projects.
- Study on integrated construction management system for site quality control.
- Design a management system for controlling the material usage of construction projects.
- Study on developing a resource management system for creating a successful real estate company.
- Study on change orders and its impact on the projects time and cost on selected road projects.
- Study on developing equipment productivity norm for construction companies.
- Study on the value engineering aspects for improving the projects performance at the implementation phase of road projects.
- Study on the problems of Design – Build projects in the construction projects.
- Effects of electro mechanical and sanitary works in building projects.
- Investigation on techniques for improving the profitability of small and medium size construction firms.
- Study on the researches that affect the growth of the current construction industry.
- Study on the prefabrication industry for the future sustainable housing projects.
- Research on fire prevention for condominium housing projects in Addis Ababa.
- Study on integrated construction management system for site problems and management evaluation with expert system implementation.
- Study on using a computer interactive model for evaluating and improving construction projects.
- Current practice and methodology of environmental safeguard on the federal road projects.

- Development of standard unit rate analysis for construction companies.
- Ambiguity and interpretation of contract provisions in the construction industry.
- Study on future advantage and disadvantage of loan agreement (memorandum of understanding) between financer and government.
- Barriers to construction contractors to implement sustainable construction in the country.
- Study on the advantages and disadvantages in the implementation of the lean construction.
- Study on material management of building construction material production for condominium projects by small and medium size enterprises.
- Study on financial performance and sustainability of real estate projects.
- Study on how to improve the labor and equipment productivity in construction projects.
- Study on the steps, process and outcome of waste Management in building construction projects.
- Study the effect of earthquakes on specific structures or buildings in Ethiopia.
- Study on concrete strength using different types of cements which are produced in Ethiopia.

5. CONCLUSIONS AND RECOMMENDATIONS

This section forwards the conclusions of this research based on the major findings stated in the previous chapter, data analysis and discussion, a brief conclusion are summarized to the findings and finally helpful recommendation for the research problems will also be forwarded.

5.1 Conclusions

1. The major finding of the analysis part of this research is that the trend or tendency of using construction research papers and their findings by the construction industry participants such as Ethiopian Roads Authority, Addis Ababa City Roads Authority, real estate developers, foreign contractors, consultants and local contractors was very low.
2. The respondents have got the knowhow that research will always be needed to improve the construction practices and processes, it is also known that research is needed to ensure new technology is created with the support of the construction industry, in addition the role of education and research in order to make the concepts and practices known and useable is also approved by the participants.
3. The findings of the research showed that the correlation between the current construction industry participants and the research trend is no linear relationship with the correlation coefficient value of 0.08. The topic areas such as concrete technology, industry overview and constructability were the most studied subject in the university. However, the ranking from the construction industry professionals indicated that the topic areas mentioned above was not their most important research topic areas. This outcome may signify that the construction industry professionals believe that concrete technology, industry overview and constructability are being sufficiently studied and the findings might be acknowledged. But more research on these topic areas is not the necessity for the recent construction industry. On the other hand, great efforts shall be made on current demands of the construction industry in order to generate numerous outcomes.
4. The construction industry respondents need is that more research should be done in the topic area of economics or cost control which is connected to factors that influence the financial aspect of projects and the construction industry, delay and cost overrun that is associated with constructions' slow rate or late deliveries and high cost beyond the contracted value, and productivity which is related with the study of individual or general

labor or equipment productivity, significant researches should be conducted by university researchers in order to satisfy the industry demand.

5. Increasing partnership between the research community and the industry is the most important method to enhance the university – industry relationship, then education and training, application of IT which can improve the link between construction industry and academics in order to easily access information as well as research and development incentives and grants are approved to improve the university – industry link.
6. Lack of proper communication and coordination among universities and construction industry, lack of knowledge or information of available resources in addition lack of financial and human resources has been the major reasons for the less involvement of research papers in the construction industry.

5.2 Recommendations

Based on the findings of the research, the following suggestions and recommendations are made.

- **Government**
  - The government should support academic institutions researchers who are trying to make the construction industry more efficient and cost effectiveness.
  - Research and development incentives and awards shall be given periodically by the Federal Government and governmental companies for university researchers in order to enhance the university industry relationships.
- **Academic institutions**
  - Academic institutions shall work more on making the university graduates competent in order to make transition from theoretical to the more applied orientation of industrial research. As well as the internship program should be well controlled in order to make the graduates familiar with the technical capability.
  - It is known that the application of IT which is essential to improve the link between construction industry and academics is on progress in AAiT and this effort shall also continue on different academic institutions for better result.
  - The academic institutions should increase their partnership with the various construction industry sectors and this partnership should go further reaching to solving urgent industry problems and obtaining new products.
  - Universities should work hard on the value and accessibility of thesis works and research projects on both undergraduate and postgraduate programs.
- **Researchers**
  - The researchers shall increase the interest of performing industrial research careers and technological innovations in order to improve the involvement of construction research in the industry.
  - The academics should give priority to study on topic areas which can satisfy the need of the current and future construction industry.
- **Professional associations**
  - Since the importance of advisory committee for the construction industry was agreed by different construction sectors, the professional associations shall create the platform for this advisory committee and also this counseling team should be

active and devoted to notify on current changes in the construction industry and on the needs in organizations.

- To enhance the university industry relationship the professional associations shall accelerate contacts between university administrators and scientists and their industrial colleagues.

❖ **Participants of the research (ERA, AACRA, Real estate developers, consultants, foreign and local contractors)**

- The trend of using construction research papers shall be improved by the construction industry professionals such as ERA, AACRA, real estate developers, consultants, foreign and local contractors.
- The construction industry participants shall use the findings of the construction researches which are previously done in the academic institutions, and then the construction industry will improve the trend of using construction research papers from universities and start recognizing the benefit of those research findings.
- Creating a research and development department like ERA is essential for every participants and stakeholders of the construction industry. And this R&D department should be able to obtain new knowledge which is applicable to the company's business needs, that eventually will result in new or improved products, processes, systems, or services and which can increase the company's or country’s value.

5.3 Future research areas

- Study on the construction research trend in the entire Civil and Environmental Engineering under and post graduate program at Addis Ababa Institute of Technology.
- Study on the construction research trend in the entire Civil and Environmental Engineering under and post graduate program at different universities of the country.
- Investigation on demand of construction researches regarding the need of the huge industry sectors such as hydro dam projects, industry parks, and housing projects.
- Design a construction research catalog database or appropriate website which can easily accessed by entire construction professionals which can enhance the trend of using research papers for problems faced in the industry.
- Study on how to organize the entire research papers of the academic institutions in the country.
- Study on foreign universities methodologies on the university industry partnership and new innovations techniques for creating a vital relationship among the university and industry.

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APPENDIX – A / Questionnaire /

ADDIS ABABA INSTITUTE OF TECHNOLOGY
አዲስ አበባ ቴክኖሎጂ ኢንስቲትዩት
ADDIS ABABA UNIVERSITY
አዲስ አበባ ዩኒቨርሲቲ

Dear Madam/Sir

Re: Request to respond to a questionnaire for a MSc thesis work

I am currently undertaking a M.Sc. degree in Civil Engineering (Construction Technology and Management Major) at Addis Ababa institute of Technology [AAiT]. In fulfillment of this MSc. degree I am carrying out a study on "**Research in Ethiopian Construction Industry: Review of Past Studies and Future Need Assessment",** emphasizing on the construction research trends and research needs of the industry.

Objectives of the research includes;-

- To examine the construction research trends in Ethiopia.
- To identify topic areas which are relevant for existing construction industry demand.
- To identify the future research needs of the construction industry based on different perspectives and industry type.

I would be grateful if you could complete the attached questionnaire. Here, I promise, the information provided will be treated with strict confidence and individual projects or companies will not be identified and it is only used for academic reason. Equally, a copy of the summary report can be availed, if requested. This research is conducted for academic purposes; therefore please try to answer the questions wisely and truthfully.

Habenom Gebru Zeray

Email: habenomgebru@yahoo.com Cell: +251 911718170

Advisor

Dr. Abraham Assefa Tsehayae, Addis Ababa Institute of Technology

Section 1 - Personal and organizational profile of respondent

1. Name of Organization (Optional): _____
2. Type of Organization:

   ☐ Client ☐ Consultant ☐ Contractor ☐Regulatory body

   ☐Other (Please specify) _____

3. Year of establishment of your company or organization:_____
4. Organization's/ company's category:

   ☐ Grade 1 ☐ Grade 2 ☐ Grade 3 ☐ Grade 4 ☐ Grade 5

   ☐ Other (Please specify) _____

5. Your personal experience:

Current Position: _____

Experience in years in your current position: _____

Experience in years in the construction industry: _____

6. Please indicate your highest formal academic qualification:

   ☐ PhD ☐ Masters ☐ Bachelor ☐ Diploma

   ☐ Other (please specify) _____

Section 2 – General questions

Instruction: Tick one of the alternatives for questions under section 2.

1. How often do you use a construction research papers from universities to solve problems faced on your company?

   ☐ Always ☐ Usually ☐ Sometimes ☐ Never

2. Does the construction research paper from universities have a benefit for your company?

☐ Always ☐ Usually ☐ Sometimes ☐ Never

3. Do you believe that strong university industry relationships can enhance the basic research innovation?

   ☐ Always ☐ Usually ☐ Sometimes ☐ Never

4. Is it important to have an advisory committee or research council made up of professionals and executives in the construction industry, which informs on current changes in the construction industry and on the needs in organizations?

   ☐ Always ☐ Usually ☐ Sometimes ☐ Never

5. Do you agree that the role of education and research is to make the concepts and practices known and useable?

   ☐ Always ☐ Usually ☐ Sometimes ☐ Never

6. Do you think that the collaboration between university – industry substantially increase the tendency of firms to introduce new products?

   ☐ Always ☐ Usually ☐ Sometimes ☐ Never

7. Do you believe that the industry finds university graduates to be too theoretical and unable to make the transition to the more applied orientation of industrial research?

   ☐ Always ☐ Usually ☐ Sometimes ☐ Never

8. Does the academic research community need the construction industry? Why?

   ☐ Yes ☐ No

   _____

   _____

9. Does the construction industry need the research community? Why?

   ☐ Yes ☐ No

   _____

   _____

   _____

Section 3 – Rank of the construction research topics

Rank the following topic areas by importance to the Ethiopian construction industry. The very important topic area will be given rank 1 and the less important topic area will be given rank 24.

No.	Construction research topics	Rank
1	Alternate Dispute Resolution - Related to disputes, conflicts and resolution methods.	
2	Change orders / Variation - Connected with the replacement or substitution of demand, command or order in the construction.	
3	Computer systems / Expert systems - Associated to the use of artificial intelligence to offer advice or make decisions or creating or enhancing computer software or else calibrating some part of the software and creating or providing formulas related to the construction.	
4	Concrete technology - Related with concrete making material, the overall concrete production, the characteristics of concrete and other related issues about concrete.	
5	Constructability - Linked to the ability of a project to be built, or the technique to review the construction process or study on current defects.	
6	Delay and cost overrun - Associated with constructions with slow or late deliveries and high cost beyond the estimated value.	
7	Demolition - Related with the demolition of structures.	
8	Economics / Cost control - Connected to factors that influence the financial aspect of projects and the entire industry.	
9	Estimating / Bidding	

No.	Construction research topics	Rank
	- Associated with judging the cost of a project and securing the work through bidding.	
10	Facility Management - Interrelated to integration of multiple disciplines to maintain the functionality of a structure.	
11	Health and safety - Related with the study of techniques and advances in construction safety.	
12	Industry Overview - A look at the industry in general, such as the history, progress, or trends.	
13	Insurance - Related with construction insurance issues throughout the entire construction industry.	
14	Legal/Contracts - Studies that involve contracts, claims, or other legal issues.	
15	Material and equipment management - Linked with efficient use of materials and equipment before, during and upon completion of a building process in the construction and it is associated with the selection of proper equipment and materials to complete construction projects.	
16	Performance - Linked with research of measurement techniques of performance of construction entities or individuals and evaluation of performance.	
17	Price escalation - Connected with cause and effect of price fluctuation or adjustment techniques.	

No.	Construction research topics	Rank
18	Procurement - This topic area consist the process of obtaining projects, labor, material or project delivery method.	
19	Productivity - Connected with the study of individual techniques and methods, labor and equipment productivity or general productivity.	
20	Quality Management - Attached with the method of controlling the quality of a project.	
21	Risk management - Related with the development of programs, practices or strategies for minimizing risk.	
22	Scheduling - Associated with establishing the sequence and duration of activities on a construction project or issues concerned about planning and scheduling.	
23	Sustainability - Connected with sustainability techniques, harmful material reduction methods, and environmental impacts.	
24	Technology/Innovation - Linked to the development and implementation of new technology or technique.	

Section 4 – Benefits of university – industry linkages

Instruction: Tick one of the four scales for the given issues.

The benefits of university industry linkages are wide-reaching; the following table consists of list of probable benefits of university industry linkages from literatures. Based on your experience what is the likely contribution of these benefits in the Ethiopia?

No.	Probable benefits of university industry linkages	Scale			
		Very important	Important	Somehow Important	Not important
1.	Enhancing new technology and innovation				
2.	Solving urgent problems				
3.	Developing current and future construction industry research needs				
4.	Making the industry more competitive				
5.	Developing relevant research topics				
6.	Coordinate R&D agendas				
7.	Avoid duplications				
8.	Stimulate additional private R&D investment				
9.	Exploit synergies				
10.	Exploit complementarities of scientific and technological capabilities				

Section 5 - Methods to enhance the university - industry relationship

Instruction: Tick one of the four scales for the given issues.

The following table consists of list of probable methods to enhance the university - industry relationship from different literatures. Based on your experience what is the likely contribution of these methods in the Ethiopia?

No.	Probable methods to enhance the university industry relationship	Scale			
		Very important	Important	Somehow important	Not important
1.	R&D incentives and grants				
2.	Performance based funding of universities and reward systems for researchers				
3.	Country's technological and institutional donations				
4.	Intellectual property rights management and technology transfer offices				
5.	Involving government to create specific programs designed to stimulate contacts and substantive interaction				
6.	Accelerating contacts between university administrators and scientists and their industrial counterparts				
7.	Science parks, spin-offs and business incubators				
8.	Application of IT to improve the link between construction industry and academics to easily access information				

No.	Probable methods to enhance the university industry relationship	Scale			
		Very important	Important	Somehow important	Not important
9.	Consulting and involving the key stakeholders of the construction.				
10.	Increasing partnership between the research community and the industry				
11.	Growing emphasis on integrated topics and approaches in research				
12.	Internationalization of competition and collaboration in the research community				
13.	Education and training				
14.	Globalization and international university industry collaboration				

Section 6 - Factors which contributes for the less involvement of construction research in the industry.

Instruction: Tick one of the four scales for the given issues.

The following table consists of list of possible causes, identified from various literatures, for the less involvement of construction research in the industry. Based on your experience what is the likely contribution of these factors in the Ethiopia?

No.	Possible causes for the less involvement of construction research in the industry	Scale			
		Very often	Often	Sometimes	None
1.	Quality of the thesis works and research papers				
2.	Lack of proper communication and coordination among universities and construction industry				
3.	Accessibility of thesis works and research papers				
4.	Duplication of thesis works and research papers				
5.	Lack of knowledge or information of available resources				
6.	The disconnect between academic research from perceived industrial needs				
7.	The decreased interest among university graduates in industrial research careers				
8.	Industry's diminishing role in basic research				
9.	Inherent mismatch between the research orientations of firms and universities				
10.	Usual interest of firms in how quickly new patents or new products can be obtained				
11.	Difficulties finding contact persons and				

No.	Possible causes for the less involvement of construction research in the industry	Scale			
		Very often	Often	Sometimes	None
	transaction costs				
12.	Lack of financial and human resources				
13.	Low interest in technological innovation				

Section 7 – Additional research topics

Instruction: Provide additional research topics which are relevant for the construction industry.

1. Can you provide additional research topics which are relevant for the construction industry?
   - _____
   - _____
   - _____
   - _____
   - _____
   - _____
   - _____
   - _____
   - _____

Optional - Your Name and contact address:

- Name: _____
- Contact addresses
  - E-mail: _____
  - Tel: _____

APPENDIX – B / Analysis results of Cronbach's coefficient for reliability test /

Reliability test for ERA respondents

Analysis of section 2 - General questions

	Respondents response																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. Trend of using research pa	4	1	2	2	1	4	2	1	4	2	1	2	2	1	2	1	6	4	6	2.7076023
2. Belief of those research p	4	2	2	2	4	2	2	2	2	1	2	2	2	1	2	2	2	2	6	1.3391813
3. Belief of strong university	6	4	4	4	6	4	4	4	4	2	6	4	2	6	4	6	6	6	6	1.8011696
4. Importance of advisory co	6	4	6	2	4	6	6	6	4	6	4	4	6	2	6	6	6	6	6	1.9415205
5. Role of education and res	6	2	6	2	4	6	4	6	4	6	6	4	6	2	6	4	6	6	6	2.3625731
6. Collaboration between ur	6	2	4	4	4	6	1	6	4	6	6	4	6	2	6	4	6	6	4	2.5906433
7. Industry finds university g	4	6	4	2	6	4	4	4	4	4	4	6	4	2	2	2	6	4	4	1.7777778
	36	21	28	18	29	32	23	29	26	27	29	26	28	16	28	25	38	34	38	36.385965 Var
																				14.520468
															Cronbach's coefficient					0.7010875

8. Research needs industry	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
No																				
9. Industry needs research	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
No																				

Reliability test for ERA respondents

Analysis of section 4 - Benefits of university - industry linkages

	Respondents response																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. Enhancing new technolog	6	6	2	2	6	6	6	6	4	2	6	4	6	2	6	6	6	6	6	2.8304094
2. Solving urgent problems	4	6	2	2	6	6	6	1	2	6	4	2	4	4	4	4	2	6	6	3.1637427
3. Developing current and fu	6	6	4	6	4	4	4	4	2	2	6	4	4	2	4	6	2	6	6	2.3391813
4. Making the industry more	6	4	4	4	4	4	4	4	4	4	4	2	4	4	4	6	2	6	4	1.0994152
5. Developing relevant resea	4	4	6	4	6	4	4	6	6	4	6	6	4	4	6	6	6	4	4	1.0526316
6. Coordinate research and c	6	6	6	4	4	6	2	4	4	4	6	6	4	6	6	6	6	4	6	1.497076
7. Avoid duplications	4	6	4	2	6	2	2	4	2	2	6	6	4	2	6	6	4	6	6	3.0643275
8. Stimulate additional priva	4	6	2	4	4	4	4	4	4	2	4	6	6	4	4	4	4	4	6	1.2865497
9. Exploit synergies	6	4	6	2	4	4	4	4	4	2	4	4	2	1	2	4	1	6	4	2.3684211
10. Exploit complementariti	4	4	4	4	6	4	4	6	6	4	6	2	6	2	6	6	4	6	4	1.8011696
	50	52	40	34	50	44	40	43	38	32	52	42	44	31	48	54	37	54	52	56.385965 Var
																				20.502924
															Cronbach's coefficient					0.7070917

Reliability test for ERA respondents

Analysis of section 5 -Methods to enhance the university - industry relationships

	Respondents response																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. R&D incentives and grant	6	6	4	6	6	4	6	4	4	4	6	6	4	6	6	4	6	6	6	0.9824561
2. Performance based fundir	4	4	4	4	6	2	4	6	4	4	4	4	2	2	2	4	4	6	6	1.7777778
3. Country's technological ar	4	6	6	4	4	4	4	4	6	1	6	4	4	2	4	6	6	6	6	2.1461988
4. Intellectual property rights	4	4	4	4	6	6	6	6	4	2	2	2	6	4	4	6	6	4	6	2.1520468
5. Involving government to c	4	6	4	2	4	4	1	4	2	4	2	4	6	2	6	6	4	4	4	2.251462
6. Accelerating contacts betv	2	6	4	4	6	4	2	4	2	6	6	6	4	4	6	6	4	4	4	2.0350877
7. Science parks, spin-offs a	4	6	4	4	4	6	2	4	2	2	4	4	4	6	4	4	4	6	6	1.7309942
8. Application of IT to impro	4	4	6	6	4	4	4	6	6	6	6	4	2	4	6	6	6	6	6	1.497076
9. Consulting and involving tl	6	6	6	6	6	6	4	6	4	4	4	2	4	4	6	6	6	6	4	1.497076
10. Increasing partnership be	4	6	6	4	4	6	4	6	4	6	4	4	6	4	6	6	6	6	4	1.0526316
11. Growing emphasis on int	4	6	6	6	6	6	4	4	4	4	6	2	6	6	4	6	4	4	6	1.497076
12. Internationalization of co	4	4	4	2	6	4	1	4	2	4	4	4	1	4	4	4	4	4	4	1.4795322
13. Education and training	6	6	6	6	4	6	6	6	4	6	4	6	4	4	4	6	6	4	6	0.9824561
14. Globalization and interna	4	4	6	4	6	6	1	6	4	4	6	4	6	2	6	6	6	4	6	2.2865497
	60	74	70	62	72	68	49	70	52	57	64	56	59	54	68	76	72	70	74	68.479532 Var
																				23.368421
															Cronbach's coefficient					0.7094265

Reliability test for ERA respondents

Analysis of section 6 -Factors which contributes for the less involvement of construction research in the industry

	Respondents response																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. Quality of the thesis work	4	6	4	4	4	2	6	6	2	4	6	6	6	4	6	4	4	4	4	1.7076023
2. Lack of proper communic	4	6	4	4	6	4	6	4	4	6	6	4	6	6	4	6	6	6	4	1.0526316
3. Accessibility of thesis wor	4	4	4	4	2	4	4	4	4	2	6	1	4	4	2	2	4	4	2	1.4795322
4. Duplication of thesis work	6	6	2	2	6	2	4	6	2	2	2	4	2	4	4	6	6	6	6	3.3216374
5. Lack of knowledge or infc	6	6	6	6	4	4	4	4	2	2	6	4	2	6	4	6	4	6	4	2.1520468
6. The disconnect between a	6	6	6	6	4	2	6	6	2	2	2	2	6	6	6	6	6	6	6	3.251462
7. The decreased interest an	6	6	4	4	2	4	2	6	2	4	2	4	4	4	6	4	4	6	2	2.2222222
8. Industry's diminishing role	4	6	6	4	2	2	4	6	4	2	6	4	4	4	6	4	4	4	6	1.8947368
9. Inherent mismatch betwee	6	6	4	6	2	4	4	6	4	2	2	2	6	2	4	4	4	4	6	2.4327485
10. Usual interest of firms in	4	4	6	6	6	2	4	4	1	2	1	2	4	4	2	4	4	4	4	2.3684211
11. Difficulties finding contac	2	2	2	4	2	2	1	4	4	2	1	2	6	6	6	4	4	4	6	3.0233918
12. Lack of financial and hur	6	4	6	4	4	4	6	6	6	6	6	4	6	4	6	6	2	4	6	1.497076
13. Low interest in technolog	4	4	4	4	2	4	2	6	6	4	2	2	6	6	6	1	4	4	6	2.7192982
	62	66	58	58	46	40	53	68	43	40	48	41	62	60	62	57	56	62	62	83.719298 Var
																				29.122807
															Cronbach's coefficient					0.7064823

Reliability test for AACRA respondents

Analysis of section 2 - General questions

	Respondents response																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1. Trend of using research papers	1	1	2	1	2	1	1	2	1	1	1	2	4	1	1	2	0.6666667
2. Belief of those research papers	1	6	1	6	6	4	1	1	1	4	1	6	4	1	1	2	4.7833333
3. Belief of strong university indus	1	6	1	6	6	6	1	1	1	2	2	4	6	6	1	6	5.7333333
4. Importance of advisory committ	1	6	4	6	4	6	6	1	4	6	1	6	6	6	4	6	3.8625
5. Role of education and research i	4	6	4	6	6	6	4	4	4	6	4	6	6	6	1	6	2.0625
6. Collaboration between universi	4	6	2	6	4	4	1	1	4	6	2	4	6	4	1	6	3.6291667
7. Industry finds university graduat	2	6	4	6	6	6	4	4	4	6	4	6	4	6	4	4	1.5333333
	14	37	18	37	34	33	18	14	19	31	15	34	36	30	13	32	90.0625 Var
																	22.270833
												Cronbach's coefficient					0.878171

8. Research needs industry	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
No																
9. Industry needs research	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
No																

Reliability test for AACRA respondents

Analysis of section 4 - Benefits of university - industry linkages

	Respondents response																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1. Enhancing new technology	6	6	6	6	6	6	4	2	6	6	6	4	4	6	6	4	1.5333333
2. Solving urgent problems	4	4	2	4	2	6	2	1	2	4	4	6	4	6	4	4	2.3625
3. Developing current and future c	6	6	6	6	1	4	2	6	4	6	6	4	4	4	6	6	2.5625
4. Making the industry more comp	6	4	6	4	2	4	4	4	6	6	4	6	6	4	6	4	1.5333333
5. Developing relevant research to	6	6	6	6	2	4	6	4	6	6	6	6	6	6	6	6	1.3333333
6. Coordinate research and develo	6	6	6	6	4	4	6	6	4	6	4	4	4	6	6	6	1
7. Avoid duplications	4	6	4	2	4	2	6	4	6	4	4	6	6	6	4	6	1.9833333
8. Stimulate additional private res	4	4	6	6	2	2	6	6	4	6	4	4	6	6	6	4	2.0666667
9. Exploit synergies	4	6	6	4	4	2	4	6	6	6	6	4	4	4	6	4	1.5333333
10. Exploit complementarities of s	4	4	6	6	1	4	6	4	6	6	4	4	4	6	6	4	1.9625
	50	52	54	50	28	38	46	43	50	56	48	48	48	54	56	48	50.4625 Var
																	17.870833
												Cronbach's coefficient					0.7176213

Reliability test for AACRA respondents

Analysis of section 5 -Methods to enhance the university - industry relationships

	Respondents response																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1. R&D incentives and grants	4	4	6	4	6	4	6	4	6	6	4	6	4	6	6	4	1.0666667
2. Performance based funding of ur	6	6	2	4	2	2	4	6	6	4	4	6	6	6	4	6	2.5166667
3. Country's technological and insti	4	4	6	4	2	6	2	4	4	4	2	4	6	4	4	4	1.6
4. Intellectual property rights manag	6	2	6	6	4	4	4	4	6	6	6	4	4	6	6	1	2.4958333
5. Involving government to create s	6	4	4	2	6	2	2	4	4	6	6	6	6	6	6	1	3.3291667
6. Accelerating contacts between u	6	4	4	2	4	2	6	6	4	4	4	6	4	6	6	2	2.25
7. Science parks, spin-offs and bus	6	4	4	6	4	1	6	6	6	4	4	6	6	4	2	4	2.3958333
8. Application of IT to improve the	6	4	4	6	6	4	4	6	6	2	4	4	6	6	4	6	1.5833333
9. Consulting and involving the key	6	6	6	4	6	4	4	4	4	4	6	4	6	4	6	4	1.05
10. Increasing partnership between	6	6	6	6	2	4	6	2	6	6	4	4	4	6	6	6	2.1333333
11. Growing emphasis on integrate	6	4	2	6	4	2	2	6	6	6	6	6	4	6	4	6	2.6
12. Internationalization of competiti	6	4	1	4	1	1	2	6	2	4	4	4	4	4	6	1	3.3166667
13. Education and training	6	6	4	6	6	4	4	6	6	4	6	6	4	4	6	4	1.05
14. Globalization and international	6	4	6	6	2	4	6	6	4	4	4	6	6	6	4	1	2.4958333
	80	62	61	66	55	44	58	70	70	64	64	72	70	74	70	50	86.116667 Var
																	29.883333
													Cronbach's coefficient				0.7032201

Reliability test for AACRA respondents

Analysis of section 6 -Factors which contributes for the less involvement of construction research in the industry

	Respondents response																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1. Quality of the thesis works and r	4	4	6	4	4	2	2	6	6	4	4	4	6	4	6	2	2.0666667
2. Lack of proper communication a	6	6	6	4	6	4	4	4	4	4	6	6	6	6	6	2	1.6
3. Accessibility of thesis works and	4	4	2	4	1	6	2	6	4	6	4	4	1	6	4	2	3
4. Duplication of thesis works and	6	2	2	2	6	6	4	6	6	6	6	6	4	6	6	4	2.65
5. Lack of knowledge or informatic	6	6	6	6	6	6	4	6	6	6	4	6	4	6	6	6	0.65
6. The disconnect between academ	6	4	4	4	6	4	6	6	6	4	4	4	6	6	4	6	1.0666667
7. The decreased interest among ur	6	4	2	2	4	6	2	4	6	6	6	4	6	6	4	4	2.4
8. Industry's diminishing role in basi	6	2	6	6	4	6	6	6	6	4	4	6	6	4	4	2	2.1166667
9. Inherent mismatch between the r	6	2	4	4	6	6	4	6	4	4	6	4	4	6	6	4	1.5333333
10. Usual interest of firms in how q	6	2	2	6	6	1	4	4	4	6	4	4	6	6	6	4	2.7958333
11. Difficulties finding contact perso	6	2	2	6	4	6	2	6	2	6	2	4	4	6	2	1	3.7625
12. Lack of financial and human res	6	4	2	2	6	6	6	4	2	6	6	2	4	6	6	4	2.9333333
13. Low interest in technological im	6	2	2	6	2	6	4	6	4	4	6	4	6	6	4	4	2.4
	74	44	46	56	61	65	50	70	60	66	62	58	63	74	64	45	91.983333 Var
																	28.975
												Cronbach's coefficient					0.7420804

Reliability test for real estate developers respondents

Analysis of section 2 - General questions

	Respondents response													
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1. Trend of using research papers	1	1	1	1	4	2	2	1	1	4	1	2	2	1.19230769
2. Belief of those research papers have be	1	6	4	6	4	4	1	2	1	6	6	4	6	4.24358974
3. Belief of strong university industry rela	6	6	4	6	6	4	4	4	4	6	6	4	4	1.07692308
4. Importance of advisory committee for t	2	6	4	6	4	6	2	4	4	6	4	6	2	2.56410256
5. Role of education and research is to ma	6	4	6	6	6	6	4	6	4	6	2	6	6	1.69230769
6. Collaboration between university indus	4	6	4	6	4	6	2	6	2	6	6	4	6	2.35897436
7. Industry finds university graduates to b	4	6	4	4	6	6	4	2	4	4	4	6	6	1.58974359
	24	35	27	35	34	34	19	25	20	38	29	32	32	36.9358974 Var
														14.7179487
									Cronbach's coefficient					0.70178179

8. Research needs industry	Yes	1	1	1	1	1	1	1	1	1	1	1	1	1
	No													
9. Industry needs research	Yes	1	1	1	1	1	1	1	1	1	1	1	1	1
	No													

Reliability test for real estate developers respondents

Analysis of section 4 - Benefits of university - industry linkages

	Respondents response													
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1. Enhancing new technology	4	6	4	6	6	6	4	6	4	6	4	1	6	2.30769231
2. Solving urgent problems	6	6	6	2	6	6	2	1	2	6	6	2	1	5.16666667
3. Developing current and future construc	6	4	4	6	4	4	4	1	6	4	6	2	4	2.35897436
4. Making the industry more competitive	6	4	4	4	4	4	6	4	2	6	4	4	6	1.43589744
5. Developing relevant research topics	4	4	6	4	6	4	4	1	6	6	4	6	6	2.23076923
6. Coordinate research and development	6	6	6	4	4	6	2	4	4	4	6	2	2	2.56410256
7. Avoid duplications	4	6	4	2	6	2	2	4	2	6	2	2	6	3.23076923
8. Stimulate additional private research ar	4	6	2	4	4	4	4	4	4	4	4	4	6	0.97435897
9. Exploit synergies	6	4	6	2	4	4	4	4	4	4	4	4	2	1.33333333
10. Exploit complementarities of scientifi	4	6	6	1	6	4	4	1	1	6	4	1	4	4.23076923
	50	52	48	35	50	44	36	30	35	52	44	28	43	70.5769231 Var
														25.8333333
											Cronbach's coefficient			0.70441013

Reliability test for real estate developers respondents

Analysis of section 5 -Methods to enhance the university - industry relationships

	Respondents response													
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1. R&D incentives and grants	6	4	2	6	6	4	6	6	4	6	2	2	4	2.76923077
2. Performance based funding of universitie	4	6	4	6	6	2	4	6	4	6	4	6	4	1.69230769
3. Country's technological and institutional	4	2	4	4	4	4	4	4	6	6	4	4	4	0.97435897
4. Intellectual property rights management	4	6	2	4	6	6	6	6	4	6	6	2	6	2.41025641
5. Involving government to create specific	6	4	4	4	6	6	6	4	4	6	1	4	6	2.23076923
6. Accelerating contacts between university	6	6	4	6	4	4	4	6	4	4	4	4	4	0.92307692
7. Science parks, spin-offs and business in	4	6	4	4	4	4	6	4	4	6	4	4	6	0.92307692
8. Application of IT to improve the link bet	4	6	4	6	4	4	4	6	6	4	6	2	6	1.69230769
9. Consulting and involving the key stakeho	6	6	6	4	6	6	6	6	4	6	1	6	6	2.23076923
10. Increasing partnership between the res	6	6	6	6	6	6	4	6	2	4	4	1	6	2.97435897
11. Growing emphasis on integrated topics	4	6	4	6	6	6	4	4	6	6	1	4	6	2.30769231
12. Internationalization of competition and	4	4	4	6	4	4	6	4	2	6	2	4	1	2.41025641
13. Education and training	6	6	4	6	4	6	6	6	4	6	4	6	4	1.02564103
14. Globalization and international universit	6	4	6	6	4	6	6	6	4	4	6	4	6	1.02564103
	70	72	58	74	70	68	72	74	58	76	49	53	69	77.4230769 Var
														25.5897436
											Cronbach's coefficient			0.72098029

Reliability test for real estate developers respondents

Analysis of section 6 -Factors which contributes for the less involvement of construction research in the industry

	Respondents response													
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1. Quality of the thesis works and research	4	6	4	4	4	2	2	6	6	6	2	4	6	2.56410256
2. Lack of proper communication and coo	4	6	4	6	6	4	2	4	4	6	4	2	6	2.1025641
3. Accessibility of thesis works and researc	4	4	4	6	6	4	4	4	4	6	4	4	4	0.76923077
4. Duplication of thesis works and researcl	6	4	4	6	6	2	4	6	6	4	2	2	4	2.56410256
5. Lack of knowledge or information of av	6	6	6	4	6	4	4	6	6	6	6	4	6	0.92307692
6. The disconnect between academic resea	4	4	4	4	6	4	4	6	6	6	2	4	4	1.43589744
7. The decreased interest among university	4	4	4	6	4	4	4	6	6	4	4	6	2	1.43589744
8. Industry's diminishing role in basic resea	6	4	4	6	6	6	4	6	4	4	4	2	4	1.58974359
9. Inherent mismatch between the research	4	6	2	6	2	4	4	6	4	2	4	2	6	2.66666667
10. Usual interest of firms in how quickly n	6	2	2	6	6	2	4	4	1	2	1	2	4	3.52564103
11. Difficulties finding contact persons and	4	4	4	4	2	4	1	4	4	2	6	2	6	2.25641026
12. Lack of financial and human resources	4	4	6	4	4	4	6	6	6	6	6	4	6	1.07692308
13. Low interest in technological innovatior	6	4	4	4	2	4	2	6	6	4	2	2	6	2.66666667
	62	58	52	66	60	48	45	70	63	58	47	40	64	83.7564103 Var
														25.5769231
													Cronbach's coefficient	0.75251288

Reliability test for foreign contractors respondents

Analysis of section 2 - General questions

	Respondents response						
	1	2	3	4	5		
1. Trend of using research papers	4	2	1	1	1	1.7	
2. Belief of those research papers have be	4	1	2	2	6	4	
3. Belief of strong university industry rela	4	6	4	6	6	1.2	
4. Importance of advisory committee for t	4	6	6	4	4	1.2	
5. Role of education and research is to ma	6	6	1	4	6	4.8	
6. Collaboration between university indus	6	6	4	4	6	1.2	
7. Industry finds university graduates to b	6	4	1	1	6	6.3	
	34	31	19	22	35	52.7	Var
						20.4	
	Cronbach's coefficient					0.715054	
8. Research needs industry Yes	1	1	1	1	1		
No							
9. Industry needs research Yes	1	1	1	1	1		
No							

Analysis of section 4 - Benefits of university - industry linkages

	Respondents response						
	1	2	3	4	5		
1. Enhancing new technology	6	6	4	4	6	1.2	
2. Solving urgent problems	1	4	2	1	2	1.5	
3. Developing current and future construc	2	4	6	6	4	2.8	
4. Making the industry more competitive	4	6	6	4	6	1.2	
5. Developing relevant research topics	2	6	6	4	2	4	
6. Coordinate research and development	4	6	6	6	6	0.8	
7. Avoid duplications	2	4	4	6	6	2.8	
8. Stimulate additional private research ar	4	6	6	6	4	1.2	
9. Exploit synergies	2	6	6	4	6	3.2	
10. Exploit complementarities of scientifi	6	6	4	6	6	0.8	
	33	54	50	47	48	63.3	Var
						19.5	
	Cronbach's coefficient					0.768826	

Reliability test for foreign contractors respondents

Analysis of section 5 -Methods to enhance the university - industry relationships

	Respondents response						
	1	2	3	4	5		
1. R&D incentives and grants	2	6	6	4	4	2.8	
2. Performance based funding of universitie	2	6	4	4	6	2.8	
3. Country's technological and institutional	2	4	6	6	6	3.2	
4. Intellectual property rights management	6	4	6	6	4	1.2	
5. Involving government to create specific	4	4	6	4	4	0.8	
6. Accelerating contacts between university	4	6	6	4	6	1.2	
7. Science parks, spin-offs and business in	2	6	4	4	6	2.8	
8. Application of IT to improve the link bet	4	6	6	4	6	1.2	
9. Consulting and involving the key stakeho	6	6	6	6	2	3.2	
10. Increasing partnership between the res	2	6	6	6	4	3.2	
11. Growing emphasis on integrated topics	6	4	4	6	6	1.2	
12. Internationalization of competition and	6	6	6	4	6	0.8	
13. Education and training	4	6	6	4	4	1.2	
14. Globalization and international universit	4	6	6	4	6	1.2	
	54	76	78	66	70	91.2	Var
						26.8	
	Cronbach's coefficient					0.760459	

Reliability test for foreign contractors respondents

Analysis of section 6

Factors which contributes for the less involvement of construction research in the industry

	Respondents response						
	1	2	3	4	5		
1. Quality of the thesis works and research	2	2	4	6	6	4	
2. Lack of proper communication and coo	4	4	6	6	4	1.2	
3. Accessibility of thesis works and researc	4	4	6	4	4	0.8	
4. Duplication of thesis works and researcl	4	2	6	6	6	3.2	
5. Lack of knowledge or information of av	4	4	6	4	4	0.8	
6. The disconnect between academic resea	2	2	4	4	6	2.8	
7. The decreased interest among university	2	6	6	6	6	3.2	
8. Industry's diminishing role in basic resea	4	4	6	6	2	2.8	
9. Inherent mismatch between the research	2	4	4	4	6	2	
10. Usual interest of firms in how quickly n	6	6	6	4	6	0.8	
11. Difficulties finding contact persons and	4	2	6	6	6	3.2	
12. Lack of financial and human resources	6	4	6	4	4	1.2	
13. Low interest in technological innovatior	6	6	4	6	6	0.8	
	50	50	70	66	66	92.8	Var
						26.8	
	Cronbach's coefficient					0.770474	

Reliability test for consultants respondents

Analysis of section 2 - General questions

	Respondents response																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1. Trend of using research paper	1	2	2	2	1	1	2	1	1	2	1	1	1	1	2	1	2	2	0.261437908
2. Belief of those research pape	4	2	6	6	4	4	1	2	2	2	6	4	6	4	1	1	1	1	3.794117647
3. Belief of strong university ind	6	6	4	4	6	4	4	6	4	6	6	4	4	4	4	4	1	1	2.352941176
4. Importance of advisory comm	4	2	2	4	4	6	4	6	1	6	4	6	6	4	6	4	1	1	3.467320261
5. Role of education and researc	6	4	4	6	6	4	6	4	4	6	6	6	6	6	4	6	4	6	1.006535948
6. Collaboration between unive	4	1	4	6	4	4	4	6	4	6	6	4	6	4	4	4	1	4	2.183006536
7. Industry finds university grad	4	6	4	4	6	6	4	1	4	6	6	6	6	6	4	4	1	2	2.967320261
	29	23	26	32	31	29	25	26	20	34	35	31	35	29	25	24	11	17	40.30065359 Var
																			16.03267974
														Cronbach's coefficient					0.702535409

8. Research needs industry	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
No																		
9. Industry needs research	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
No																		

Reliability test for consultants respondents

Analysis of section 4 - Benefits of university - industry linkages

	Respondents response																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1. Enhancing new technology	6	6	4	4	4	6	6	6	6	6	6	6	6	2	6	2	6	6	1.947712418
2. Solving urgent problems	4	4	6	6	6	4	4	6	6	4	6	6	4	4	6	4	6	4	1.058823529
3. Developing current and future	6	6	6	6	4	6	4	6	4	4	6	6	4	6	6	4	6	4	1.006535948
4. Making the industry more con	4	6	6	6	4	4	6	4	4	6	6	4	6	2	4	4	4	6	1.477124183
5. Developing relevant research	4	4	6	4	4	4	4	6	2	4	4	4	6	4	6	6	6	6	1.411764706
6. Coordinate research and deve	6	6	6	6	4	6	6	6	4	4	6	6	4	6	6	6	6	4	0.849673203
7. Avoid duplications	4	6	6	6	4	4	6	4	4	6	6	4	6	1	6	6	4	6	1.937908497
8. Stimulate additional private r	4	6	6	4	4	4	4	4	4	4	4	6	6	6	6	2	6	6	1.477124183
9. Exploit synergies	6	4	4	6	2	2	4	6	4	2	6	6	6	2	6	2	6	6	3.08496732
10. Exploit complementarities o	4	4	4	6	1	4	4	6	1	4	6	6	6	4	6	6	4	6	2.614379085
	48	52	54	54	37	44	48	54	39	44	56	54	54	37	58	42	54	54	47.23202614 Var
																			16.86601307
																		Cronbach's coefficient	0.714346118

Reliability test for consultants respondents

Analysis of section 5 -Methods to enhance the university - industry relationships

	Respondents response																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1. R&D incentives and grants	6	6	4	2	6	4	6	2	4	4	2	2	4	6	6	4	6	6	2.614379085
2. Performance based funding of	4	6	6	4	6	4	6	4	2	4	4	4	2	2	2	4	4	6	2.104575163
3. Country's technological and ir	4	4	4	4	6	6	4	4	4	6	1	4	4	4	2	6	4	4	1.676470588
4. Intellectual property rights mar	6	1	4	4	1	4	4	6	4	6	2	4	2	4	2	4	6	4	2.653594771
5. Involving government to creat	6	6	4	4	6	6	6	6	4	6	2	4	4	6	2	4	4	4	1.882352941
6. Accelerating contacts betwee	6	4	6	4	6	6	6	6	4	6	6	2	1	4	2	6	6	4	2.800653595
7. Science parks, spin-offs and b	6	4	6	1	6	4	6	2	2	4	2	4	4	6	2	4	6	6	3.088235294
8. Application of IT to improve t	6	6	6	6	4	6	4	4	6	6	4	6	4	6	6	6	4	6	0.941176471
9. Consulting and involving the k	6	4	6	4	4	4	4	2	6	4	6	2	4	4	4	1	6	6	2.330065359
10. Increasing partnership betwe	4	6	6	4	4	6	6	6	6	6	4	6	6	6	4	6	4	6	0.941176471
11. Growing emphasis on integra	4	6	6	2	6	6	6	6	4	6	6	4	2	4	2	6	4	4	2.352941176
12. Internationalization of compe	4	4	4	2	2	4	6	4	2	4	4	4	2	4	6	6	6	2	2.104575163
13. Education and training	6	6	6	6	4	6	6	6	4	6	4	2	4	4	4	6	6	4	1.529411765
14. Globalization and internation	4	4	4	4	4	6	2	6	4	4	6	4	6	6	2	6	6	4	1.790849673
	72	67	72	51	65	72	72	64	56	72	53	52	49	66	46	69	72	66	85.86928105 Var
																			28.81045752
														Cronbach's coefficient					0.715598909

Reliability test for consultants respondents

Analysis of section 6 -Factors which contributes for the less involvement of construction research in the industry

	Respondents response																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1. Quality of the thesis works an	6	2	4	6	6	6	6	6	6	6	2	2	4	2	4	2	2	4	3.241830065
2. Lack of proper communicatio	4	6	6	6	4	6	6	4	6	6	4	2	2	6	6	6	1	6	2.852941176
3. Accessibility of thesis works a	6	4	4	6	6	6	6	6	4	6	6	6	6	6	2	4	4	4	1.516339869
4. Duplication of thesis works ar	6	4	6	2	4	4	6	6	6	4	2	4	4	4	4	4	6	6	1.790849673
5. Lack of knowledge or informa	4	6	4	4	6	4	4	4	6	6	4	6	4	6	6	6	4	6	1.058823529
6. The disconnect between acad	6	2	6	1	2	4	4	6	6	6	6	2	6	2	2	2	2	6	4.055555556
7. The decreased interest among	6	4	4	2	4	4	2	6	2	4	2	4	4	4	6	4	4	6	1.882352941
8. Industry's diminishing role in b	6	2	6	2	2	6	6	6	2	6	4	4	4	4	2	2	4	4	2.823529412
9. Inherent mismatch between th	6	4	4	2	2	4	6	6	6	6	2	2	6	2	4	2	2	6	3.294117647
10. Usual interest of firms in how	4	4	4	4	4	2	6	4	6	6	4	4	4	4	2	2	2	4	1.633986928
11. Difficulties finding contact pe	4	4	4	4	2	6	2	4	2	4	4	4	6	2	2	4	4	4	1.529411765
12. Lack of financial and human	6	6	6	6	4	6	6	6	6	6	6	4	6	4	6	6	2	4	1.411764706
13. Low interest in technological	6	4	6	4	2	4	2	6	6	4	2	2	6	6	6	1	4	4	3.088235294
	70	52	64	49	48	62	62	70	64	70	48	46	62	52	52	45	41	64	91.15359477 Var
																			30.17973856
														Cronbach's coefficient					0.724656126

Reliability test for local contractors respondents

Analysis of section 2 - General questions

	Respondents response																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. Trend of using research pape	1	1	2	1	2	1	2	1	2	2	2	4	4	1	1	1	4	1	2	1.14035088
2. Belief of those research pape	2	1	2	2	4	4	2	2	2	1	2	2	2	1	2	2	2	1	2	0.66666667
3. Belief of strong university in	1	6	4	6	6	4	4	6	4	2	6	6	1	2	4	6	1	6	4	3.69590643
4. Importance of advisory comr	2	6	4	6	4	6	4	6	4	6	4	6	2	6	4	6	2	6	4	2.24561404
5. Role of education and resear	4	6	4	6	6	6	4	6	4	6	4	6	4	6	6	6	4	6	4	1.02923977
6. Collaboration between unive	4	6	4	6	4	4	4	6	4	6	6	6	2	1	2	6	2	6	4	2.80116959
7. Industry finds university grad	2	6	4	6	6	6	4	6	4	6	4	4	2	6	4	4	2	6	4	2.15204678
	16	32	24	33	32	31	24	33	24	29	28	34	17	23	23	31	17	32	24	34.4502924 Var
																				13.7309942
															Cronbach's coefficient					0.70166355

8. Research needs industry	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
No																				
9. Industry needs research	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
No																				

Reliability test for local contractors respondents

Analysis of section 4 - Benefits of university - industry linkages

	Respondents response																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. Enhancing new technology	4	4	6	6	4	4	6	4	4	4	6	4	6	4	4	6	6	6	6	1.05263158
2. Solving urgent problems	4	6	2	2	6	6	6	1	2	6	4	2	4	4	4	4	2	6	6	3.16374269
3. Developing current and futu	6	6	4	4	2	4	4	4	4	2	6	1	4	4	2	2	4	6	6	2.49707602
4. Making the industry more co	6	4	2	2	6	2	4	6	2	2	2	4	2	4	4	6	2	6	4	2.78362573
5. Developing relevant researc	4	4	6	6	4	4	4	4	2	2	6	4	2	6	4	6	6	4	4	1.89473684
6. Coordinate research and dev	6	6	4	4	4	4	6	6	4	4	4	4	6	6	6	6	6	4	6	1.05263158
7. Avoid duplications	6	6	2	4	1	1	4	2	4	1	2	1	4	4	2	4	1	4	6	3.21052632
8. Stimulate additional private	6	6	2	4	6	4	6	4	2	2	4	1	6	4	4	4	4	4	6	2.47368421
9. Exploit synergies	6	4	6	2	4	4	4	4	4	2	4	2	6	4	6	6	2	6	6	2.33918129
10. Exploit complementarities	6	6	2	2	2	2	4	2	6	4	2	2	6	4	6	6	4	6	6	3.32163743
	54	52	36	36	39	35	48	37	34	29	40	25	46	44	42	50	37	52	56	75.7836257 Var
																				23.7894737
															Cronbach's coefficient					0.76231877

Reliability test for local contractors respondents

Analysis of section 5 -Methods to enhance the university - industry relationships

	Respondents response																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. R&D incentives and grants	6	4	6	6	6	6	6	6	6	6	6	6	4	6	6	6	6	6	6	0.39766082
2. Performance based funding c	4	6	2	6	4	6	6	4	4	4	4	4	2	2	2	4	4	6	6	2.1754386
3. Country's technological and i	6	4	6	2	4	6	6	6	2	4	6	4	2	6	6	6	2	6	6	2.76023392
4. Intellectual property rights ma	4	6	4	2	4	6	2	6	2	6	4	2	4	4	6	4	2	6	6	2.61988304
5. Involving government to crea	6	6	4	6	4	4	2	4	6	6	6	4	1	6	4	6	4	2	6	2.59064327
6. Accelerating contacts betwee	6	6	4	2	4	4	4	2	4	4	2	2	4	4	4	6	2	6	6	2.22222222
7. Science parks, spin-offs and	6	4	2	2	6	4	4	6	2	6	6	6	2	4	6	2	4	4	4	2.61988304
8. Application of IT to improve	4	4	2	6	4	6	2	6	6	6	4	6	6	6	6	6	4	4	6	1.94152047
9. Consulting and involving the l	6	6	4	4	6	2	2	4	4	4	6	2	2	4	4	6	2	4	2	2.43274854
10. Increasing partnership betw	4	6	4	6	6	6	6	4	4	6	6	6	2	6	6	6	6	6	6	1.35672515
11. Growing emphasis on integr	6	4	6	2	4	4	4	4	4	2	4	4	2	4	2	4	6	6	4	1.77777778
12. Internationalization of comp	4	4	4	4	6	4	4	6	6	6	6	2	6	4	6	6	4	6	6	1.49707602
13. Education and training	6	6	6	6	4	6	2	6	2	6	6	6	2	6	6	6	2	4	6	2.83040936
14. Globalization and internatior	4	4	4	4	4	6	2	6	4	4	5	4	2	6	6	6	2	6	6	2.04093567
	72	70	58	58	66	70	52	70	56	70	71	58	41	68	70	74	50	72	76	92.2280702 Var
																				29.2631579
															Cronbach's coefficient					0.73522483

Reliability test for local contractors respondents

Analysis of section 6 -Factors which contributes for the less involvement of construction research in the industry

	Respondents response																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. Quality of the thesis works ar	2	6	4	2	6	4	6	4	2	4	6	6	6	4	6	4	4	4	4	2.03508772
2. Lack of proper communicatio	6	6	6	6	6	6	6	6	4	6	6	4	6	6	4	6	6	6	4	0.70175439
3. Accessibility of thesis works	4	2	4	4	4	6	4	4	4	2	6	1	4	4	2	2	4	4	2	1.81871345
4. Duplication of thesis works a	2	4	6	4	4	6	4	6	2	2	2	4	6	4	4	6	2	6	2	2.66666667
5. Lack of knowledge or inform	2	6	6	6	6	6	6	6	2	6	2	2	6	6	6	6	2	6	4	3.25146199
6. The disconnect between acad	4	4	2	2	4	4	4	6	4	4	4	4	6	4	6	6	2	6	2	1.98830409
7. The decreased interest amon	4	4	6	6	4	6	4	4	2	4	2	4	4	4	6	4	4	6	2	1.73099415
8. Industry's diminishing role in	2	6	4	4	4	4	4	4	2	2	2	4	2	4	6	6	4	4	6	1.98830409
9. Inherent mismatch between t	2	6	6	6	6	6	6	4	2	2	2	2	6	6	6	4	2	6	2	3.67251462
10. Usual interest of firms in hov	4	4	6	4	4	4	6	6	4	4	4	4	6	4	2	4	4	4	4	1.00584795
11. Difficulties finding contact p	4	4	6	6	4	4	2	2	2	2	2	4	4	6	6	4	4	4	2	2.1754386
12. Lack of financial and humar	6	4	6	4	4	4	6	6	6	6	6	4	6	4	6	6	2	4	6	1.49707602
13. Low interest in technologica	4	4	4	4	2	4	2	6	6	4	2	2	6	6	6	1	4	4	6	2.71929825
	46	60	66	58	58	64	60	64	42	48	46	45	68	62	66	59	44	64	46	80.3216374 Var
																				27.251462
															Cronbach's coefficient					0.71578085

Ranking of topic areas by ERA professionals

	Respondents ranking																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Mean
1. Alternate Dispute Resolutio	9	13	12	20	11	2	4	2	13	20	16	22	7	22	14	19	13	24	18	13.737
2. Change orders / Variation	8	19	13	12	3	6	2	15	22	7	6	4	4	8	16	15	12	11	19	10.632
3. Computer systems / Expert s	23	2	16	10	5	8	12	4	10	9	22	10	17	19	20	10	7	16	16	12.421
4. Concrete technology	12	21	18	13	19	20	3	16	3	21	18	23	8	7	15	17	21	8	22	15
5. Constructability	15	23	6	7	15	16	24	17	19	5	7	16	20	20	11	20	20	13	17	15.316
6. Delay and cost overrun	2	18	11	15	2	1	1	3	23	12	1	3	1	2	17	4	11	1	8	7.1579
7. Demolition	16	20	21	23	21	24	16	23	24	19	24	24	24	24	21	23	22	6	24	21
8. Economics / Cost control	3	6	14	8	1	9	6	1	1	6	8	1	9	5	5	9	4	7	13	6.1053
9. Estimating / Bidding	1	5	22	1	4	5	9	5	9	8	15	6	13	9	8	16	9	20	6	9
10. Facility Management	18	16	23	18	17	19	21	24	8	14	21	17	21	16	22	21	19	19	9	18.053
11. Health and safety	4	17	9	9	20	10	11	20	16	22	2	21	2	1	7	14	14	12	11	11.684
12. Industry Overview	22	24	15	19	18	15	20	12	15	24	19	15	12	4	24	24	18	18	10	17.263
13. Insurance	19	11	24	11	9	3	23	19	5	17	20	20	14	3	23	22	8	17	23	15.316
14. Legal/Contracts	10	10	4	3	12	14	17	14	18	18	12	14	15	18	9	13	23	21	2	13
15. Material and equipment ma	20	3	7	24	13	22	10	18	6	23	9	7	10	17	12	3	15	4	4	11.947
16. Performance	21	12	8	17	14	7	19	10	7	1	14	9	16	21	19	5	16	14	5	12.368
17. Price escalation	5	8	17	16	6	4	22	11	12	15	10	8	11	14	13	11	17	15	20	12.368
18. Procurement	11	4	19	4	8	11	18	8	11	4	11	5	19	13	6	12	10	10	12	10.316
19. Productivity	6	1	5	2	10	18	8	7	4	10	5	2	3	12	3	1	1	2	3	5.4211
20. Quality Management	17	22	20	14	23	13	5	22	14	13	17	19	23	23	18	7	5	5	21	15.842
21. Risk management	24	9	10	5	16	12	15	13	17	3	3	13	5	11	4	6	6	3	14	9.9474
22. Scheduling	7	14	3	6	7	21	14	21	2	16	13	11	6	6	10	2	2	23	1	9.7368
23. Sustainability	14	15	2	21	22	17	13	6	20	11	23	12	22	15	2	18	24	22	15	15.474
24. Technology/Innovation	13	7	1	22	24	23	7	9	21	2	4	18	18	10	1	8	3	9	7	10.895
	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	

Ranking of topic areas by ERA professionals

Rank	Topic	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Mean
1	19	6	1	5	2	10	18	8	7	4	10	5	2	3	12	3	1	1	2	3	5.4211
2	8	3	6	14	8	1	9	6	1	1	6	8	1	9	5	5	9	4	7	13	6.1053
3	6	2	18	11	15	2	1	1	3	23	12	1	3	1	2	17	4	11	1	8	7.1579
4	9	1	5	22	1	4	5	9	5	9	8	15	6	13	9	8	16	9	20	6	9
5	22	7	14	3	6	7	21	14	21	2	16	13	11	6	6	10	2	2	23	1	9.7368
6	21	24	9	10	5	16	12	15	13	17	3	3	13	5	11	4	6	6	3	14	9.9474
7	18	11	4	19	4	8	11	18	8	11	4	11	5	19	13	6	12	10	10	12	10.316
8	2	8	19	13	12	3	6	2	15	22	7	6	4	4	8	16	15	12	11	19	10.632
9	24	13	7	1	22	24	23	7	9	21	2	4	18	18	10	1	8	3	9	7	10.895
10	11	4	17	9	9	20	10	11	20	16	22	2	21	2	1	7	14	14	12	11	11.684
11	15	20	3	7	24	13	22	10	18	6	23	9	7	10	17	12	3	15	4	4	11.947
12	16	21	12	8	17	14	7	19	10	7	1	14	9	16	21	19	5	16	14	5	12.368
13	17	5	8	17	16	6	4	22	11	12	15	10	8	11	14	13	11	17	15	20	12.368
14	3	23	2	16	10	5	8	12	4	10	9	22	10	17	19	20	10	7	16	16	12.421
15	14	10	10	4	3	12	14	17	14	18	18	12	14	15	18	9	13	23	21	2	13
16	1	9	13	12	20	11	2	4	2	13	20	16	22	7	22	14	19	13	24	18	13.737
17	4	12	21	18	13	19	20	3	16	3	21	18	23	8	7	15	17	21	8	22	15
18	5	15	23	6	7	15	16	24	17	19	5	7	16	20	20	11	20	20	13	17	15.316
19	13	19	11	24	11	9	3	23	19	5	17	20	20	14	3	23	22	8	17	23	15.316
20	23	14	15	2	21	22	17	13	6	20	11	23	12	22	15	2	18	24	22	15	15.474
21	20	17	22	20	14	23	13	5	22	14	13	17	19	23	23	18	7	5	5	21	15.842
22	12	22	24	15	19	18	15	20	12	15	24	19	15	12	4	24	24	18	18	10	17.263
23	10	18	16	23	18	17	19	21	24	8	14	21	17	21	16	22	21	19	19	9	18.053
24	7	16	20	21	23	21	24	16	23	24	19	24	24	24	24	21	23	22	6	24	21
		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	

Ranking of topic areas by AACRA professionals

		Respondents ranking																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Mean
	1. Alternate Dispute R	15	22	11	10	16	11	16	17	19	15	16	15	7	2	8	19	13.6875
	2. Change orders / Va	1	3	5	9	1	1	4	7	3	1	5	8	3	3	7	11	4.5
	3. Computer systems	10	9	15	13	8	7	7	2	22	14	15	1	12	9	15	9	10.5
	4. Concrete technolog	19	4	6	22	21	24	19	23	17	24	6	23	24	4	22	22	17.5
	5. Constructability	12	5	12	23	9	18	21	18	13	23	12	18	21	5	23	13	15.375
Topic	6. Delay and cost over	2	6	3	8	2	3	1	4	7	2	3	4	1	6	10	8	4.375
areas	7. Demolition	13	24	13	24	17	21	22	24	24	17	13	24	20	21	24	24	20.3125
	8. Economics / Cost co	14	7	4	12	3	5	10	1	14	4	4	2	2	7	12	3	6.5
	9. Estimating / Bidding	3	1	2	4	5	10	5	14	2	6	2	14	4	1	5	4	5.125
	10. Facility Manageme	16	8	16	5	20	22	9	10	6	7	11	10	15	8	4	18	11.5625
	11. Health and safety	23	21	7	7	23	9	13	20	21	22	7	20	22	24	9	20	16.75
	12. Industry Overview	22	20	20	20	24	23	24	22	23	18	20	19	23	20	20	21	21.1875
	13. Insurance	21	19	14	11	22	15	17	11	10	12	14	11	16	19	11	15	14.875
	14. Legal/Contracts	8	12	10	17	10	19	14	21	12	21	10	21	19	17	16	17	15.25
	15. Material and equi	4	10	18	16	15	16	3	6	15	5	18	6	13	10	17	5	11.0625
	16. Performance	5	11	8	15	18	17	23	16	5	10	8	16	5	11	13	6	11.6875
	17. Price escalation	6	18	21	6	7	4	6	12	4	13	21	12	6	18	6	2	10.125
	18. Procurement	18	2	19	3	11	8	15	15	20	11	19	17	11	22	3	16	13.125
	19. Productivity	7	13	9	1	12	2	2	3	1	9	9	3	8	13	2	1	5.9375
	20. Quality Manageme	20	23	1	21	4	6	18	13	11	20	1	13	17	23	21	23	14.6875
	21. Risk management	24	17	23	2	14	14	11	8	9	8	23	7	14	12	1	10	12.3125
	22. Scheduling	11	14	17	18	19	20	12	5	16	19	17	5	9	14	18	12	14.125
	23. Sustainability	17	16	24	19	13	12	20	19	18	16	24	22	18	16	19	14	17.9375
	24. Technology/Innov	9	15	22	14	6	13	8	9	8	3	22	9	10	15	14	7	11.5
		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	

Ranking of topic areas by AACRA professionals

Rank	Topic	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Mean
1	6	2	6	3	8	2	3	1	4	7	2	3	4	1	6	10	8	4.375
2	2	1	3	5	9	1	1	4	7	3	1	5	8	3	3	7	11	4.5
3	9	3	1	2	4	5	10	5	14	2	6	2	14	4	1	5	4	5.125
4	19	7	13	9	1	12	2	2	3	1	9	9	3	8	13	2	1	5.9375
5	8	14	7	4	12	3	5	10	1	14	4	4	2	2	7	12	3	6.5
6	17	6	18	21	6	7	4	6	12	4	13	21	12	6	18	6	2	10.125
7	3	10	9	15	13	8	7	7	2	22	14	15	1	12	9	15	9	10.5
8	15	4	10	18	16	15	16	3	6	15	5	18	6	13	10	17	5	11.0625
9	24	9	15	22	14	6	13	8	9	8	3	22	9	10	15	14	7	11.5
10	10	16	8	16	5	20	22	9	10	6	7	11	10	15	8	4	18	11.5625
11	16	5	11	8	15	18	17	23	16	5	10	8	16	5	11	13	6	11.6875
12	21	24	17	23	2	14	14	11	8	9	8	23	7	14	12	1	10	12.3125
13	18	18	2	19	3	11	8	15	15	20	11	19	17	11	22	3	16	13.125
14	1	15	22	11	10	16	11	16	17	19	15	16	15	7	2	8	19	13.6875
15	22	11	14	17	18	19	20	12	5	16	19	17	5	9	14	18	12	14.125
16	20	20	23	1	21	4	6	18	13	11	20	1	13	17	23	21	23	14.6875
17	13	21	19	14	11	22	15	17	11	10	12	14	11	16	19	11	15	14.875
18	14	8	12	10	17	10	19	14	21	12	21	10	21	19	17	16	17	15.25
19	5	12	5	12	23	9	18	21	18	13	23	12	18	21	5	23	13	15.375
20	11	23	21	7	7	23	9	13	20	21	22	7	20	22	24	9	20	16.75
21	4	19	4	6	22	21	24	19	23	17	24	6	23	24	4	22	22	17.5
22	23	17	16	24	19	13	12	20	19	18	16	24	22	18	16	19	14	17.9375
23	7	13	24	13	24	17	21	22	24	24	17	13	24	20	21	24	24	20.3125
24	12	22	20	20	20	24	23	24	22	23	18	20	19	23	20	20	21	21.1875
		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	

Ranking of topic areas by real estate developers professionals

		Respondents ranking													
		1	2	3	4	5	6	7	8	9	10	11	12	13	Mean
	1. Alternate Dispute Resolutio	18	24	23	11	22	16	11	10	12	23	13	20	10	16.38462
	2. Change orders / Variation	15	11	16	12	18	13	4	18	9	3	8	12	8	11.30769
	3. Computer systems / Expert	10	19	3	7	5	8	9	3	4	4	1	6	1	6.153846
	4. Concrete technology	3	13	2	13	1	12	16	5	21	22	19	11	22	12.30769
	5. Constructability	9	5	4	4	2	9	6	9	1	2	3	7	2	4.846154
Topic	6. Delay and cost overrun	8	4	5	14	3	2	10	2	15	16	4	2	3	6.769231
areas	7. Demolition	24	23	22	8	23	5	21	22	18	21	23	5	18	17.92308
	8. Economics / Cost control	2	1	10	1	10	4	3	19	2	14	6	4	4	6.153846
	9. Estimating / Bidding	19	17	14	2	14	3	15	13	8	13	12	3	9	10.92308
	10. Facility Management	20	10	17	23	17	20	23	23	10	12	14	13	17	16.84615
	11. Health and safety	17	14	19	10	19	19	22	17	23	20	24	21	24	19.15385
	12. Industry Overview	23	22	21	20	21	23	24	21	17	15	22	19	23	20.84615
	13. Insurance	14	21	20	16	24	11	19	20	24	17	15	14	12	17.46154
	14. Legal/Contracts	6	12	13	19	7	22	13	14	20	5	16	22	16	14.23077
	15. Material and equipment m	1	8	11	5	6	7	1	6	11	7	2	9	15	6.846154
	16. Performance	7	9	1	17	4	15	18	4	14	6	18	15	13	10.84615
	17. Price escalation	5	3	8	9	11	6	5	1	13	1	7	1	14	6.461538
	18. Procurement	13	7	6	24	8	10	14	11	16	18	17	18	19	13.92308
	19. Productivity	16	18	15	3	15	14	2	16	3	9	5	23	11	11.53846
	20. Quality Management	22	16	18	21	16	21	20	24	22	10	11	24	21	18.92308
	21. Risk management	12	6	7	18	13	17	7	12	19	11	9	10	20	12.38462
	22. Scheduling	11	15	12	15	9	18	8	7	7	19	20	17	6	12.61538
	23. Sustainability	21	20	24	22	20	24	17	15	6	24	21	16	5	18.07692
	24. Technology/Innovation	4	2	9	6	12	1	12	8	5	8	10	8	7	7.076923
		300	300	300	300	300	300	300	300	300	300	300	300	300	

Ranking of topic areas by real estate developers professionals

Rank	Topic	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean
1	5	9	5	4	4	2	9	6	9	1	2	3	7	2	4.846154
2	8	2	1	10	1	10	4	3	19	2	14	6	4	4	6.153846
3	3	10	19	3	7	5	8	9	3	4	4	1	6	1	6.153846
4	17	5	3	8	9	11	6	5	1	13	1	7	1	14	6.461538
5	6	8	4	5	14	3	2	10	2	15	16	4	2	3	6.769231
6	15	1	8	11	5	6	7	1	6	11	7	2	9	15	6.846154
7	24	4	2	9	6	12	1	12	8	5	8	10	8	7	7.076923
8	16	7	9	1	17	4	15	18	4	14	6	18	15	13	10.84615
9	9	19	17	14	2	14	3	15	13	8	13	12	3	9	10.92308
10	2	15	11	16	12	18	13	4	18	9	3	8	12	8	11.30769
11	19	16	18	15	3	15	14	2	16	3	9	5	23	11	11.53846
12	4	3	13	2	13	1	12	16	5	21	22	19	11	22	12.30769
13	21	12	6	7	18	13	17	7	12	19	11	9	10	20	12.38462
14	22	11	15	12	15	9	18	8	7	7	19	20	17	6	12.61538
15	18	13	7	6	24	8	10	14	11	16	18	17	18	19	13.92308
16	14	6	12	13	19	7	22	13	14	20	5	16	22	16	14.23077
17	1	18	24	23	11	22	16	11	10	12	23	13	20	10	16.38462
18	10	20	10	17	23	17	20	23	23	10	12	14	13	17	16.84615
19	13	14	21	20	16	24	11	19	20	24	17	15	14	12	17.46154
20	7	24	23	22	8	23	5	21	22	18	21	23	5	18	17.92308
21	23	21	20	24	22	20	24	17	15	6	24	21	16	5	18.07692
22	20	22	16	18	21	16	21	20	24	22	10	11	24	21	18.92308
23	11	17	14	19	10	19	19	22	17	23	20	24	21	24	19.15385
24	12	23	22	21	20	21	23	24	21	17	15	22	19	23	20.84615
		300	300	300	300	300	300	300	300	300	300	300	300	300	

Ranking of topic areas by foreign contractor professionals

		Respondents ranking					
		1	2	3	4	5	Mean
	1. Alternate Dispute Resolution	19	15	11	7	5	11.4
	2. Change orders / Variation	24	8	10	22	10	14.8
	3. Computer systems / Expert sys	22	5	15	8	6	11.2
	4. Concrete technology	11	21	19	23	20	18.8
	5. Constructability	3	20	1	6	4	6.8
Topic	6. Delay and cost overrun	7	10	18	14	21	14
areas	7. Demolition	20	23	17	15	12	17.4
	8. Economics / Cost control	2	9	16	3	22	10.4
	9. Estimating / Bidding	18	11	22	1	13	13
	10. Facility Management	8	1	8	4	15	7.2
	11. Health and safety	1	2	7	12	14	7.2
	12. Industry Overview	23	24	23	24	24	23.6
	13. Insurance	17	6	6	13	18	12
	14. Legal/Contracts	13	17	20	9	7	13.2
	15. Material and equipment man	12	12	14	20	23	16.2
	16. Performance	6	16	21	10	9	12.4
	17. Price escalation	9	13	12	19	17	14
	18. Procurement	21	22	24	21	19	21.4
	19. Productivity	4	14	13	16	1	9.6
	20. Quality Management	16	7	2	5	11	8.2
	21. Risk management	10	19	3	17	2	10.2
	22. Scheduling	5	18	4	11	16	10.8
	23. Sustainability	15	3	9	18	8	10.6
	24. Technology/Innovation	14	4	5	2	3	5.6
		300	300	300	300	300	

Ranking of topic areas by foreign contractor professionals

Rank	Topic	1	2	3	4	5	Mean
1	24	14	4	5	2	3	5.6
2	5	3	20	1	6	4	6.8
3	10	8	1	8	4	15	7.2
4	11	1	2	7	12	14	7.2
5	20	16	7	2	5	11	8.2
6	19	4	14	13	16	1	9.6
7	21	10	19	3	17	2	10.2
8	8	2	9	16	3	22	10.4
9	23	15	3	9	18	8	10.6
10	22	5	18	4	11	16	10.8
11	3	22	5	15	8	6	11.2
12	1	19	15	11	7	5	11.4
13	13	17	6	6	13	18	12
14	16	6	16	21	10	9	12.4
15	9	18	11	22	1	13	13
16	14	13	17	20	9	7	13.2
17	6	7	10	18	14	21	14
18	17	9	13	12	19	17	14
19	2	24	8	10	22	10	14.8
20	15	12	12	14	20	23	16.2
21	7	20	23	17	15	12	17.4
22	4	11	21	19	23	20	18.8
23	18	21	22	24	21	19	21.4
24	12	23	24	23	24	24	23.6
		300	300	300	300	300	

Ranking of topic areas by consultant professionals

		Respondents ranking																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Mean
	1. Alternate Dispute Resolut	22	3	11	6	22	6	9	11	16	16	15	18	7	5	4	13	10	8	11.22
	2. Change orders / Variation	19	5	4	22	23	7	10	12	4	19	4	15	4	14	11	19	18	10	12.22
	3. Computer systems / Exper	23	13	9	8	13	5	2	1	7	12	14	10	17	4	9	2	3	3	8.611
	4. Concrete technology	7	6	16	23	21	23	16	17	19	14	16	3	8	23	20	21	5	20	15.44
	5. Constructability	1	2	6	7	19	16	13	20	21	15	19	16	20	18	6	23	16	19	14.28
Topic	6. Delay and cost overrun	15	7	10	14	14	17	12	16	1	7	1	8	1	19	17	18	2	16	10.83
areas	7. Demolition	11	4	21	15	24	24	24	21	22	23	23	24	24	20	16	20	22	21	19.94
	8. Economics / Cost control	20	8	3	3	12	22	11	19	10	6	3	2	9	22	3	6	19	17	10.83
	9. Estimating / Bidding	17	20	15	1	15	1	3	2	5	11	13	19	13	2	15	5	13	1	9.5
	10. Facility Management	2	15	1	20	3	19	19	23	3	9	6	1	10	21	1	3	6	23	10.28
	11. Health and safety	24	10	22	12	5	4	17	5	13	5	2	17	2	9	22	17	17	7	11.67
	12. Industry Overview	12	12	24	24	18	20	23	24	24	17	24	23	12	24	24	24	21	22	20.67
	13. Insurance	16	11	19	13	6	14	18	9	17	22	21	14	14	3	19	11	20	6	14.06
	14. Legal/Contracts	9	17	13	9	7	12	20	10	14	4	12	6	15	15	14	10	14	13	11.89
	15. Material and equipment	10	9	23	4	8	21	1	15	9	10	5	20	21	16	23	16	23	18	14
	16. Performance	5	14	18	10	2	13	21	14	23	8	7	7	16	11	13	12	4	14	11.78
	17. Price escalation	18	19	5	19	16	11	8	8	6	21	8	5	11	10	5	8	1	11	10.56
	18. Procurement	21	24	14	21	17	15	22	22	15	24	9	13	19	17	18	4	11	24	17.22
	19. Productivity	3	16	2	16	4	9	7	4	2	3	10	9	3	6	2	1	9	2	6
	20. Quality Management	6	1	20	5	20	18	15	6	18	20	20	22	23	7	21	22	24	9	15.39
	21. Risk management	13	22	7	17	9	10	14	18	11	13	18	12	5	12	7	9	12	15	12.44
	22. Scheduling	8	18	8	11	1	2	4	13	12	1	11	11	6	13	8	14	7	12	8.889
	23. Sustainability	14	23	17	18	11	3	6	7	20	18	17	21	22	8	10	15	15	5	13.89
	24. Technology/Innovation	4	21	12	2	10	8	5	3	8	2	22	4	18	1	12	7	8	4	8.389
		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	

Ranking of topic areas by consultant professionals

Rank	Topic	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Mean
1	19	3	16	2	16	4	9	7	4	2	3	10	9	3	6	2	1	9	2	6
2	24	4	21	12	2	10	8	5	3	8	2	22	4	18	1	12	7	8	4	8.389
3	3	23	13	9	8	13	5	2	1	7	12	14	10	17	4	9	2	3	3	8.611
4	22	8	18	8	11	1	2	4	13	12	1	11	11	6	13	8	14	7	12	8.889
5	9	17	20	15	1	15	1	3	2	5	11	13	19	13	2	15	5	13	1	9.5
6	10	2	15	1	20	3	19	19	23	3	9	6	1	10	21	1	3	6	23	10.28
7	17	18	19	5	19	16	11	8	8	6	21	8	5	11	10	5	8	1	11	10.56
8	6	15	7	10	14	14	17	12	16	1	7	1	8	1	19	17	18	2	16	10.83
9	8	20	8	3	3	12	22	11	19	10	6	3	2	9	22	3	6	19	17	10.83
10	1	22	3	11	6	22	6	9	11	16	16	15	18	7	5	4	13	10	8	11.22
11	11	24	10	22	12	5	4	17	5	13	5	2	17	2	9	22	17	17	7	11.67
12	16	5	14	18	10	2	13	21	14	23	8	7	7	16	11	13	12	4	14	11.78
13	14	9	17	13	9	7	12	20	10	14	4	12	6	15	15	14	10	14	13	11.89
14	2	19	5	4	22	23	7	10	12	4	19	4	15	4	14	11	19	18	10	12.22
15	21	13	22	7	17	9	10	14	18	11	13	18	12	5	12	7	9	12	15	12.44
16	23	14	23	17	18	11	3	6	7	20	18	17	21	22	8	10	15	15	5	13.89
17	15	10	9	23	4	8	21	1	15	9	10	5	20	21	16	23	16	23	18	14
18	13	16	11	19	13	6	14	18	9	17	22	21	14	14	3	19	11	20	6	14.06
19	5	1	2	6	7	19	16	13	20	21	15	19	16	20	18	6	23	16	19	14.28
20	20	6	1	20	5	20	18	15	6	18	20	20	22	23	7	21	22	24	9	15.39
21	4	7	6	16	23	21	23	16	17	19	14	16	3	8	23	20	21	5	20	15.44
22	18	21	24	14	21	17	15	22	22	15	24	9	13	19	17	18	4	11	24	17.22
23	7	11	4	21	15	24	24	24	21	22	23	23	24	24	20	16	20	22	21	19.94
24	12	12	12	24	24	18	20	23	24	24	17	24	23	12	24	24	24	21	22	20.67
		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	

Ranking of topic areas by local contractor professionals

		Respondents ranking																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Mean
	1. Alternate Dispute Resoluti	5	20	1	20	24	13	22	16	11	10	12	23	14	20	2	11	22	9	3	13.58
	2. Change orders / Variation	22	16	9	2	15	14	18	13	4	18	9	3	17	12	7	12	18	8	13	12.11
	3. Computer systems / Expert	15	9	10	10	9	12	5	8	9	3	4	4	19	6	16	7	5	23	16	10
	4. Concrete technology	10	12	16	19	6	5	1	12	16	5	21	22	13	11	20	13	1	4	6	11.21
	5. Constructability	6	13	2	17	16	19	15	14	2	16	3	9	1	23	4	3	15	15	1	10.21
Topic	6. Delay and cost overrun	7	14	6	1	17	15	3	2	10	2	15	16	24	2	3	14	3	2	14	8.947
areas	7. Demolition	11	24	12	24	23	16	23	5	21	22	18	21	16	5	10	8	23	16	12	16.32
	8. Economics / Cost control	8	15	15	16	7	3	10	4	3	19	2	14	15	4	11	1	10	3	19	9.421
	9. Estimating / Bidding	12	10	8	15	10	4	14	3	15	13	8	13	2	3	9	2	14	1	7	8.579
	10. Facility Management	3	19	14	23	11	6	17	20	23	23	10	12	11	13	12	23	17	18	11	15.05
	11. Health and safety	1	2	3	8	1	9	19	19	22	17	23	20	12	21	23	10	19	12	4	12.89
	12. Industry Overview	16	23	5	9	12	24	21	23	24	21	17	15	23	19	14	20	21	22	5	17.58
	13. Insurance	14	4	11	22	2	8	24	11	19	20	24	17	10	14	15	16	24	19	20	15.47
	14. Legal/Contracts	24	21	22	5	21	2	7	22	13	14	20	5	3	22	17	19	7	10	23	14.58
	15. Material and equipment r	4	5	13	12	13	18	6	7	1	6	6	7	18	9	21	5	6	14	2	9.105
	16. Performance	2	11	19	11	19	7	4	15	18	4	14	6	4	15	24	17	4	21	18	12.26
	17. Price escalation	13	17	17	13	18	17	11	6	5	1	13	1	20	1	8	9	11	5	22	10.95
	18. Procurement	21	6	20	6	22	11	8	10	14	11	16	18	21	18	13	24	8	11	17	14.47
	19. Productivity	9	1	4	21	14	23	16	21	20	24	22	10	5	24	1	21	16	17	8	14.58
	20. Quality Management	18	7	18	3	3	1	2	9	6	9	1	2	9	7	22	4	2	6	15	7.579
	21. Risk management	17	22	7	4	4	10	13	17	7	12	19	11	8	10	5	18	13	24	21	12.74
	22. Scheduling	19	8	24	7	5	20	9	18	8	7	7	19	7	17	18	15	9	7	10	12.32
	23. Sustainability	20	18	21	18	20	21	20	24	17	15	11	24	22	16	19	22	20	20	9	18.79
	24. Technology/Innovation	23	3	23	14	8	22	12	1	12	8	5	8	6	8	6	6	12	13	24	11.26
		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	

Ranking of topic areas by local contractor professionals

Rank	Topic	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Mean
1	20	18	7	18	3	3	1	2	9	6	9	1	2	9	7	22	4	2	6	15	7.579
2	9	12	10	8	15	10	4	14	3	15	13	8	13	2	3	9	2	14	1	7	8.579
3	6	7	14	6	1	17	15	3	2	10	2	15	16	24	2	3	14	3	2	14	8.947
4	15	4	5	13	12	13	18	6	7	1	6	6	7	18	9	21	5	6	14	2	9.105
5	8	8	15	15	16	7	3	10	4	3	19	2	14	15	4	11	1	10	3	19	9.421
6	3	15	9	10	10	9	12	5	8	9	3	4	4	19	6	16	7	5	23	16	10
7	5	6	13	2	17	16	19	15	14	2	16	3	9	1	23	4	3	15	15	1	10.21
8	17	13	17	17	13	18	17	11	6	5	1	13	1	20	1	8	9	11	5	22	10.95
9	4	10	12	16	19	6	5	1	12	16	5	21	22	13	11	20	13	1	4	6	11.21
10	24	23	3	23	14	8	22	12	1	12	8	5	8	6	8	6	6	12	13	24	11.26
11	2	22	16	9	2	15	14	18	13	4	18	9	3	17	12	7	12	18	8	13	12.11
12	16	2	11	19	11	19	7	4	15	18	4	14	6	4	15	24	17	4	21	18	12.26
13	22	19	8	24	7	5	20	9	18	8	7	7	19	7	17	18	15	9	7	10	12.32
14	21	17	22	7	4	4	10	13	17	7	12	19	11	8	10	5	18	13	24	21	12.74
15	11	1	2	3	8	1	9	19	19	22	17	23	20	12	21	23	10	19	12	4	12.89
16	1	5	20	1	20	24	13	22	16	11	10	12	23	14	20	2	11	22	9	3	13.58
17	18	21	6	20	6	22	11	8	10	14	11	16	18	21	18	13	24	8	11	17	14.47
18	14	24	21	22	5	21	2	7	22	13	14	20	5	3	22	17	19	7	10	23	14.58
19	19	9	1	4	21	14	23	16	21	20	24	22	10	5	24	1	21	16	17	8	14.58
20	10	3	19	14	23	11	6	17	20	23	23	10	12	11	13	12	23	17	18	11	15.05
21	13	14	4	11	22	2	8	24	11	19	20	24	17	10	14	15	16	24	19	20	15.47
22	7	11	24	12	24	23	16	23	5	21	22	18	21	16	5	10	8	23	16	12	16.32
23	12	16	23	5	9	12	24	21	23	24	21	17	15	23	19	14	20	21	22	5	17.58
24	23	20	18	21	18	20	21	20	24	17	15	11	24	22	16	19	22	20	20	9	18.79
		300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	

All industry rankings and result of Pearson correlation test

300		300	300	300	300	300	300	300	271
Topic	Research ra	ERA rank	AACRA ra	Real estat	Foreign co	Consultan	Local cont	All sector	Research rank
1	19	16	14	17	12	10	16	14	19
2	5	8	2	10	19	14	11	7	5
3	10	14	7	3	11	3	6	6	10
4	1	17	21	12	22	21	9	20	1
5	3	18	19	1	2	19	7	13	3
6	10	3	1	5	17	8	3	2	10
7	23	24	23	20	21	23	22	23	23
8	10	2	5	2	8	9	5	1	10
9	10	4	3	9	15	5	2	4	10
10	19	23	10	18	3	6	20	18	19
11	23	10	20	23	4	11	15	15	23
12	2	22	24	24	24	24	23	24	2
13	19	19	17	19	13	18	21	21	19
14	5	15	18	16	16	13	18	16	5
15	16	11	8	6	20	17	4	9	16
16	5	12	11	8	14	12	12	12	5
17	10	13	6	4	18	7	8	8	10
18	4	7	13	15	23	22	17	19	4
19	16	1	4	11	6	1	19	3	16
20	10	21	16	22	5	20	1	17	10
21	8	6	12	13	7	15	14	11	8
22	8	5	15	14	10	4	13	10	8
23	19	20	22	21	9	16	24	22	19
24	16	9	9	7	1	2	10	5	16

	Pearson coefficent
ERA	0.172119
AACRA	0.057982
RE	0.33739
FC	-0.35474
CO	-0.23238
LC	0.315476
ALL	0.081722