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# Innovation enablers: A review of Turkish contractors' collaborative activities and sources of information

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**Abstract:** This study attempts to examine the differences in the collaborative activities between the Turkish contracting firms that are listed as the "Top 225 International Contractors" by *Engineering News Record* (ENR), according to their international revenues, and other large contracting firms that are not on this list. For this purpose, 30 large-scale Turkish general contracting firms, including 15 listed by the ENR, have been examined in terms of their collaborations during the innovation process as well as the levels of significance for the sources of information that serve as the means of "sources of innovation". Results show some remarkable differences between the top-listed firms and other large-scale contracting companies. The levels of importance indicated for the collaborations made with "universities and research institutions" and the sources of information "conferences, fairs and exhibitions" and "scientific/technical publications" show remarkable differences between the two groups of companies. Contractors who are not ENR listed are more active in making collaborations. While the number of collaborations is increasing in the timeline, both groups of contractors indicate the most important collaborations as "consultants, private R&D institutions" and "suppliers". Findings also show a decreasing interest against collaborations with universities. Finally, findings of the research are discussed in the context of innovation, expecting to contribute to international contracting firms in evaluating their innovation approaches to their competitive advantage.

**Keywords:** construction innovation, innovation brokers, sources of innovation, Turkey, international contractors, ENR

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## 1 Introduction

Construction has long been considered as a labour-intensive activity depending on the craftsmanship passing through master to apprentice using conventional materials and techniques for ages. Today, construction is a global market shared by giant enterprises, many of them having several times more business volume internationally than they do in their home country. The competition between these multinational enterprises is beyond national borders. Although there are many variables, from political influences to personal considerations of their managerial bodies, the competitive advantage of such large-scale construction companies mostly depends on management capabilities, technical infrastructure and human resources investments towards increasing the quality of their services and fulfilling customer needs. Innovative solutions to technical problems and ways of doing business arise from the need for a continuous change to defeat rivals.

Rogers (2003) defines innovation as "... an idea, a practice or object that is perceived as new by an individual or other unit of adoption". The Oslo Manual of the Organisation for Economic Co-operation and Development (OECD), covering the proposed guidelines for collecting and interpreting technological innovation data, defines innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD, 2005). These definitions underline some of the important characteristics of innovation: (1) The idea should be new to the observer, rather than being newly discovered at that time. (2) An idea or invention is not enough alone; it should be implemented successfully, with a potential commercial value. (3) The "product" innovation consists of "goods" and "services", whereby, as a "service" industry, the construction industry should be considered accordingly. The Oslo Manual also underlines innovation as "complex" in the services sector (OECD, 2005)

Innovation is a complex process and there are many actors in it. Making things work in such a complex process passes through the steps of understanding it and measuring it carefully. Great care should be devoted to the innovation measurement system for collecting and interpreting innovation data. An incautious measurement system may cause damage instead of behaving like a catalyst of an innovation effort (Davila et al., 2013).

Research and development (R&D) is one of the major activities in an innovation system (Dikmen et al., 2005). Thus, R&D expenditure, number and qualifications of R&D personnel, patents and publications are considered as major measures for innovation activities. Nevertheless, these measures are far from reflecting the real potential of the construction industry due to their project-based nature. In the literature, the construction industry has been examined with some concerns about its innovativeness, but these concerns have motivated some researchers to pay attention to the issues facing and the solutions for the construction industry (Gann, 2000). Although the level of innovation is considered as low, compared to that in other industries, and poorly innovative, the potential of the industry to innovate is also acknowledged by a few studies (Slaughter, 2000; Dikmen et al., 2005; Pries and Janzsen, 1995). Winch (2003) argues that the evidence for this perception is usually based on comparative industrial performance data, which are not suitable for construction, as argued earlier. Hence, like any industry, construction needs to increase the rate of innovation (Slaughter, 2000).

The literature on technical change and innovation focuses on creation and development, but the real gain will be achieved when innovations are widely spread and widely diffused (Hall, 2006). Most of the innovation theories and diffusion discussions in literature treat diffusion as a non-integral part of the innovation process. In this context, Widen (2006) argues that there is a gap in innovation theory, particularly, diffusion theory, for project-based sectors such as construction. A simple form of innovation diffusion model focuses on describing and explaining the adoption process as a process of innovation diffusion at the aggregate level (Kale and Arditi, 2010). Innovations emerge from knowledge accumulated within the system and the resource recombination chosen by the firm to produce a service/product (Slaughter, 2000; Dikmen et al., 2005). However, the source of information as the means of source of innovation is as important as the accumulated knowledge within the organization and there is a scarce amount of research focusing on this part of the innovation diffusion process.

Widén and Hansson (2007) discuss obtaining information on innovations by a third party under three topics. These are as follows: (1) Inactively observing other parties implementing innovations; (2) inactively obtaining information about an innovation as a promotion or from a diffusion process; and (3) during an active effort towards reaching information. Similar to people, organizations do seek innovations from similar organizations (Rogers, 2003). Dikmen et al. (2005) mention this process as environmental scanning, whereas Kale and Arditi (2010) mention this process as an imitative behaviour. Benchmarking and reverse engineering are examples for innovations arising from imitating or extending what others do by watching others or scanning the environment. In this manner, environmental scanning and imitating are two consequent actions of the innovation process. Environmental scanning is the state where new technologies and opportunities are chased actively or inactively. The selection stage follows scanning, wherein comes the motivation to imitate as an internal factor and during which the top management of the firm or a champion of innovation emerges. However, most of the innovations being implemented by a firm are not dependent on first-time inventions. Rather than radical innovations, they are mostly adaptations from other industries or incremental innovations, depending on the development of products or processes, with the use of up-to-date technology and with the help of current conditions. Especially for industries like construction, which have limited capabilities for R&D and associated measures, this aspect leads construction firms to look out for sources of information and possible collaborations outside the firm.

There are institutions acting as intermediary agents for transfer of new technologies, coordination of innovation efforts and diffusion of innovations. These specialist institutions are called innovation intermediaries or "innovation brokers" (Lorch, 2000). Innovation brokers are usually independent people or institutions with an organizational structure that changes according to the environment they act in. These institutions can be supported by the public or be professional organizations. Although information flow problems may arise between professional organizations due to the competitive environment, they have the same function as the public-supported institutions (Winch and Campagnac, 1995). Some of these innovation brokers conduct research on the significant problems of the industry, while others support industry during the stage of application of the emerging technologies.

Although information is one of the most valuable assets of our time, commercial intermediaries are not the only source of valuable information that industry needs.

Besides public and privately owned R&D institutions and universities (Mowery and Sampat, 2006), unions and associations also help disseminate valuable information that has a potential of being converted into innovations that increase efficiency, market share or profits. Consultants, suppliers and customers (Dikmen et al., 2005), as well as information channels such as professional journals, trade magazines and trade shows (Kale and Arditi, 2010), are also pointed out as important external sources of innovation.

Western companies have responded to competition with continuous improvement for decades (Porter, 1998; Manseau and Seaden, 2001). International competition is becoming severe in the construction industry with the significant rise of non-Western contractors. Therefore, it is quite important to analyse the factors affecting the competitiveness of international contractors, especially for the countries where the economy is heavily based on the construction industry. In this context, construction companies' sources of information and collaborations for fostering innovation are significant components of the innovation system. However, construction innovation literature focused on these nodes of communication is not quite profound.

## 2 Giants' League: Top International Contractors

One of the sources that annually publish information about international construction firms is the USA-based *Engineering News Record* (ENR) magazine. Depending on the firms' diverse activities, different kinds of lists are published, and the rankings depend on the firm's revenue. One of them is the "Top 225 International Contractors" list, recently changed to "Top 250 International Contractors". The list depends on the international revenues of the firms. This list can be considered as the giants' league of construction companies, with a total international revenue of US$383.8 billion in the year 2009 (ENR, 2010).

ENR 2010 data, depending on the revenues of contractors made in the year 2009, show the leading companies and the countries they are based in. In terms of the total revenue, People's Republic of China is the leading country, with US$50.573.3 billion with 54 contractors. In the ENR 2010 Top 225 International Contractors list, Turkey takes second place with 33 contractors and ninth place with total revenue of US$14.1 billion. The total revenue of these 33 ENR-listed Turkish contractors correspond to 3.7% of the total giants' league's revenue.

In the past decade, the number of Turkish construction firms listed among the Top 225 International Contractors has increased significantly. However, a literature survey on differences between innovation approaches of these firms has shown no evidence of any existing research. As well as featuring valuable data on Turkish construction industry's place in the global market, ENR's top international contractors list also has great potential, with the contractors listed on how they succeeded. For this reason, large-scale contractors that have a significant contribution to the Turkish construction industry and the Turkish economy are considered as the object of this research.

This study forms a section of a larger-scale research that aims to reveal the innovation activities of large-scale contractors, as well as their approaches to internal and peripheral factors effective on reaching innovations. Discussion and analysis made under this study include the following:

- emphasis given to collaborations in knowledge networks; and
- emphasis given to sources of information for innovation activities

by contractors and the differences between ENR-listed and other large-scale Turkish contractors.

## 3 Research Methodology

There are some available sources of information that contain data on the Turkish construction industry. However, sources on innovativeness in the industry are very limited. The Turkish Statistical Institute (TurkStat) releases sector-based innovation surveys regularly. Nevertheless, the data TurkStat releases for the construction industry have been found insufficient for sample size after a metadata analysis. Similarly, data released by the Undersecretariat of Foreign Trade and other sector-specific private institutions were insufficient for the international perspective as they were mostly dealing with basic indicators of innovation.

At this point, a survey was carried out in order to obtain data about large-scale construction contractors' innovation approaches. The survey included R&D attitude, product, process, organizational innovation activities, drivers and barriers affecting innovation efforts, information and communications technology (ICT) investments, intercompany training activities, emphasis given to sources of information and collaborations of contractors. In order to reveal the changes in the timeline, two different

periods were investigated in the survey where appropriate. These time periods were 2004–2006 and 2007–2009. Innovation activities, emphasis given to sources of information and collaborations-related sections and findings of this survey are discussed in this paper.

Contractors studied in this research were identified according to the following two institutions' contractor lists:

- Top 225 International Contractors list of *Engineering News Record* (ENR) magazine –ENR 2010,
- Turkish Contractors Association (TCA) members

In the first group, according to the revenues made in 2009, 33 Turkish contractors are listed in ENR 2010. As the population size is limited in this first group, business development managers or people with similar managerial positions were targeted personally in order to reach a decent number for reclamation.

From around the 1970s up to the present, Turkish contractors have completed almost 6500 projects in 93 countries. Their business volume abroad has reached approximately US$205 billion. The business volume of TCA members encompasses nearly 90% of all international contracting work done so far by Turkish construction companies (TCA, 2010). TCA is an independent, nonprofit organization and TCA member contractors are taken into account as the second group. The Association had 152 members at the date of research and 31 of the ENR-listed contractors were also members of the Association. The remaining 123 members of the Association were found appropriate for comparison with and discussion relative to the ENR-listed contractors. The survey was emailed to the 123 members of the Association.

The number of valid responses for both ENR-listed contractors and Turkish Contractors Association (TCA) member firms was 15 each. This number refers to a response rate of approximately 48% for ENR-listed companies and 12% for the other TCA members. The sample size was validated using Kish formula and found appropriate (Kish, 1965). Data from the completed questionnaire were analysed using SPSS 15.0 software; non-parametric tests were used because of the sample size. Graphics and tables were generated using Microsoft Excel.

## 4 Analysis

Questions about the company structure show that 60% of the ENR-listed firms are members of a group of companies, whereas it is 47% for the TCA members. For the year 2009, the ENR-listed firms' average revenue was US$1.380 million and number of personnel was 5217, while the figures for the same were US$189 million and 1023 personnel for TCA contractors, respectively. The two periods examined show a significant difference among the two contractor groups in terms of revenue increase. Concerning the revenue change between years 2006 and 2009, ENR-listed firms' income was nearly doubled (99.6%), but the change for the TCA contractors was significantly lower (19.5%). Average ICT expenditure per annum of ENR contractors was US$228.2K and 105.7K for other TCA members. The most significant market for ENR-listed contractors was the former Soviet States (87%), whereas it was the domestic market, Turkey (50%), for the TCA members.

Contractors' sources of information and their collaborative activities for innovation are examined in the survey. Collaboration percentages of the ENR-listed and non-ENR-listed TCA-member firms in the periods 2004–2006 and 2007–2009 are shown in Figure 1. In the period 2004–2006, both contractor groups have collaboration rate below 50%. However, in the period 2007–2009, rates increase above 50% for both groups. Non-ENR-listed TCA-member firms have a higher rate of collaboration in both periods.

Institutions that are indicated as ENR-listed firms for collaboration for the two successive periods are "consultants and private R&D institutions" with ten connections, "suppliers" (nine), "other specialist institutions" (four), "customers" (two), "rival/other firms" (two), and "universities" (one). ENR-listed firms did not state collaboration with any "public research institutes" among these 28 connections. While five of these successful connections are European Union (EU) based, two of them are from the USA and one of them is indicated as "other country".

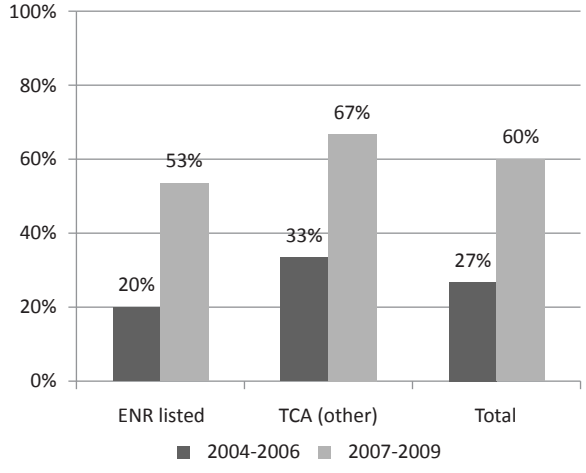


**Fig. 1:** Collaboration with other institutions in the periods 2004–2006 and 2007–2009 for ENR-listed and TCA-member non-ENR-listed contractors.

For the same two successive periods, institutions indicated by TCA-member non-ENR-listed contractors are "suppliers"(18), "consultants and private R&D institutions" (17), "other specialist institutions" (ten), "rival/other firms" (eight) "customers"(seven), "universities"(five) and "public research institutes" (two), with a total number of 67 connections. EU-based connections are 15 and USA-based ones are five. TCA contractors also stated that five of the connections are based in an "other country".

In order to reveal the significance of these collaborations towards innovations, the contractors are asked to state the level of importance for each type of collaboration. Furthermore, in order to get a complete body of knowledge, "conferences, fairs and exhibitions", "scientific and technical journals" and "unions and associations" are also explored to identify other types of sources of innovation. Likert-scale assessments were used and attitudes were scored with five for "very high", four for "high", three for "neutral", two for "low" and one for "very low". The levels of importance for the collaborations indicated for the period 2003–2006 by the two groups of contractors are shown in Figure 2 and the same assessments for the period 2007–2009 are shown in Figure 3.

ENR firms indicated only two of the types of collaboration as important in the period 2004–2006. These types of collaborations are "consultants and private R&D institutions" and "suppliers". ENR firms did not indicate the importance either for any other collaboration or for the sources of innovation. For TCA-member firms, "universities" are the most highly rated institution for collaboration, followed by "consultants and private R&D institutions" and "suppliers". These large-scale contractors that are not listed in ENR also indicate the importance for "customers" type of collaboration and all the three sources of innovation, "conferences, fairs and exhibitions", "scientific and technical journals" and "unions and associations". Between the two groups of contractors, the evaluation difference for "universities" seems very significant.

Parallel to the increasing number of collaborations, both ENR-listed and TCA-member non-ENR-listed firms evaluate more collaborations as well as sources of innovation in the period 2007–2009 (Figure 3). However, the importance levels indicated show the same results for ENR-listed firms. Only "consultants and private R&D institutions" and "suppliers" are rated more than the neutral level of importance. For the TCA members, all types of collaborations and sources of innovation seem to have lost their importance relative to the first period except a minor rise for the indicated importance level of "rival firms". "Universities" are the foremost type of collaboration that has lost ground in the period 2007–2009. "Suppliers" and "consultants and private R&D institutions", as types of collaboration, and "conferences, fairs and exhibitions", as sources of innovation, are the only ones indicated with an importance level more than the neutral by the TCA members (Figure 3).

According to the acquired survey results, tests of hypothesis were conducted to find possible statistical significances between ENR-listed firms and other TCA member firms. Due to the sample size, the significance level was undertaken at two different levels: $\alpha$=0.05 and $\alpha$=0.1. The null hypothesis about the contractors' sources

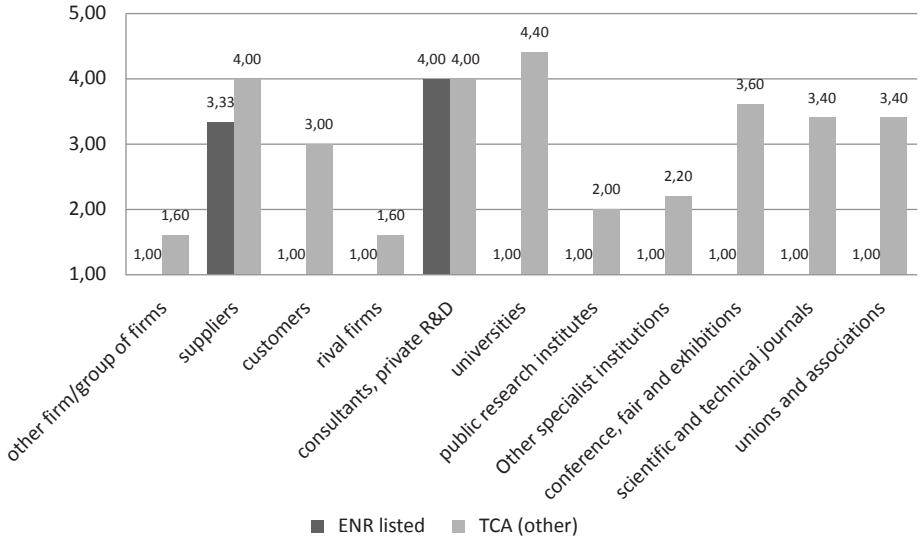


**Fig. 2:** Level of importance indicated for the types of collaboration and sources of information for the period 2004–2006.

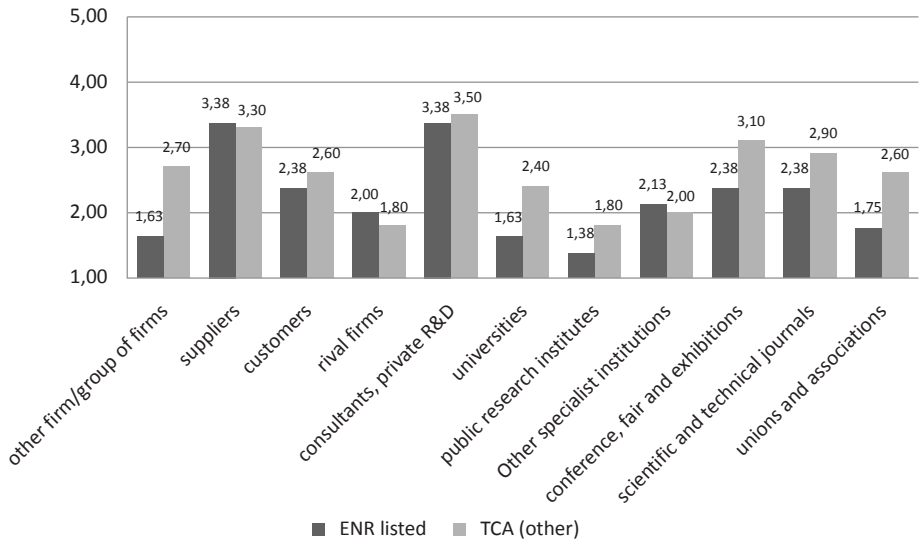


**Fig. 3:** Level of importance indicated for the types of collaborations and sources of information for the period 2007–2009.

of information and their collaborative activities was formulated as follows:

H0: There is no statistically significant difference among the ENR-listed and the TCA member contractors according to their sources of information and collaborative activities.

Two different analyses were performed for the two different periods of 2004–2006 and 2007–2009. Results of the performed Mann–Whitney *U*-test for the first hypothesis for the period 2004–2006 are presented in Table 1.

The same hypothesis was tested for the second period of 2007–2009 (Table 2). Mann–Whitney *U*-test shows *P*-value =0.018 for the collaborations with "universities". As the value $P<0.05$ at the significance level $\alpha=0.05$, the null hypothesis is rejected, meaning a clear significance for "universities" between the two contractor groups. Moreover, at $\alpha=0.1$ level, *P* values for "conferences, fairs and exhibitions" and "scientific and technical journals" are 0.50 and 0.53, respectively, showing significance for these types of sources of innovation between the two contractor groups (Table 2).

## 5 Conclusion

Collaborative activities of large-scale international contractors of Turkish origin are examined using a survey, looking for differences between ENR-listed and non-ENR-listed TCA-member companies. Findings show that non-ENR-listed TCA-member companies are more active in making collaborations than the ENR-listed Turkish contractors for both periods 2004–2006 and 2007–2009. However, while the collaborations are increasing by number for both the contractor groups, the level of importance indicated for collaborations and sources of information decreases. In the second period, there are only two types of collaborations that both groups of contractors indicated more-than-neutral importance: "consultants, private R&D institutions" and "suppliers". "Conferences, fairs and exhibitions" are also indicated as important, more than the neutral level, by non-ENR-listed TCA-member companies.

Most significant change between the two time periods in the level of importance scale is the scale of "universities". While it was indicated as the highly important collaboration by non-ENR-listed TCA-member companies in the period 2004–2006 with a level of 4.4/5, "universities" lost ground in the period 2007–2009 and are indicated only 2.4/5, which is below the neutral level indicated by 3.0. However, TCA-member contractors indicate statistically significant level of importance to collaborations with "universities" and sources of innovation "conferences, fairs and exhibitions" and "scientific and technical journals" in the period 2007–2009.

These findings highlight the relationship between contractors and "suppliers" as well as "consultants, private R&D institutions", similar to previous research (e.g. Kale and Arditi, 2010). One of the most compelling findings of this research is contractors' decreasing interest in entering into collaborations with universities despite efforts to encourage university-industry partnership. This particular result should be noteworthy for the public and private bodies engaged in developing strategy and policies for the diffusion and

**Tab. 1:** Contractor group × importance level for sources of information and collaborative activities (2004–2006).

| | Other firm/ group of firms | Suppliers | Customers | Rival firms | Consultants, private R&D institutions | Universities |
|---|---|---|---|---|---|---|
| Mann–Whitney *U* | 24,500 | 36,500 | 38,000 | 37,000 | 38,500 | 29,000 |
| Wilcoxon *W* | 60,500 | 91,500 | 74,000 | 92,000 | 93,500 | 65,000 |
| *Z* | –1,525 | –,329 | –,198 | –,320 | –,138 | –1,114 |
| Asymp. Sig. (two-tailed) | ,127 | ,742 | ,843 | ,749 | ,890 | ,265 |
| | **Public research institutes** | **Other specialist institutes** | **Conferences, fairs and exhibitions** | **Scientific and technical journals** | **Unions and associations, etc.** | |
| Mann–Whitney U | 30,500 | 39,000 | 28,000 | 33,500 | 29,000 | |
| Wilcoxon *W* | 66,500 | 94,000 | 64,000 | 69,500 | 65,000 | |
| *Z* | –1,070 | –,102 | –1,109 | –,605 | –1,116 | |
| Asymp. Sig. (two-tailed) | ,285 | ,919 | ,268 | ,545 | ,264 | |

Valid for all the collaborations and sources of innovation, at the significance level $\alpha$=0.05, *P*-value >0.05 and at $\alpha$=0.1, *P*<0.1; thus, the H0 hypothesis is accepted. As a result, for the period 2004–2006, ENR-listed firms and non-ENR-listed TCA-member contractors do not show a statistically significant difference according to the level of importance indicated for sources of information and collaborative activities.

**Tab. 2:** Contractor group × importance level for sources of information and collaborative activities (2007–2009).

| | Other firm/ group of firms | Suppliers | Customers | Rival firms | Consultants, private R&D institutions | Universities |
|---|---|---|---|---|---|---|
| Mann–Whitney *U* | 6,000 | 7,500 | 3,000 | 6,000 | 7,500 | ,000 |
| Wilcoxon *W* | 12,000 | 13,500 | 9,000 | 12,000 | 13,500 | 6,000 |
| *Z* | –,775 | ,000 | –1,549 | –,775 | ,000 | –2,366 |
| Asymp. Sig. (two-tailed) | ,439 | 1,000 | ,121 | ,439 | 1,000 | ,018 |
| | **Public research institutes** | **Other specialist institutes** | **Conferences, fairs and exhibitions** | **Scientific and technical journals** | **Unions and associations, etc.** | |
| Mann-Whitney U | 4,500 | 4,500 | 1,500 | 1,500 | 3,000 | |
| Wilcoxon W | 10,500 | 10,500 | 7,500 | 7,500 | 9,000 | |
| Z | –1,171 | –1,183 | –1,960 | –1,932 | –1,587 | |
| Asymp. Sig. (2-tailed) | ,242 | ,237 | ,050 | ,053 | ,112 | |

There is a significant difference between the ENR-listed firms and TCA-member non-listed contractors in terms of the level of importance given to collaborations and sources of innovation. As a result, TCA member contractors indicate statistically significant level of importance to collaborations with "universities" and sources of innovation "conferences, fairs and exhibitions" and "scientific and technical journals" in the period 2007–2009.

implementation of innovations in the construction industry. Findings show the need for further research on collaborations between contractors and innovation broker institutions and other sources of information for innovations, to recognize the stimulation towards and outcomes of innovation.

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