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The Current State of Research and Development Approach (R&D) in the Saudi Construction Industry

Yasir Alhammadi^{a*}, Mohammed Algahtany^b, Dean Kashiwagi^c, Kenneth Sullivan^d,
Jacob Kashiwagi^e,

^{ab}M.S., School of Sustainable Engineering and the Built Environment, Arizona State University at Tempe, 660 S College Ave., Tempe, AZ 85281, United States

^cProfessor, P.E., School of Sustainable Engineering and the Built Environment, Arizona State University at Tempe, 660 S College Ave., Tempe, AZ 85281, United States

^dProfessor., School of Sustainable Engineering and the Built Environment, Arizona State University at Tempe, 660 S College Ave., Tempe, AZ 85281, United States

^eAssistant Research Professor, School of Sustainable Engineering and the Built Environment, Arizona State University at Tempe, 660 S College Ave., Tempe, AZ 85281, United States

Abstract

For the past three decades, the Saudi construction industry (SCI) has exhibited poor performance. Many research efforts have tried to identify the problem and the potential causes but there have been few publications identifying ways to mitigate the problem and describing testing to validate the proposed solution. This paper examines the research and development (R&D) approach in the SCI. A literature research was performed identifying the impact that R&D has had on the SCI. A questionnaire was also created for surveying industry professionals and researchers. The results show evidence that the SCI practice and the academic research work exist in separate silos. This study recommends a change of mindset in both the public and private sector on their views on R&D since cooperation is required to create collaboration between the two sectors and improve the competitiveness of the country's economy.

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* Corresponding author.

E-mail address: yalhamma@asu.edu

1. Introduction

In many countries, more attention is being given to innovation in the construction industry. The decision makers, researchers, government analysts and industry professionals are all engaged in observing new and updated innovations [1]. A paper, *The ABC of R&D*, written by David Novick in 1965 from the RAND Corporation states that “We should stop talking about research and development as though they were an entity and examine research on its own and development as a separate and distinct activity” [2]. Research and experimental development (R&D), technology purchase, commercialization of products and knowledge transfer and generation are all part of innovation activities. For developing nations, emerging economies and industrialized nations, the R&D statistics are found to be an essential tool for policy planning. For national development and economic competitiveness, it becomes necessary to perform, contract, measure and accomplish the R&D activities. The following are the reasons for this activity [3]:

- Using transfer of technology, it is possible to include various kinds of technologies within R&D.
- Local perspectives and solutions are to be developed for local development issues. Knowledge systems must be included as the technological solutions are mostly socially and culturally adopted. The R&D can be used to bring forward innovation if it integrates with the knowledge systems since they are culturally sensitive and require guidance.
- Development also requires highly qualified personnel. Higher Education Institutions (HEI) must use human resources to train them efficiently. For higher education quality, R&D and HEI are essential.

In Saudi Arabia, the petroleum industry is the largest contributor to its gross domestic production (GDP) followed by the building and construction sector [4]. The government spending on infrastructure was \$574.7 billion from 2008 to 2013 indicating that the construction industry has experienced a boom period [5]. However, in the last 30 years, the performance of the SCI has been poor. The issues of the industry have been highlighted by various research studies [6, 7, 8, 9, 10].

2. Research aim and objectives

One objective of the Ninth Development Plan (2010 to 2015) issued by the Saudi ministry of Economy and Planning is to encourage R&D and innovation through developing and upgrading the capacities of existing research centers. Therefore, the aim of this paper is to investigate the current research and development statues in Saudi Arabia in the field of construction and find if the research efforts have helped increase the construction industry’s performance. Based on the findings, this study will recommend solutions that may help the Saudi R & D improve SCI’s performance.

3. Research methodology

The methodology in this research is literature review and survey based. The methodology will proceed in the following steps:

- Conduct a literature review to identify the success level of R & D in the construction industry.
- Search the existing R & D approach in the SCI. In this step, the authors will review the existing academic papers published in the construction industry in Saudi Arabia in order to identify the level of success of existing R&D.
- Surveying researchers and industry professionals in SCI will be surveyed. In this step, the opinion of researchers and industry professionals will be identified regarding the SCI’s existing R&D approach.

4. Research and development in construction industry

The construction industry’s low performance levels is not only an issue in Saudi Arabia but, according to the literature, is widespread in both developed and developing nations. Many research studies show how delay and cost

overrun constraints with low customer satisfaction have affected the construction projects [11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24].

To enhance the profits, efficiency and competitiveness of the construction industry, it is essential to adopt effective R&D practices [25]. Because there is limited R & D, construction performance has not improved. Currently, there is no impact measurement of the existing academic research on the industry, and it rarely repeats prototype testing of the proposed solutions on actual industry projects. Research success of an academic unit is measured by alliances with other research institutions, PhD student number, referred research paper amount, number of faculty accomplishing the research, research funding. This long term view has dissatisfied the industry [26]. Therefore, the literature review supports the idea that few studies have impact on the real construction projects or have helped the industry performance improve. Research reports mentioned below have highlighted the issues subjected upon the construction industry.

- The issue has been endorsed in research by Graham in which he states that the research studies are unable to support and assist the construction industries of the nation [27]. The needs of the industry and the information presented in the journals are not aligned and this fact was stated after a thorough analysis of 607 research publications. It is also stated that after historically reviewing the literature, it can be confirmed that the construction industry's development has not been assisted by research.
- The National Academy of Sciences (NAS) in the United States of America (USA) stated that the construction industry of this nation does not have a research agenda which covers the industry at large [28]. It is unable to identify those research areas that would be most beneficial and would enhance industry performance in terms of efficiency, productivity and competitiveness.
- Within the Pakistani context, there is no professional body in construction business that has significant data on the demands and prevailing market trends. Also both the private and public sectors lack a proper research organization, which may establish the existing and upcoming market needs to cover the gap. This particular industry cannot achieve its extreme potential with such a lack of constructive feedback and research. Subsequently, with the help of personal interviews and questionnaires, researchers are to evaluate the demands and needs of the industry. This, however, might be difficult because of the personal exposures and interests of an individual [29].
- According to Al-sehaimi, the problem solving mechanism found in the studies is reportedly weak since it cannot address the issues recently discovered. Many other research studies report the same reasons of delay [30]. However, according to the recommendations of several authors, the situation cannot be improved based on the lack of pragmatic methods or effective solutions.
- In their 2007 study, Gue and Chow described how, aside from the Malaysian private sector's contribution in financial year 2001-02 to R&D, the construction industry has demonstrated small contribution, which has brought disappointment and, as a result, the developmental works have suggested boosting the contributions from private sector [25].
- In the United Kingdom (UK), a study by Reichstein found that the construction industry has an inconsiderable role as a source of knowledge to bring improvement, whereas on the other hand, there is a lot of enhancement in the manufacturing industry [31].

5. Research and development in Saudi Arabia

Besides 200 scientific research units linked with universities, the King Abdulaziz City for Science and Technology (KACST) and numerous public and private institutions are included in the national system of R&D. The overheads on R&D were estimated to be almost 0.4% of GDP in 2008 [32]. Nonetheless, the R&D sector in Saudi Arabia has been considerably boosted because of the great concerns shown by the government. That significant growth has also been witnessed by its spending on R&D. As far as any revolution of the R&D sector, the Saudi appropriation from 0.25% of GDP in 2000 will increase to 1% between 2010 and 2015 aiming to reach 2% between 2015 and 2017 [33]. On the other hand, in Saudi Arabia, out of a population of 100,000, only 23 scientific researchers are involved. This compares to the developed nations, where, for every 100,000 individuals, 500 scientific researchers are involved in investigations of the issues [34]. In university context, the expenditures in 2013 on R & D in Saudi universities were \$521.7M. Overseas scholarships were granted to the university lecturers for

earning their masters and doctorate degrees and the Ministry of Education has to annually bear the cost of almost \$154.6 Million for this purpose [35].

The Saudi government intends to apply more efforts in the R&D approach as reported in the Ninth Development Plan issued by the Saudi ministry of Economy and Planning. In that plan, the following targets were presented:

- Implementing applied and strategic R&D in the KACST in support of economic and social development programs nationally, at an annual average of 400 national research projects at a cost of \$261.3 million;
- Providing grants for strategic research projects at universities and national research centers with \$240 million annually;
- Supporting operational research and studies in government agencies at an annual rate of \$80 million, and R&D in private-sector companies at an annual rate of \$53.3 million.

6. Research method

This particular paper draws extensively upon the literature review and surveys. The literature review was used successfully in concluding a review of the construction management research efforts conducted within the SCI. Associated literature referred to in the course of the research that were published in English language included academic journals, conferences and thesis/ dissertation. The process of finding research papers for this study includes the following:

- To ensure the inclusion of the maximum possible published relevant material in the context of the SCI, the overall parameters were kept as broad as possible. Five databases were accessed, including Google Scholar, EI Compendex, ASCE Library, Emerald Journals and ABI/Inform. To this end, a search code comprising "construction industry" or "construction projects" or "infrastructure projects" and "Saudi" was used.
- Leading industry professionals and associated academic researchers were asked whether or not they have been involved in or know studies that have implemented tests in the SCI.
- Finally, reference lists of the papers were also identified in this regard.

A survey was also conducted using a questionnaire circulated amongst relevant industry professionals and associated academic researchers. To this end, 25 Saudi universities were identified and leading academics professionals were short-listed and mailed a copy of the questionnaire. Additionally, the same set of questions were sent to construction managers registered with the Saudi Council of Engineers' project management chapter. The questions initially identified the experience level of the respondents and focused on the respondents' specific experience with regard to whether they had worked in academic institutions, within the public or the private sector. Further, the respondents were enquired on the number of research publications on which they had worked.

The survey was designed based on the literature review performed. The questions in the survey focused on validating the literature review findings. To create the survey questions the authors first contacted academics in Saudi Arabia and at PBSRG, Arizona State University, to ensure the questions were clear and appropriate. The survey contained two parts, the first part asking for personnel and academic information and the second part containing 5 research questions. Each question could be answered with five options (strongly agree, agree, unsure, disagree, and strongly disagree). The survey also asked the participants to identify any research that they knew that had led to improvement in the SCI and had any documented performance results.

7. Data analysis and discussion

7.1 literature review method

The relevant publications (journal papers, conference papers, and dissertations) from the search results were found through reading titles, keywords, abstracts and then scanning the publication's manuscript in order to filter out unrelated papers. On completing a review of the online databases and the relevant search engines to ensure the deletion of repeated titles, in-depth reviews were conducted for related articles referenced in already identifiable

publications. In this regard, the same five parameters were employed initially to source relevant articles. Correspondingly, Informaworld, ProQuest, Saudi digital library, ScienceDirect, Illiad interlibrary services were also used in the subsequent stage which concluded in the identification of 28 related and relevant articles.

Further to the literature search employed, two additional questions were incorporated within the survey. These asked academicians and professionals whether they could help identify relevant research articles and/or researchers known to have applied experimental research processes in the context of the SCI. It was concluded that the respondents were unable to provide any new information other than what was already available within the database. An initial review of the database concluded some 21,000 papers of which some 483 links were considered for further review. The associated details of the findings were evaluated using MS EXCEL. The database concluded in this regard included details on aspects relevant to the identity of the author, the journal or the conference referred to, the title of the publication, the corresponding abstract and the date of the publication. Distribution and number of identified construction management research papers published every five years is shown in Figure 1 and the most frequent sources of the identified papers are shown in table 1.

Table 1: Most frequent sources of the identified papers

Name of Sources	No. of Papers
Journal of Construction Engineering and Management	18
International journal of project management	14
Construction Management and Economics	13
Journal of management in engineering	11
Building research and information	11
Association of Researchers in Construction Management	8
Cost Engineering	7
Journal of Performance of Constructed Facilities	6

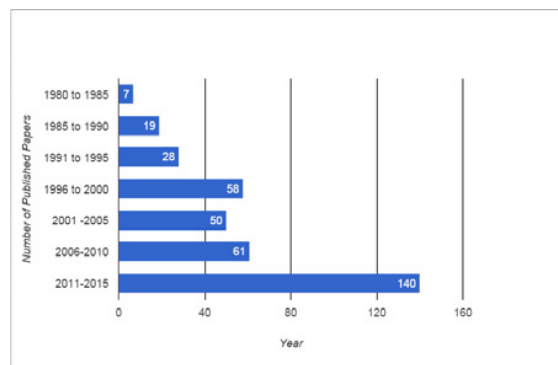


Fig.1 Distribution and number of relevant papers for every five years.

On completing the database, the results were evaluated using quantitative processes, with the target papers selected from within construction management studies relevant to aspects of planning and scheduling, quality, delay, safety, managerial topics, O&M, cost and so on. Technical research efforts evaluated in the context of the construction industry related to aspects of concrete, cement, soil and the related were excluded. Of the 483 research papers tagged within the database, 120 were identified to be technical in nature while the remaining 363 were concluded to be related to construction management as shown in Table 2. The data compiled was grouped into the following three basic categories:

1. The Theoretical research based category included studies which had not been implemented in the context of actual construction projects identified.

2. Prototype test research included studies which had been only once tested previously within real time construction projects.
3. Implementation based research included all studies which had been repeatedly tested in real life scenarios towards ensuring the validity of the propositions made and ensuring continuity of the performance levels observed.

Table 2: The research efforts in Saudi Arabian construction industry

Academic Search Engines	Total Results	Relevant Hits	Years Range
EI Compendex	303	222	1981- 2015
ASCE Library	221	47	1983- 2015
ABI/ Inform	3914	58	1986- 2015
Emerald Journals	201	21	1996 – 2015
Google Scholar	16,600	135	1977- 2015
Total		483	

As it is shown in table 3, the conclusions reached indicated that 94.5% of the collected construction management publications in Saudi Arabia are theoretical in nature, while a 5.5% had actually been tested within construction projects. There were no publications available which had been repeatedly tested in real life scenarios to validate the proposed solutions and had documentation to measure performance with regard to the research results.

Table 3: The analysis of construction management research based

Category	Number
Total construction management research based	363
Theoretical research based	343 (94.5 %)
Prototype test research based	20 (5.5 %)
Implementation research based	0

7.2 Survey method

A total of 166 questionnaires were sent to both SCI professionals and the academic researchers who specialized in construction engineering and management (110 SCI professionals and 56 academic researchers). The total number received was 76 respondents (35 from academic researchers and 41 from SCI professionals). A 26.3% of respondents had doctorates, 47.37% had a master degree and 26.32% held a Bachelor degree. The experience level of the respondents along with the number of publications they could claim are respectively stated in Tables 4 and 5. As shown in Table 6, the response generated seemingly agreed that the SCI has major shortcomings with regard to its performance. Also, it is agreed that the research publications seem to have minimal impact on the SCI. The participants believed that the theory and practices adopted within the SCI are completely separate and independent from each other and the existing R&D approach in SCI must be changed.

Table 4: Participants' years of experience

Years of experience	Percentages (%)
1-5	34.21
5-10	31.58
10-20	21.05
More than 20	13.16

Table 5: Participants research efforts

Number of publications	Percentages (%)
Non	39.47
1-5	39.47
5-10	7.89
More than 10	13.16

Table 6: The Questionnaire result

No	Statement	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1	The SCI is suffering from issues in performance (Delay, over Cost, , Quality or Safety)	66.67%	30.56%	2.78%	0.00%	0.00%
2	Most of the academic research works have no impact in SCI practice	38.89%	30.56%	19.44%	11.11%	0.00%
3	Most of the given solutions in academic research work are not tested in SCI	33.33%	52.78%	11.11%	2.78%	0.00%
4	The Saudi construction industry practice and the academic research work are in separate silos	55.56%	38.89%	5.56%	0.00%	0.00%
5	The existing R&D approach in SCI must be changed	70.59%	23.53%	5.88%	0.00%	0.00%

8. Conclusion

An attempt has been made to find effective research efforts and best practices in SCI that incorporate the theoretical studies and industry practices and through which the industry performance can be enhanced. By surveying the researchers and industry professionals, a questionnaire has also been developed. According to the findings, both research methods, the literature review and the survey, have the same results indicating that the theoretical research work and the industry practice in the SCI operate independently and without collaboration or cooperation between the two. As a result, the SCI practice is not considerably affected by the academic research work. It has been learned that the majority of research publications keep a record of existing industry practices. This includes what industry practitioners recognize and observe and their different proposals based on consent of opinions. The prototype testing of concepts are run by very few academic researchers. Moreover, a considerable gap has been found between the academic research publication and the SCI practice according to the survey results. In the response session, it was agreed that the transformations must be made to the current R&D efforts in SCI.

This study suggests that the kingdom's economic productivity could be enhanced and the synergy between the two sectors would be developed by changing a mind-set in both the public and private sector with regards to R&D co-operation/collaboration. Research centers where participants are drawn from the industry could help to bridge this gap between the SCI and academic research. The aforementioned steps must be ensured to support the future research and development approach:

- Theoretical development research.
- Prototype Testing
- Implementation testing.
- Performance metrics must be kept on the action research results.

In the delivery of services across the construction industry, persistent conceptual development and rapid impact is ensured by this future based approach. The implementation of the proposed solutions and recommendations in the studies is extremely important in order to validate the results. Therefore, the academic research peer review would not endorse the authentication of the developed concepts, but it would be supported by sustainability of the research effort and action research test results.

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