

AN INSIGHT INTO THE REASONS BEHIND THE UNPOPULARITY OF DRYWALL SYSTEMS IN THE IRANIAN CONSTRUCTION INDUSTRY

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ABSTRACT

The building industry in developed countries has seen major growth during the past century, but Iran, as a developing country, has not yet experienced similar development. In developed countries, various prefabricated materials which accelerate the speed of construction are used in the industry. One such prefabricated material is drywall, which is used globally for the finishing construction of interior walls and ceilings. Although generally available, drywall has failed to gain popularity in the Iranian building industry. The objective of this study is to identify the factors that cause this unpopularity. Seven potential influencing factors, cost, culture, overall quality, availability of installation teams, quality of finished surfaces, high skill requirements and the nature of clients, were identified through a review of the literature and interviews with consultants and contractors involved in the Iranian building industry. These factors were included in a questionnaire in order to analyze their significance and to rate their effect in the industry. The responses to the questionnaires from 30 construction companies were statistically analyzed. The results of the data analysis indicate that four factors are statistically significant in influencing the unpopularity of drywall: culture, clients, availability of installation teams, and high skill requirements. The factors were ranked according to their importance.

Keywords: Building Materials; Construction Industry; Drywall; Iran

1. INTRODUCTION

The building industry in developed countries has experienced major development during the past century. However, as a developing country, Iran has yet to undergo a similar situation. Its construction techniques are mainly traditional, with any changes limited to structural analysis methods, and to the construction of foundations and reinforced concrete/steel structures. In essence, enhanced analysis techniques are used, although virtually the same conventional construction practices are employed. While the construction of the structural elements of buildings has improved, some other building elements, such as internal walls, are still constructed using traditional materials and methods. One of the main disadvantages of this is the relatively low quality of these materials, which affects the lifespan of the whole building. The average life of a building in developed countries is estimated to be around 80–100 years (Cooke, 2007), whereas it is thought to only be in the region of 20 to 30 years in Iran. An estimated 20% of materials are wasted when using these traditional materials and methods, while this figure is approximately 5% in developed countries (Moetamedi, 2014).

Developments in prefabricated materials manufactured outside building sites contribute greatly

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to improvements in the building industry, one of these being the accelerated speed of construction (Zhao & Riffat, 2007). Iran urgently needs high quality affordable residential units to replace the worn out urban buildings that are not resistant to earthquakes. There was a sharp rise in the population during 1980s, and this generation is now mature and in need of housing. This will lead to the demand for housing in the coming years to continually increase. A prolonged construction process would make the construction industry fall behind schedule, mainly due to the traditional materials and techniques still used today (Financial Tribune, 2015; Econews, 2016) According to the deputy minister for roads and urban development, Hamed Mazaherian, housing demand is predicted to grow by 5% in the current Iranian year (Khajehpour, 2016). Furthermore, due to the fact that Iran is in an earthquake zone, the practice of employing high quality materials with a low specific weight but high strength is of the utmost importance. The imbalance between the supply and demand of these materials has led to monopolization of the market by a handful of companies which, through the use of poor quality, mainly traditional, materials, has had a negative impact on the Iranian building industry. In addition, the total weight of buildings increases when using traditional materials and techniques. Consequently, as the structure of the building does not achieve an acceptable level of flexibility, the risk and magnitude of damage following an earthquake will increase considerably (Elnashai & Di Sarno, 2015).

The lack of standardization and the poor quality of materials also have an adverse effect on the insurance business. Insurance companies find it difficult to make accurate risk assessments and are often unwilling to insure buildings due to this unpredictability (Alami, 2015). Utilization of standardized, prefabricated, high quality materials and systems such as drywall would maximize efficiency and improve the quality of construction.

1.1. Overview of Drywall Systems

Drywall is a man-made building material and a method of constructing interior walls and ceilings using panels made of gypsum plaster pressed between two thick sheets of paper and then kiln dried. The panels are sometimes called gypsum board, sheetrock or plasterboard (in the USA, UK, Ireland and Australia) (Merriam-Webster, 2015). Nowadays, drywall is commonly used in many types of building construction, such as commercial and residential developments, hospitals, schools, exhibition halls, hotels and restaurants. A large number of manufacturers and contracting companies work in this field around the world. Various types of panels with different sizes and thicknesses are produced. The standard panel size is 1200×2400 mm², with the thickness varying between 6.5 mm and 20 mm. The standard drywall thickness is 75mm, with a total weight of about 25 kg per square meter. An experienced installation team can typically build 60 square meters of wall per day using this material (Anvari, 2014).

1.2. Scope of the Research

Drywall, in comparison to traditional methods, is not only economical, but also provides significant time savings in installation. However, lack of familiarity with this system in Iran means the benefits have been disregarded by the industry, which still prefers traditional methods. Materials of choice are usually bricks and blocks produced in many different shapes, sizes and colors. These methods, in comparison with drywall, are time consuming and involve a high percentage of waste material; nevertheless, they are commonly used by builders/contractors and stipulated by architects/designers in their designs. This has consequently been the cause of significant delays and extra costs. As mentioned above, the increase in demand for housing requires more efficient building methods, so therefore it is necessary to ascertain what obstacles have prevented the application of this system in Iran. To address this, the study aims to explore the obstacles to the utilization of drywall in the Iranian building industry and to identify the reasons behind its limited application.

1.3. Comparison between Drywall and Traditional Materials

In order to establish the obstacles to using drywall, in this section a comparison will be made between traditional methods, clay bricks and block walls, in terms of cost, weight, speed of construction, thickness, quality of finished surface, availability of expert bricklayers and execution of work.

Figure 1a shows a comparison between the total cost of drywall, clay bricks and clay blocks. Although drywall has the highest cost, it has significant economic benefits, as discussed below. Figure 1b illustrates the total weight of each system. Drywall is the lightest (25 kg/m^2); through its use a reduction of 36 percent of the total weight of the building is achieved (Karami, 2015). The main impact of this reduction is to provide a lighter structure than that of steel/reinforced concrete structure. Since the cost of a steel/reinforced concrete structure is about 25 percent of the total construction costs in Iran, this means a significant saving for the builders/clients (Anvari, 2014).

For example, in a five-storey building, of which the total area is approximately 995 square meters, it is possible to reduce the total weight of the steel structure from 45.15 tons to 43.5 tons by using drywall instead of clay brick walls (Azadpoor, 2013). This reduction in weight affects the design radically, hence another benefit of using drywall is the considerable reduction in the amount of concrete, along with the reinforcements in the foundation, particularly in high rise buildings (Emami, 2015).

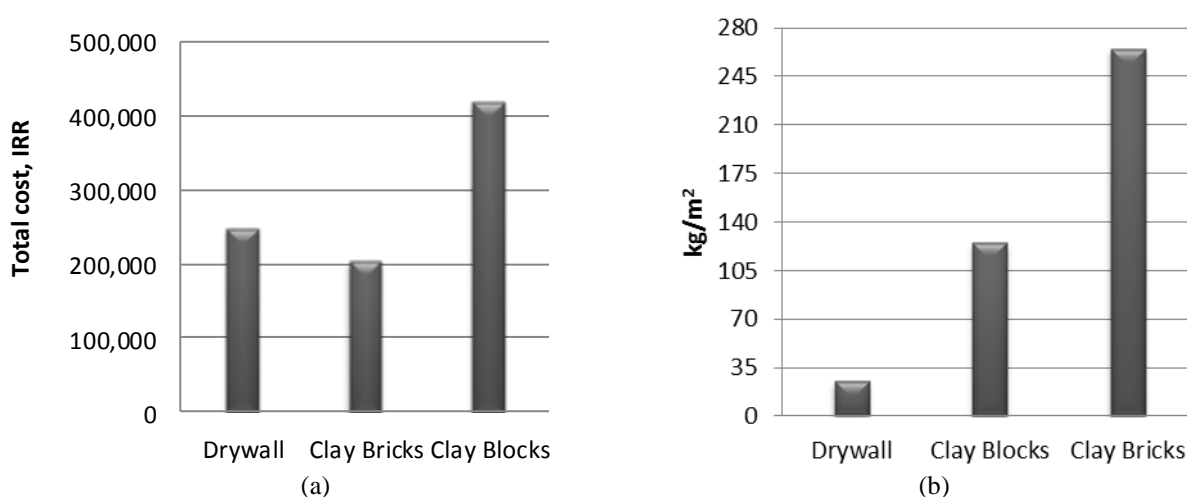


Figure 1 Comparison between drywall and traditional materials: (a) total cost of each system in IRR (Anvari, 2014); (b) total weight of each system (Karami, 2015)

Unlike structural components, most of the non-structural ones, including architectural, mechanical, electrical and plumbing elements, are vulnerable to relatively low earthquake activity. They contribute significantly to economic losses in buildings subjected to seismic loading (Lee et al., 2006). According to Hirakawa and Kanda (1997), non-structural components represented 40% of the cost of damage to 210 reinforced concrete (RC) buildings affected by the the 1995 Hyogo-ken Nanbu earthquake in Japan, while the cost for structural components was also 40%. Consequently, it is widely agreed that mitigation of non-structural damage will dramatically improve the risk of structures from economic loss. The same is true for the Iranian construction industry, as Iran is in a region prone to earthquakes. Due to its relatively lower weight, utilizing drywall would minimize the risk of damage to structures and also other non-structural components, as mentioned above. In general, a significant degree of protection/damage limitation can be achieved in terms of economic loss due to earthquakes.

Furthermore, drywall offers protection to victims who would otherwise perish under the weight of walls built with traditional materials (Karami, 2015).

Figure 2a illustrates that an experienced team, including two expert installers, can construct 60 square meters of drywall in a day, which is 3.75 times faster than using clay bricks and 1.81 times faster than with blocks. Furthermore, in traditional methods, two plastering stages must be implemented before painting, while drywall is ready to be painted on immediately after installation. As a result, a substantial amount of time can be saved in the construction process by applying this system. In addition, during the construction phase of brick/block walls, materials such as cement, sand and clay are left on the floors of the building, which prolongs the process and adds complications. In comparison, the installation of the studs, runners and pallets of No.40 gypsum board panels is less time consuming and complicated (Emami, 2015).

Using drywall in construction is an efficient method of standardizing quality, as the more traditional methods rely mainly on the skills and experience of the bricklayers/laborers, who often lack formal training (Shams, 2014). Figure 2b illustrates the finished thickness of each system. Less interior space is wasted by applying drywall with a thickness of 75 mm.

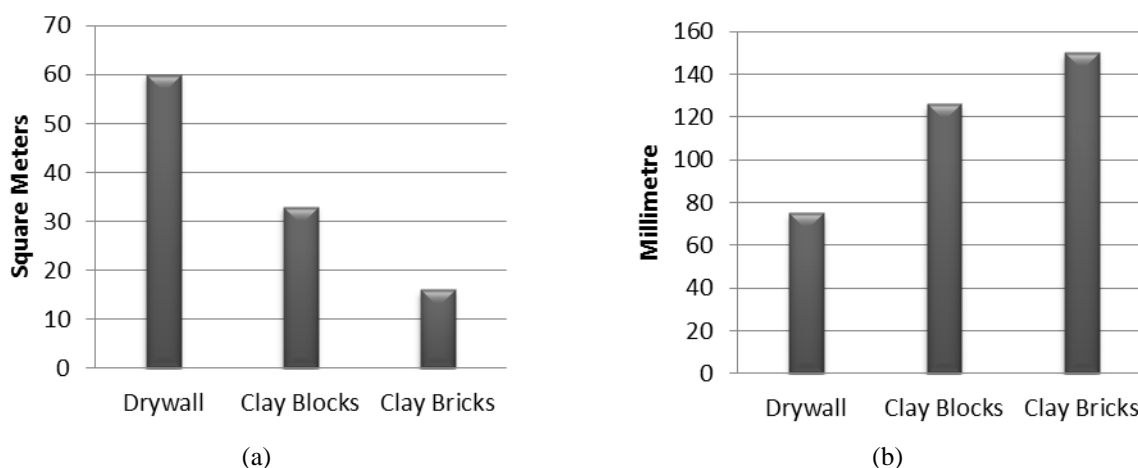


Figure 2 Comparison between drywall and traditional materials: (a) Speed of construction (Emami, 2015); (b) Thickness of each system (Shams, 2014)

The quality of the finished surface, the floor slab, is important for the drywall installation procedure. Runners need to be installed on a smooth surface. In many countries, when the concrete for the floor slab is poured it is finished off by a power floater. A smooth surface is achieved by this technique; however, in Iran more traditional methods such as manual instrument application are used, meaning a completely smooth surface is hard to create. Unlike drywall, the quality of the floor surface does not have any impact on building walls with brick or clay blocks (Shams, 2014).

Drywall systems should be installed by expert installation teams who are trained and skilled. However, one problem is the shortage of such workers in Iran. On the other hand, there are many skilled bricklayers who can use both bricks and blocks. Furthermore, there is no need for special techniques when constructing traditional walls, so the construction process is less complicated (Shams, 2014). The factors discussed in this section are used in the following one to develop a comprehensive research methodology to thoroughly investigate the barriers that are preventing the application of the drywall system in Iran.

2. METHODS

2.1. Development of Methodology

Identifying the problems involved in using drywall requires in-depth understanding of the environment in which the research was carried out. Through a review of drywall system application in Iran and a comparison with traditional methods, several facets which could be the reason behind the unpopularity of drywall in the country are identified. These are: (1) cost; (2) lack of drywall installation teams; (3) high skill requirements; and (4) the quality of the finished surface. To confirm the influence of these factors, a series of interviews with ten respondents was arranged, who were selected from well-known contractors and consultants involved in building construction projects in Tehran. Following the methods used by Ansari et al. (2016), during the interviews a set of standard questions was asked about their involvement in projects using drywalls, and the factors that normally affected their decisions on the choice of materials for internal walls. Participants were also asked if they thought the identified factors were important when deciding whether to use the drywall system or not.

After analyzing the interviews, it was concluded that in addition to the four selected factors there were also three further ones that consultants and contractors felt were important in their choice of material. First, culture; the general public believe that the system does not have enough strength. This was mentioned by eight of the respondents. Second, quality; the quality of the end product is not as high as it should be due to the lack of proper installation equipment. This was mentioned by seven of the respondents. And third, the clients, who are not familiar with the benefits of the system. This was mentioned by seven of the respondents.

Once these seven factors had been identified and confirmed, they were included in a questionnaire, which was compiled in Persian. The factors were: F1. Cost; F2. Culture; F3. Overall quality; F4. Availability of installation teams; F5. Quality of the finished surface; F6. High skill requirements; and F7. Clients. The questionnaire comprised two main sections. The first asked participants to confirm or deny if each factor played a determining role in the unpopularity of drywall systems in Iran. The second section asked the respondents to evaluate the effect of the factors using a five-point scale, namely 1-Very Low 2- Low 3-Medium 4-High 5-Very High.

2.2. Selection of the Companies

Based on the authors' personal experience, it was decided that the questionnaires should be distributed to construction companies who had some level of familiarity and experience with this material. The criterion for selecting contractors was either of the following: (1) Completion of a minimum of five projects involving drywall as a major component of the buildings; or (2) Completion of one or more construction projects with a total contract value of 5 million USD. The number of companies with experience or familiarity with this material is very low in the city in which the research was conducted. Around 40 companies were found to meet the above criteria, and data were obtained from 30 of them. The type and value of properties in Tehran varies from area to area. For example, the Northern district is the most affluent part, with the price of three bedroom apartments around 650,000 USD or higher, whilst in the relatively deprived Southern region, two bedroom apartments are modestly priced in comparison, at around £75,000. The centre of the city is mainly dominated by commercial and office buildings (Office of Urban and Residential Construction Planning, 2017) The samples were divided into three groups: Group 1, companies that mainly operate in the northern part of Tehran; Group 2, companies that mainly operate in the southern part of the city; and Group 3, companies which specialize in the construction of office blocks and commercial buildings. Ten companies were selected in each group.

3. DATA ANALYSIS

The data received from the 30 construction companies in Tehran were statistically analyzed to identify the relevant obstacles to using the drywall system. Most respondents (97%) were male. This is not surprising, as the construction industry in Iran has traditionally been male dominated. 60% of the MDs were educated to master's level, with the remainder to bachelor's level; none had a PhD. All the data collected from the questionnaires were analysed using SPSS software. In order to determine the significance in the difference between positive and negative answers in the first question, a chi-square (X^2) test was used (Fellows & Liu, 2015). This was calculated by the formula:

$$\chi^2 = \sum \frac{(\text{Observed Count} - \text{Expected Count})^2}{\text{Expected Count}} \quad (1)$$

The predetermined alpha level of significance is 0.05, and the degree of freedom is (df = 1).

If the probability level > 0.05 , then the null hypothesis can be accepted.

If the probability level < 0.05 , then the null hypothesis can be rejected.

The probability level is calculated by the measured X^2 value with a degree of freedom.

In the following section, the results of the evaluation of the factors based on their effects are illustrated by figures and tables. The factors are ranked based on the importance by calculating the mean for each one (Schumacker & Lomax, 2015).

Table 1 Chi-square analysis and results from the first part of the survey

Code	Factors	Observed N			Expected N		Residual		Chi-Square	df	p-value	P-value > 0.05	P-value < 0.05
		Yes	No	Total	Yes	No	Yes	No					
F1	Cost	19	11	30	15	15	4	-4	2.1333	1	0.144	✓	
F2	Culture	27	3				12	-12	19.2		0.0000118		✓
F3	Overall quality	12	18				3	-3	1.200		0.273	✓	
F4	Availability of installation teams	24	6				9	-9	10.800		0.001		✓
F5	Quality of finished surface	18	12				3	-3	1.200		0.273	✓	
F6	High skill requirements	26	4				11	-11	16.133		0.00006		✓
F7	Clients	26	4				11	-11	16.133		0.00006		✓

It can be observed from the analysis that culture, availability of installation teams, high skill requirements and clients are the factors which have a significant effect on the unpopularity of drywall systems in Iran. Analysis of the data obtained does not show any significant division or difference in responses between the three groups; this means that the knowledge and experiences of the companies in various parts of Tehran are mostly similar.

3.1. Development of Methodology

Cost, at 14%, and culture, at 0%, were the highest and lowest factors selected in the very low category. In the low category, all the factors except culture (3%) were similarly selected in the range of 10–15%. Quality and installation teams have the highest values of 44%, while culture has the lowest of 14%, in the medium category. 57% of the participants found culture to be highly effective, whilst only 17% believed overall quality to be so. Clients, at 40%, and quality

of finished surface at 0.66% were the highest and lowest factors selected in the highly effective category.

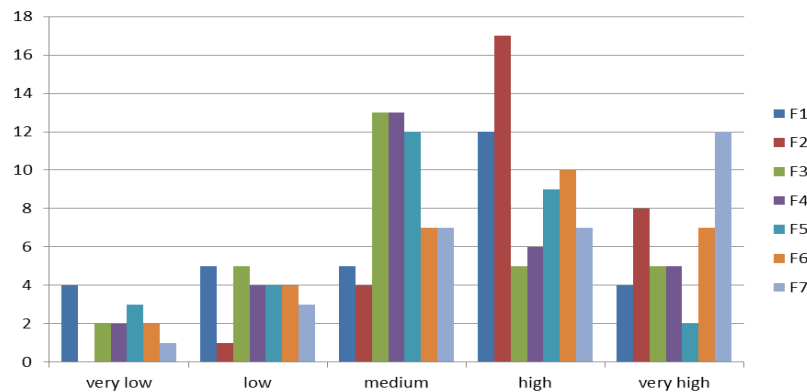


Figure 3 Data obtained from the second part of the survey with respect to the level of effectiveness of the factors

The ranking of the factors is shown in Table 2.

Table 2 Means of the factors

	Importance of cost	Importance of culture	Importance of overall quality	Importance of the availability of installation teams	Importance of the quality of the finished surface	Importance of high skills requirements	Importance of clients
N Valid	30	30	30	30	30	30	30
Mean	3.23	4.07	3.20	3.27	3.10	3.53	3.87

4. DISCUSSION OF THE RESULTS

Analysis of the data reveals that both methods produced similar results. The chi-square (X^2) test results show that culture, clients, high skill requirements and availability of installation teams are significant factors affecting the industry and preventing the increased usage of drywall. The data from the Likert scale questionnaires clarify that the most effective factors with the highest mean are culture, clients, high skills and availability of installation teams. The results from the chi-square (X^2) test indicate that four factors are significant, at $\alpha = 5\%$, in influencing the non-application of drywall. These are listed in Table 3.

Table 3 Most significant factors in the unpopularity of drywall ranked

No	Factors
1	Culture
2	Clients
3	High skill requirements
4	Availability of installation teams

4.1. Significant factors

4.1.1. Culture

Culture was highlighted as the most critical factor affecting the unpopularity of drywall in Iran, with the general public believing that the system does not have enough strength. It took 25

years for builders in America to begin using drywall in any substantial quantities since it was thought of as a compromised alternative to traditional wall systems, with none of the fine art associated with using plaster. Since people did not want to live in homes that were poorly constructed, they stuck with the tradition and expense of plaster (Turner, 2007)

The same is true for the Iranian general public and those who are involved in the construction industry. It will take time for drywall to be accepted as a substitute material in the sectors of the building industry dominated by traditional methods and materials. Naturally, as the construction industry evolves, new techniques and materials will be developed and used. Hence the drywall system, being a more modern concept, has a fair chance of being accepted and dominating the market as a part of the advances.

In Fox and Skitmore's (2002) study, six factors were shown to be important to the future development of the construction industry in a variety of countries. One of these factors was culture. The study commented that "a learning culture is something that is necessary and important within the construction industry, and so a large number of stakeholders within the industry need to be involved. In addition, stakeholders outside of the industry would also need to play their part, especially the national government through any appropriate changes in the education and training processes generally."

Therefore, in terms of culture the government of Iran can play a positive role in developing the drywall system. The benefits can be introduced to the public through the mass media. Among the advantages, its lightweight properties should be highlighted as the primary benefit, since Iran is in a region prone to earthquakes. It should be mentioned that using drywall offers protection to victims who would otherwise perish under the weight of walls built by traditional materials, and it also would minimize the risk of damage to structures and also other non-structural components.

Furthermore, there are few manufacturers of the system in Iran, with the most famous being Knauf-Iran Company. The government could support those companies wanting to manufacture drywall by providing specific low-rate loans and also tax-free investments for those wanting to invest in this field. The government could also play a positive role in the education process. More detailed information about the system should be taught in universities in the fields of civil engineering and architecture. Consequently, the general public would become more familiar with it and the benefits provided against earthquakes compared to more traditional methods. In addition, it would be advantageous if Knauf-Iran Company became more involved in informing the general public about the benefits of drywall by advertising on television as well as in the newspapers.

Raftery et al. (1998) identified three effects of globalization that can improve Asian construction industries: larger private sector participation in infrastructure projects; increased vertical integration in the packaging of construction projects; and increased foreign participation in domestic construction. There are no barriers to international companies wishing to enter the Iran construction market; however, investors in the industry need to have confidence that the return on their investment is commensurate with the risk of political instability (Fox & Skitmore, 2002). Even though several sanctions against Iran have been removed, there are still various complications and the risk of political instability is high; subsequently, there is no interest from international building companies at the moment. If Iran were able to attract international companies, they could import their modern technology and systems into the industry or invest in local licensed production. Well-known companies often have a reputation for guaranteed quality and modern concepts, which are usually accepted with less resistance by the general public. This could be used as an educational and marketing point.

4.1.2. *Clients*

Client information, i.e. unfamiliarity with the benefits of the system, was ranked as the second most crucial factor. Clients/builders in general have limited knowledge about drywall and its benefits. In order to overcome this obstacle, communication between clients, both public and private, and those who are involved in the industry is important and can assist in setting standards for good practice. A strong argument often put forward by researchers is that since the government is a major client of the industry, it could, and should, use its influence to promote and encourage best practice (Fox & Skitmore, 2002). Therefore, the Iranian government could promote the drywall system by using it in certain projects, such as social housing and office buildings. This could set a good example for the private sector to become more familiar with the product and its benefits compared to traditional methods.

Furthermore, the manufacturing company Knauf-Iran could present the benefits of drywall to potential clients by arranging workshops and training courses and using advanced marketing strategies. Consultants could also play a positive role by highlighting the benefits of drywall to their clients. Moreover, adopting quality management (QM) and value management approaches in the manufacturing and marketing process could help the manufacturers of drywall to promote the material within the market. Manufacturers could provide information to customers on how drywall can increase efficiency and add value to buildings (Berawi et al., 2013).

At present, there is no information about the drywall system in the Iranian Code of Practice for Seismic Resistant Design of Building. As previously mentioned, Iran is in a region prone to earthquakes so it is essential to include detailed information about the system and its advantages in the code of practice. The information provided by the Ministry of Housing and Urban Development would be available to clients, builders and contractors, who would subsequently gain more knowledge about the usage, as well as the benefits, of drywall. A strong argument would be that thousands of lives could be saved in an earthquake by applying this method. Another fact that sometimes deters clients from using drywall is that since only one company is currently providing a high quality product in Iran, there is little or no room for negotiations on price compared to traditional methods. The introduction of new companies and healthy competition into the market should be promoted and supported by the government.

4.1.3. *High skill requirements and availability of installation teams*

High skill requirements and availability of installation teams were ranked fourth in respect of their influence on the reluctance to use drywall in Iran. Installation of drywall requires higher skills compared to traditional methods, and installation teams usually spend at least three months in training. Several qualifications are required before they can be accepted onto training courses, but considering the low level of education of craftsmen in Iran, this often poses a hindrance to obtaining proper training, markedly limiting the number of installation teams. In Fox and Skitmore's (2002) study, "financial and human resources" were among the six factors shown to be important in the development of the construction industry. The second aspect included this factor is human resources, and the development and availability of skills and knowledge. There is a shortage of skilled drywall installers in Iran. It was clear from the interviews that delays in installations regularly occur due to overbooking of installation teams. As electrical and piping installation is dependent on completion of the walls, this often results in delays to project completion and the total cost of the construction could subsequently rise. This problem can be tackled by promoting relevant training courses and more effective introduction to drywall for vocational college students on building and construction courses.

Knauf-Iran could play a more active role in preparing teachers and instructors, interacting with educational institutes and also contributing training material, which is often considered too costly for schools to acquire. The courses can also be adapted to the levels of knowledge and

skills of existing bricklayers, giving them a chance to learn the skills without the need for a degree as a pre-requirement. The company could also prepare specific accredited courses in collaboration with relevant international bodies and Iranian technical and vocational training organizations in order to boost the skilled workforce in this field.

5. CONCLUSION

Despite the recent success of drywall in western countries, the system remains unpopular among Iranian construction companies. Seven factors were identified as the main reasons for this problem through a thorough literature review and interviews with companies involved in the construction industry in Iran. These factors were cost, culture, overall quality, availability of installation teams, quality of the finished surface, high skill requirements and clients. The study was based on quantitative and qualitative data collection through interviews and questionnaires. Three factors, namely cost, overall quality and quality of the finished surface proved to be less significant, while the other four were statistically significant. These four factors could act as guides or action points for the government and companies to promote and market the drywall system in Iran

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