

BIM Competencies Insight and Improvement Perspective for Qatari Construction Industry

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Abstract: In order to support mega-events in the near future such as the FIFA 2022 World Cup, the Qatari construction sector is dealing with exceptional opportunities and challenges in the Building Information Modeling (BIM) domain. Big projects based on the use of this advanced new process are currently under development in new economic cluster areas in the country. For this reason, BIM is being implemented using any available method on many large projects despite the absence of any mandated BIM standards and/or government policies. Most companies in Qatar are collating portions of international BIM standards to produce guidelines aimed at resolving problems and overcoming projects constraints. All this raises a need for higher BIM competencies. An assessment in terms of BIM competencies to understand where Qatars construction industry practitioners are and where they are trying to go has become a necessity. Accordingly, this article seeks to provide a local insight of the BIM competencies available by adopting an integrated approach to BIM assessment. More than 220 practitioners have completed the assessment campaign that was conducted on a large scale across Qatar. Based on the findings, BIM level among practitioners within the Qatari construction industry varies from basic, intermediate to advanced. There is a need to raise this BIM level and improve BIM competencies. An educational BIM framework is under development to tackle those needs and fulfil industry expectations of academia.

Keywords: BIM, BIM competencies, Qatars construction industry, BIM campaign assessment

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INTRODUCTION

Organizations success is based on knowledge and competencies, it is not capital, equipment or technology that differentiates organizations; “it is their workforce and the processes by which that workforce is established, leveraged, and maintained”. Competencies provide a fundamental basic unit for ensuring that all of the employees in the organization could be fully integrated (Hijazeh, 2011). Therefore, competencies represent the common set of standards to be used for all human resources processes (Houtzagers, 1999) across several jobs regardless of organizational departments and units (Sanchez & Levine, 2009). Individual competency is the unit measure of an individuals ability to perform a specific activity and/or deliver a quantifiable result. Individual competency applies to a single person regardless of his/her role, position or employment status. Therefore; “Individual BIM competencies are the personal traits, professional knowledge, practical experiences, and technical abilities required by an individual to perform a BIM activity or deliver a BIM-related outcome. These abilities, activities or outcomes must be measurable against performance standards and can be acquired or improved through education, training and/or development” (Succar, Sher, & Williams, 2012; Wartika, Surendro, Satramihardja, & Supriana, 2015). A couple of researchers, have highlighted the need for an approach identifying and maintaining generic competencies related to BIM (Sharma & Gupta, 2019; Succar, Sher, & Williams, 2013). This will help BIM adoption as well as clarifying one of the indispensable qualities of BIM based projects which is the complexity of the activities during multidisciplinary collaboration. This latter is guaranteed by the examination of the fundamental components of BIM which are Process, Policy, Technology and most

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important People or Individuals as shown hereunder (see Fig. 1) in a study conducted by Underwood et al. (2015).

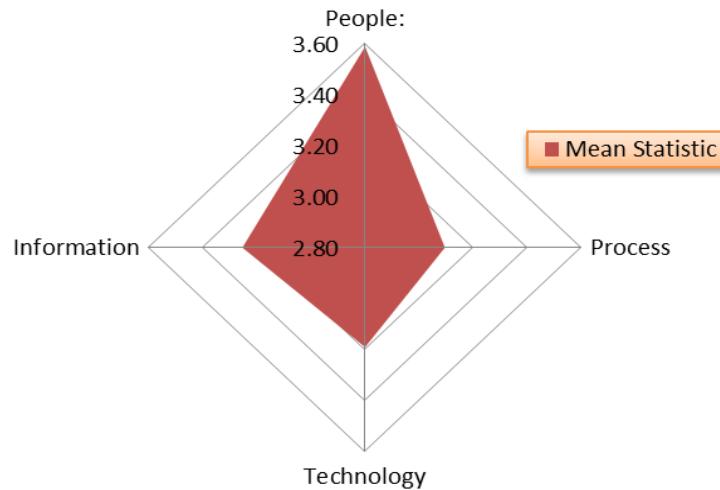


Figure 1. People component represent a major consideration for BIM

Accordingly, this article focuses on people/individual component and seeks to provide a general understanding of BIM Competency of Qatars construction industry practitioners by conducting a BIM assessment campaign based on an integrated approach to BIM (BIM Hierarchy) developed by Succar et al. (2012). This article provides and discusses the results of this local campaign, as well. It has been addressed to professionals of the construction industry and its findings will be utilized to enhance their BIM competencies.

REVIEW OF LITERATURE

Most of recent BIM research and industry publications focuses on how to improve the BIM technology tools (i.e., software programs, technical structure etc.) in order to deliver data-enriched BIM outcomes (Miettinen & Paavola, 2014). They have equally focused on deliverables based on BIM models and their diverse technical, procedural and regulatory criteria. There has been a focused interest in understanding and developing the non-technical competencies, while on the other hand, there are only a few focusing on the emerging BIM roles (Barison & Santos, 2011), and the identification, assessment and cataloguing of design competencies in the AEC-FM sector (Cerovsek, 2010). It is important to understand the different ways of competency manifestation in order to describe, assess and predict individual performance. There has been very limited attention given to this area of interest. A more advanced study of BIM competencies, of Individual competencies and BIM roles, would brighten the path towards better work management and flow in the Qatari construction industry. This output would consist of the basis for compiling an assessment and for the benchmark competency campaign. These tools are used in a manner to achieve a complex understanding and knowledge about BIM roles, competencies, requirements and gaps in the construction sector.

By reviewing several related literature studies, journals, articles, we put the focus on similar theoretical approaches interest in BIM individual competencies and assessment approaches. Despite the rapid growth of interest shown towards BIM, there remains a lack of studies examining its capability in relation to human workflow and workers. At the University of the West of England, UK, a series of professionals conducted a study regarding the prequalification and selection of construction supply chains firms for BIM projects (see Fig. 2). The results reinforced the criticality of BIM experience in delivery success (Mahamadu, Mahdjoubi, & Booth, 2017). To address the aims of the study, a survey was used to generate a list of competency sets, capability attributes that are relevant to the success of the project. The campaign was addressed only to the professionals in charge of the development and implementation of BIM. From studying the background of the participants, a majority of professionals have between 11

and 15 years of experience in the industry. This suggests a considerable number of well experienced and knowledgeable professionals. It is also a sign of stability, of how BIM technology has fixed its roots deep in the UK's construction industry sector.

BIM Qualification Criteria		Survey of Projects (S) n=64				Delphi Study (D) n=25		ANOVA - Type of Organisation		Agreement (S-RII and D-RII)			
		R _{II}	SD	Mean	Mean (Rank)		Mean (Rank)		F	p	<i>rho</i>	p	
Competence	Qualification	Key Technical Staff BIM Qualification	0.588	1.067	2.938	3.067 (9)	4.180 (3)	1.571	0.155	0.018	0.960		
		BIM Staff Availability for Project	0.669	0.946	3.344								
		Organisation's BIM Accreditations and Certifications	0.478	1.229	2.391								
		Organisation's BIM Training	0.719	1.065	3.594								
	Staff Experience	Managerial Staff BIM Experience	0.713	1.125	3.563	3.883 (1)	3.449 (1)	4.080 (6)	4.173 (1)	0.939	0.493		
		Key Technical Staff BIM Experience	0.841	0.858	4.203								
	Organisation Experience	BIM Software Experience	0.731	0.781	3.656	3.399 (3)	4.260 (1)	0.734	0.661				
		Past BIM Project Experience	0.719	0.921	3.594								
		BIM Experience on Similar Project	0.603	1.076	3.016								
	Capacity and Resources	Internal Use of Collaborative IT Systems	0.666	0.977	3.328								
		IT Vision and Mission	0.631	0.979	3.156	3.333 (5)	3.933 (9)	0.892	0.530	-0.047	0.884		
		Quality of BIM Implementation Strategy	0.719	0.849	3.594								
		BIM Research and Development	0.650	1.084	3.250								
		Technical (Physical) Resources	0.700	0.960	3.500	3.068 (8)	4.213 (2)	2.089	0.053				
		Software Availability	0.566	0.901	2.828								
		Data Storage (suitability and capacity)	0.575	0.951	2.875								
		Specific BIM Modelling Capacity	0.725	1.266	3.625	3.244 (2)	4.160 (4)	0.771	0.629				
		BIM Standards	0.700	1.039	3.500								
		Data Classification and Naming Practices	0.578	1.143	2.891								
	Proposed Methodology	BIM Modelling Maturity	0.738	1.125	3.688								
		Suitability of Proposed BIM Execution Plans for Project	0.769	0.801	3.844	3.149 (7)	3.940 (8)	1.367	0.232				
		BIM Vendor Involvement and Support	0.491	1.181	2.453								
Culture and Attitude	Reputation	Reputation of Organisation	0.491	1.181	2.453	2.453(11)	4.040 (7)	1.135	0.355	0.058	0.913		
		Attitude and Willingness	0.672	1.060	3.359								
	Technology Readiness	Awareness of BIM Benefits (in project context)	0.747	0.802	3.734	3.354 (4)	2.863 (4)	4.120 (5)	3.987 (3)	2.089	0.053		
		Extent of IT Support to Core Business and Processes	0.594	1.098	2.969								
	Organisational Structure	Levels of Decentralisation	0.556	1.105	2.781	2.781(10)	3.800 (11)	2.186	0.043				
Cost	Price of BIM Service	0.638	0.906	3.188	3.188 (6)	3.188 (3)	3.920 (10)	3.920 (4)	1.038	0.420			

Figure 2. Analysis of criteria relative influence on BIM delivery success in practice

Nowadays, good managerial and digital competencies of managers represent a key feature, a competitive advantage to every company. These kinds of skills and competencies lead to a better result in the construction industry. Although, as several studies and literature reviews have suggested, there are a series of countries around the world where this problem is not fully addressed. Mesároš, Mandičák, Mesárošová, and Behún (2016) focuses on proposing a solution for filling the gaps in Slovakia's construction industry, by conducting a survey, analysing data, and providing answers towards the development of managerial and digital competencies through BIM technologies. It is necessary to put the spotlight on the importance of monitoring the requirements and the competencies needed in this sector. It is true to say that for the use of intelligent information systems for buildings, it is essential to acknowledge a set of skills and digital competencies. In the context of the construction sector, BIM represents the process of delivering assets using well-structured digital information. BIM is a tool to connect and bring together several professionals with different roles, with different competencies. In other words, BIM is a tool of communication (Mesároš et al., 2016). After the survey was conducted among Slovakia's construction industry professionals, the data was processed, and after crossing the line, a few hypotheses came through. The research hypotheses put some light on the complex network of industry, and where there are gaps that need bridging. It is said that there is a direct connection between the size of the construction company and the improvement in management processes used by BIM technologies. Also, the participant of the construction project has an effect on improving the management process and thereby improving acquisition of managerial and digital competencies of managers. The researchers discovered how Slovakia's construction sector shows unceasingly growing trend towards the use of BIM technologies. It quantifies how much of an impact it has and how much it can improve the digital and managerial competencies. (see Fig. 3)

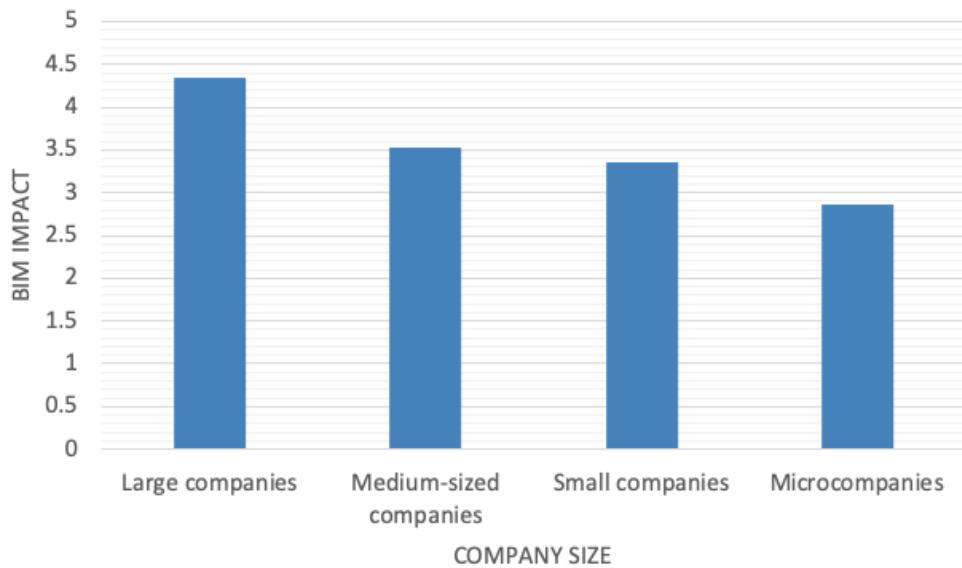


Figure 3. Developing managerial and digital competences of managers through BIM (company size view)

In the process of improving the quality of BIM execution, facility owners play a vital role in Architecture, Engineering, Construction, and Operation Industry. On the other hand, BIM is not fully understood and implemented. A team of researchers conducted a study which expands upon the foundation and suggests a different approach to assessments which incorporate a more inclusive list of variables. By using Delphi method, a survey was conducted by [Giel and Issa \(2014\)](#). The survey targeted only professionals, of five typologies, and of five different categories, namely:

- Architects/Engineers
- Constructors
- Owners
- Consultants
- Academics

As an outcome, this study defined and prioritized 66 critical BIM competency factors needed for the building owners to possess. Two important factors were frequently highlighted, among the surveys answers, to evaluate building owners' BIM competency included: having adequate support from upper management and for a quality control plan for checking BIM deliverables. Based on this study, the need and the importance of BIM competencies among building owners were highlighted. Starting with the Upper Management factors to the Hardware Standards factors, all 66 competency factors concluded, are highly important and relevant for the facility owners' network of processes. (see Fig. 4)

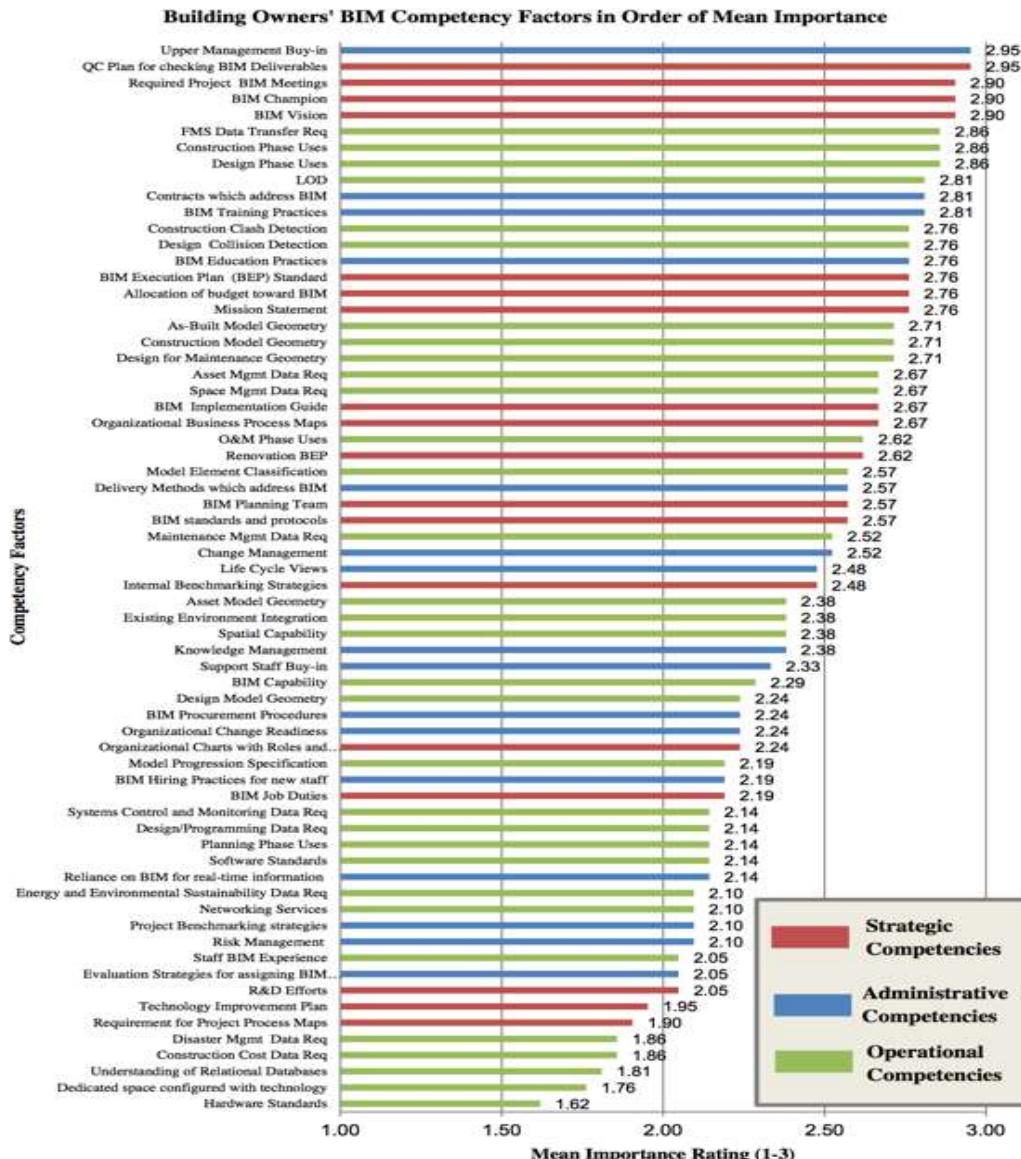


Figure 4. R3 mean importance ratings for competency factors in order of relevance

LOCAL CONTEXT

Due to the never-ending growth of technology and its accelerating development, the identification of a specific set of BIM roles will not be permanent. They will be the subject of diverse transformation, a fact that is actually a feature of the present not only the future. But, it is more important and relevant to discover the BIM competencies among the construction industry, competencies that are shaping the current roles and affect emergent ones. In order to identify BIM competency that needs to be learned, an integrated approach to BIM assessment developed as stated earlier is adopted. Specifically, this approach is tailored for the Qatari construction market and a BIM competency assessment campaign has been launched. In the perspective of national development, of reducing cost, of working more efficiently, all the data accumulated in this research will set the grounds for quality education and training abreast of the rapid evolution nowadays. Qatar will be among the first countries in the world to complete such an assessment, generate detailed benchmarks, and have such rich data at its disposal to guide performance improvement. It is designed based on a pilot study (preliminary one) that was done previously, which provided valuable insights about the Qatari construction market. An online platform was established <https://qatarbimcompetencies.qa/survey/> within the research project website including

an introduction to the project, research team structure, as well as the professionals who should participate.

METHODOLOGY

Through methodology, we understand a set of methods, a series of steps used in a particular area of study or activity. This study was approached in a methodological way, a series of steps leading to a concrete base for conducting this assessment. Before conducting the campaign, it is important to collect relevant information in order to set the base for what is next to come. Firstly, the data was obtained. The amount of information needed for this preliminary phase, for creating a sustainable and valid assessment, was obtained with the help of several different methods. Several interviews with Qatari's industry professionals and experts were conducted. By talking to a large number of professionals, we could draw a picture of the current status of Qatar's construction industry in terms of BIM competencies. A further analysis was conducted on a series of job adverts, job postings regarding BIM roles. Secondly, a well-structured inventory of competency sets was put in place by categorizing and classifying the competency sets and requirements according to their scale or, more precisely, into a hierarchy. A meaningful aggregation of BIM knowledge was used to perform the assessment. Establishing the BIM competency hierarchy forms the universal method for classification and interpretation of collected data sets of competencies. It is a subdivision from tiers, sets, topics to items, which helps in understanding an individual competency profile using a broad spectrum of topics. The BIM Competency Hierarchy includes three BIM competency tiers which are divided into several BIM competency sets which are, in turn, subdivided into BIM competency topics. These tiers, sets, topics and their granular subdivision into competency items represent all the measurable abilities, outcomes and activities of individuals who deliver model-based products and services. (See Fig. 5)

The study was conducted covering two competency components, knowledge, and experience, by using the Individual Competency Index. It measures both conceptual knowledge, understood as "knowledge", and procedural knowledge understood as "skill", both needed by individuals in order to perform defined activities and to deliver a measurable outcome.

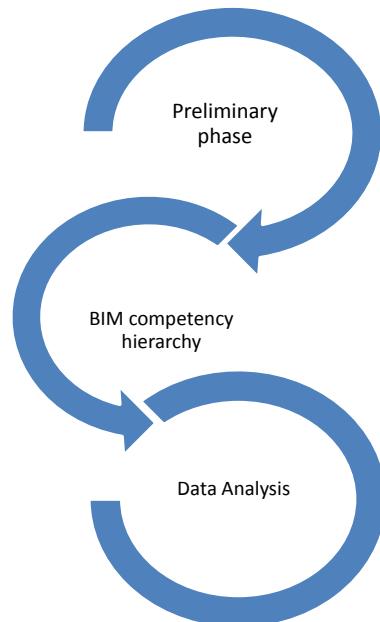


Figure 5. The methodology flowchart

The survey

The main campaign was conducted based on an organized network of competency items, divided into 8 competency sets which are a part of BIM competency hierarchy under the domain tier mentioned earlier. There are four primary sets: Managerial, Functional, Technical, Supportive and four secondary sets: Administration, Operation, Implementation, and Research & Development. Each competency item

has its own set of questions and its own criteria of validation based on specific skills and abilities to engage in different situations, actions, and processes (See Fig. 6).

(Managerial) Do you have the ability to: *

	0-None...	1-Basic...	2-Inter....	3-Adv....	4-Expert.	N/A....
1-Generate an overall mission statement covering BIM Implementation within your organization	<input type="radio"/>					
2-Communicate the big picture transformations caused by the diffusion of BIM tools and workflows within industry	<input type="radio"/>					
3-Establish the BIM Goals and BIM Objectives of your organization according to its overall Business Vision	<input type="radio"/>					
4-Develop a clear, high-level Information Management and Collaboration strategy that suit the unique requirements of each Collaborative BIM Project	<input type="radio"/>					
5-Identify client requirements and objectives which can be delivered through a Model-based Workflow	<input type="radio"/>					
6-Identify changes to organizational processes as necessary to benefit from BIM Software Tools and Model-based Workflows	<input type="radio"/>					

Figure 6. The managerial sample set

Data collection

The novelty of this campaign consists of the focus for the aspects related to the people, to the human part, rather than particular BIM technologies and processes. A big part of the process of reaching out to the public was played by the organization of several industry forums in Qatar. Both BIM Hub Talk, and Future Projects Qatar Conference, represented perfect platforms for the study to be heard and to reach Qatari professionals, project owners, contractors, service providers, technology providers, consultants, investors. It was an opportunity to meet, to discuss and to evaluate. To achieve the goal of reaching as many professionals as it can, a call was made on several social media platforms such as LinkedIn and Twitter. Thanks to this, a series of construction industry professionals, involved in design, construction, and operations of the built assets, took part in the BIM assessment campaign. Official emails were sent including an official invitation letter to relevant contacts in the Qatari construction industry market.

RESULTS AND DISCUSSION

Main campaign collected more than 220 respondents after closing the questionnaire. A set of quantitative ratings, charts and textual summaries is generated during the data analysis section.

Data pre-processing

A series of problems with the data consistency were highlighted. These inconsistencies related to several identical respondents (names, emails) detected, i.e., duplicates. Different source files contain

different respondent names; some of the responses seem to be fake ones, or not consistently taken questionnaire. Values for some responses are identified as outliers, because the values are the same for all the items and the email and name are suspicious. As for that, arrangements to validate and curate this data is a priority. An authenticity check was conducted by the research team in order to curate and detect both unique respondents and verifiable respondents. This check intended to ascertain that the declared job role (which is basic for the comparison taken) is consistent with the LinkedIn profile information, if existent, or available trustworthy professional reference. Inconsistencies were found when the profile did not match the expected one, and a further assessment on the consistency of the responses for these was conducted. The aim of this is to avoid lack of coherence associated to a specific job-related category. The number of unique responses became equal to 190.

Data analysis

Firstly, a classification of the different job-related groups in which the population of respondents lies on was conducted. The bar plot for this first classification method highlighted that some of the groups would not have enough respondents to make the assessment relevant in terms of the competency gaps. A second approach was designed in order to classify these respondents by job-related categories (See Table 1 & Fig. 7)

Table 1: Income groups classification

Categories	Description
Category A	Designers and Drafts people - all disciplines and levels
Category B	All information management roles across domains
Category C	Project Managers and Facility Managers
Category D	Academia, Cost Surveyors, Sales, Admin and Others

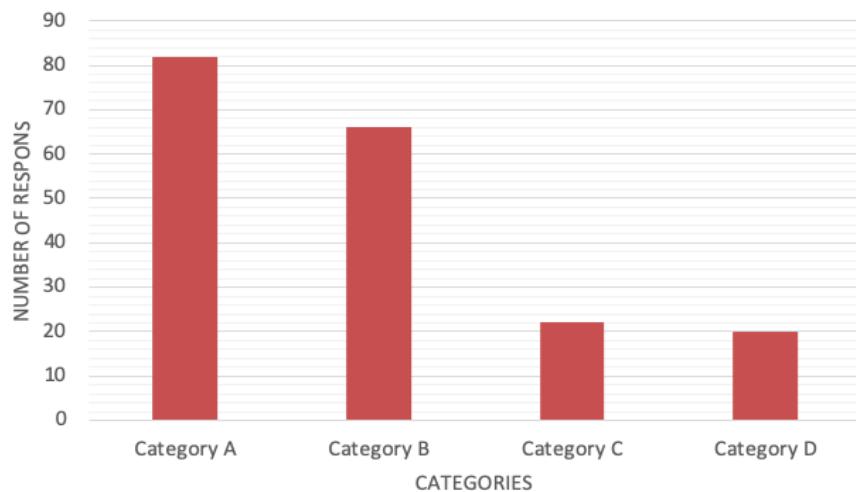


Figure 7. Number of respondents per job-related categories

Categories specifically related to CAD, drafting and BIM related jobs (A) and to information or BIM management (B) are the most populated, which will add consistency to the analysis that is trying to depict an image from the existing construction industry sector. The distribution in terms of experience in Qatar shows a majority of respondents in the interval of 1 to 5 years of experience, this confirms the trend in the Qatar construction industry of high level of personnel rotation (See Fig. 8).

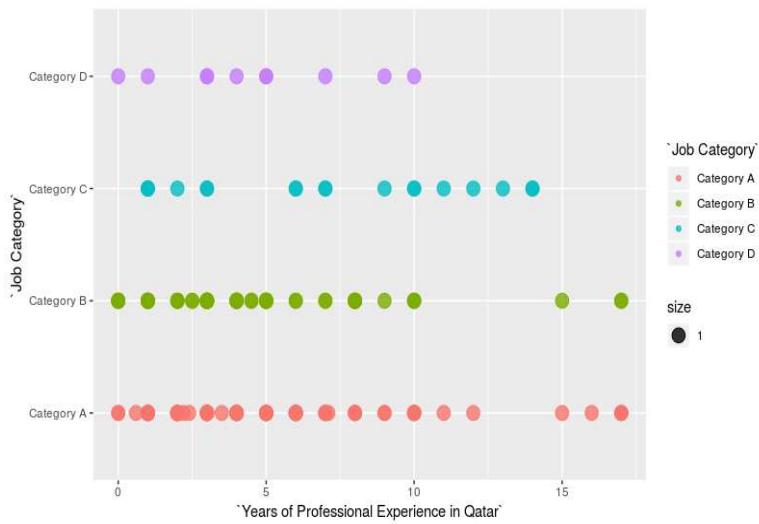


Figure 8. Years of professional experience in Qatar per job-related categories

For category A, the median value is around 5.3 however, there is a significant number of respondents who have recently started their career in Qatar.

For category B, the median value is around 4.5 which is close to that of category A with a significant number of respondents who have recently started their career in Qatar (up to 2 years). This confirms that BIM natives and information management positions are filled in with professionals new to the Qatari environment, be them new graduates, or coming from different countries. Another explanation to this would be that as a novel technology, adoption by more experienced professionals is limited.

For category C, the median value is around 7.85 with an evenly more balanced distribution, while the median for category D is around 4.5 but with similar concerns on the number of respondents to that of category C.

In Fig. 9 below, we can clearly see that category B does have high score for all sets average values, which can be inferred that the target competency profiles (TCPs) are related to this category. The average values are ranging between 2 and 3, this indicates an intermediate to advanced BIM level among this category. The resting categories (A, C & D) dont have high score but close sets average values that are ranging between 1 to 2 which confirms the softness knowledge of BIM among those categories (basic to intermediate).

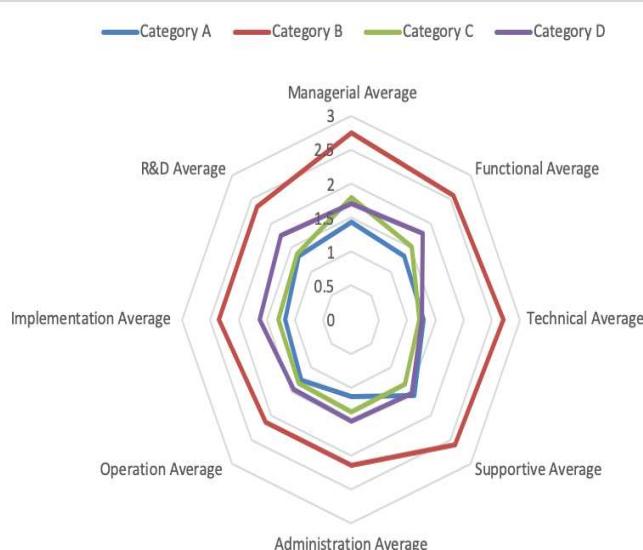


Figure 9. Sets' average values for all categories

The results for the different job-related categories across the competency topics are shown in clustered columns hereunder (fig10, 11, 12 and 13). The purpose is to summarise the statistical frequency and main indicators that enables a visual index of the most proficient topics in each category.

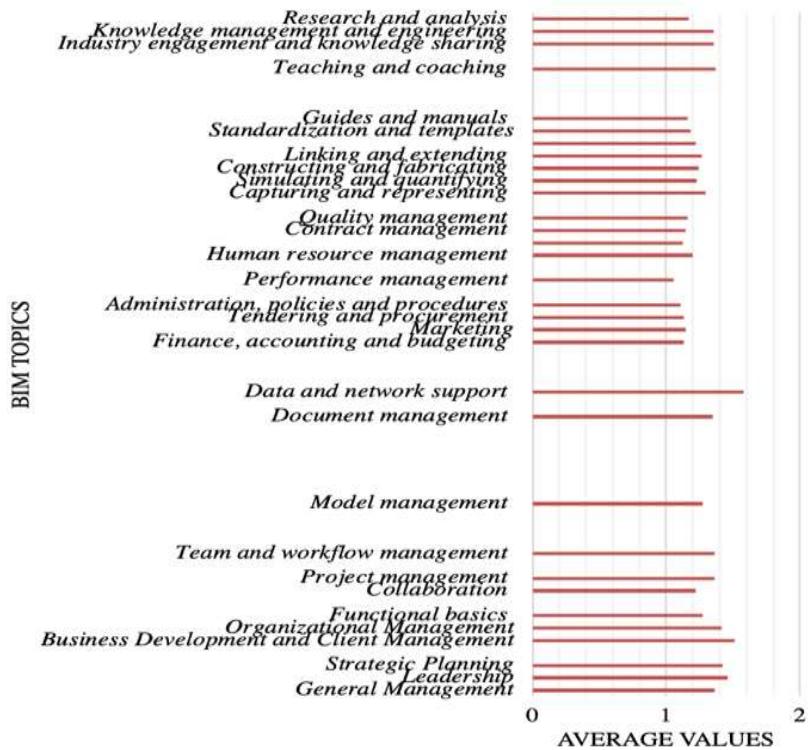


Figure 10. Topics average values for category A

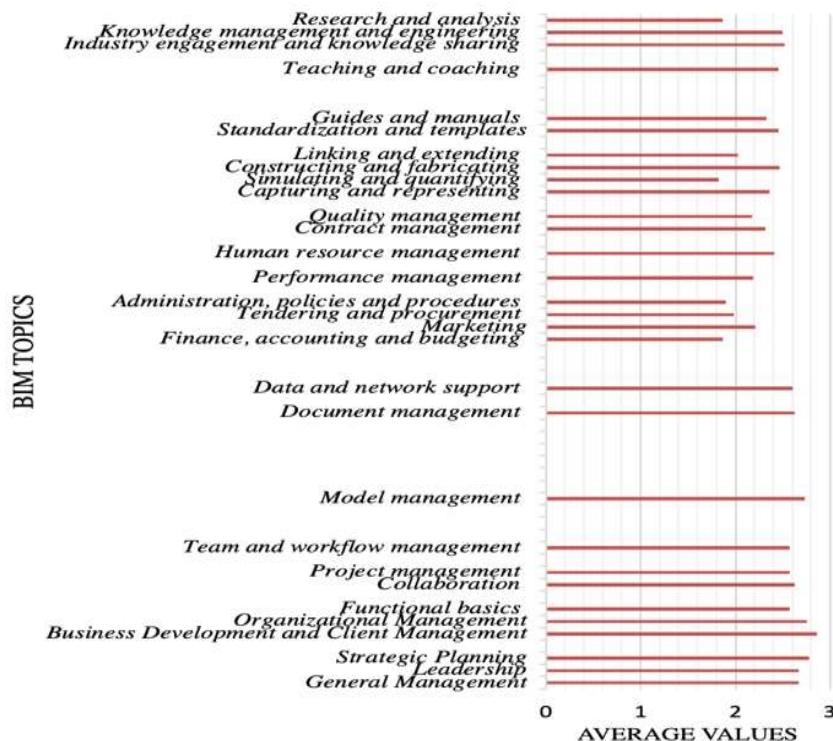


Figure 11. Topics average values for category B

Most of the topics in the category A do not have a high score, the average values are ranging between 1 and 1.5 which means that BIM level among this category is basic to less intermediate. Data and Network support, and Business Development and Client Management have the highest score however other relevant topics have more consistent rate of responses such as Leadership, Organizational Management, Strategic Planning, Document management.

Most of the topics in the category B do have a high score, the average values are ranging between 2 and 3 which means that BIM level among this category is intermediate to advance. The need from this professional sector is crucial to the use of BIM within the organisations.

General Management, Leadership, Strategic Planning, Business Development and Client Management, Organizational Management, Functional Basics, Collaboration, Project management, Team and workflow management, Model management, Document management and Data and Network support have the highest score which indicates that they are more pertaining to this job-related category. There is a more consistent rate of response over all topics that cover the majority of BIM tasks to be performed within an organization.

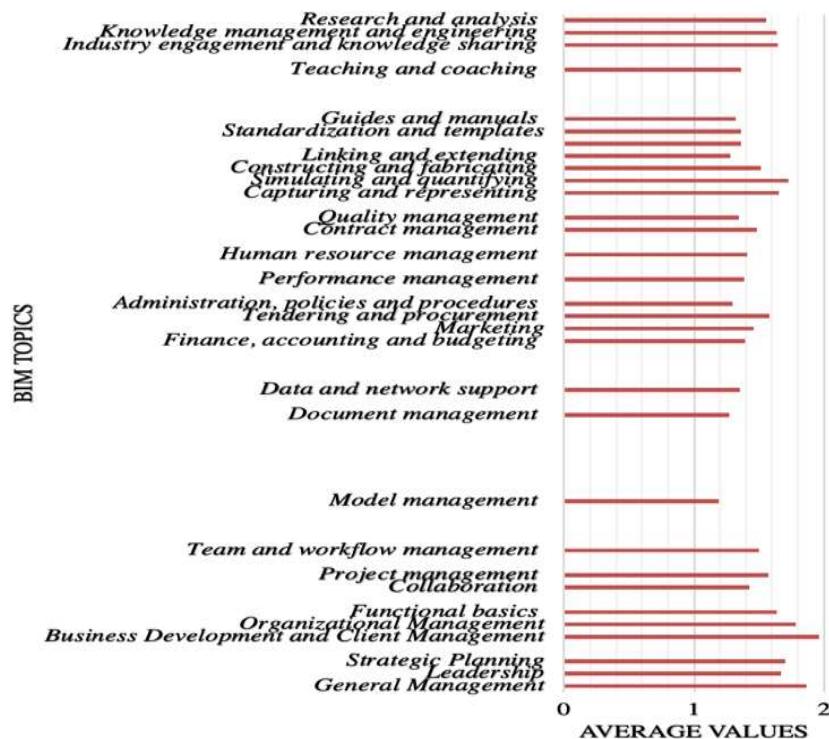


Figure 12. Topics average values for category C

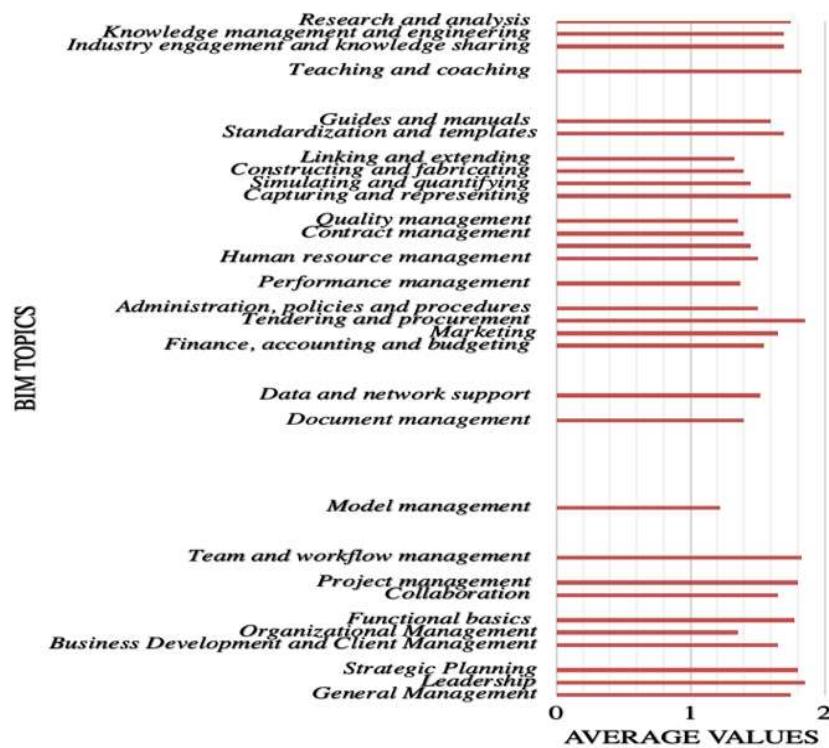


Figure 13. Topics average values for category D

Most of the topics in the category C do have a medium score, the average values are ranging between 1 and 2 which means that BIM level among this category is basic to intermediate. General Management, Leadership, Strategic Planning, Business Development and Client Management, Organizational Management, Functional basics, Project management, Tendering and procurement, Capturing and representing, Stimulating and Quantifying, Industry engagement and knowledge sharing, Knowledge management and engineering and Research and analysis have the highest score which indicates that it is more pertaining to this job-related category. Most of the topics in the category D have a medium score, the average values range between 1 and 2 which means that BIM level among this category is basic to intermediate. General Management, Leadership, Strategic Planning, Business Development and Client Management, Organizational Management, Functional basics, Collaboration, Project management, Team and workflow management, Tendering and procurement, Capturing and representing, Stimulating and Quantifying, Standardization and templates, Industry engagement and knowledge sharing, Guides and manuals, Teaching and coaching, Industry engagement and knowledge sharing, Knowledge management and engineering and Research and analysis have the highest score which indicates that it is more pertaining to this job-related category.

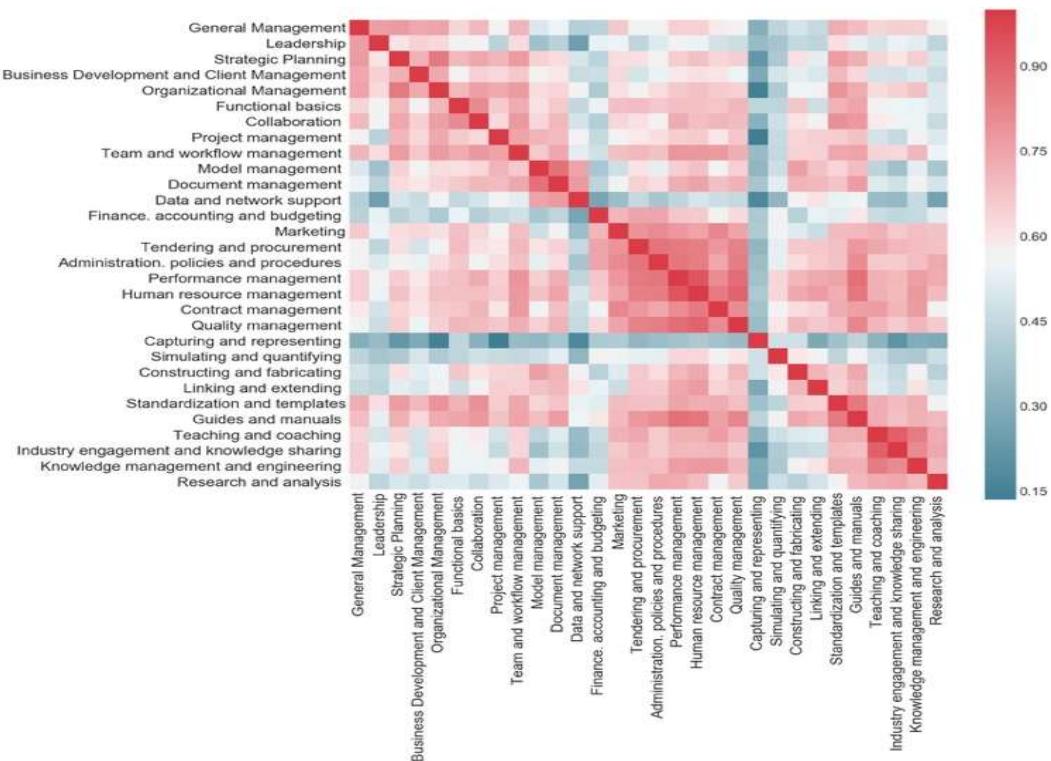


Figure 14. Correlation across competency topics

The correlational analysis (Fig. 14) helps identifying mutual relationships between two topics or more. If there is a high correlation between topic X and topic Y; the existence of topic X within an organisation would be likely to bring topic Y. Since the category B represents most of BIM practitioners in Qatar, the correlation analysis is based on the result of this category. Two competencies aspects compose the high priorities topics to focus on in this analysis i.e. most valuable and easily transferable. The competency topics with higher added value to a company are represented with low correlation, and high maturity level such as Data and network support, Capturing and representing, Simulating and quantifying, Research and analysis. Those topics are assigned to small number of professionals within the organization due to their specificity which is justified by the low correlation proportion. The easily transferable competency topics are highly correlated with each other, and they can be understood without difficulties, therefore those are deemed as primary competency topics in terms of prioritisation. Those topics include (General Management, Leadership, Strategic Planning, Business Development and Client Management, Organizational Management, Functional basics, Collaboration, Project management, Team and workflow management, Model management, Document management, Tendering and procurement, Administration policies and procedures, Performance management, Human resource management, Contract management, Quality management, Constructing and fabricating, Linking and extending Standardization and templates, Guides and manuals. The topics that have low correlation and are not highly demanded, understood, or recognised by the respondents within their usual activities, are deemed as secondary competency topics in terms of prioritisation such as Finance, accounting and budgeting, Marketing, Teaching and coaching, Industry engagement and knowledge sharing, Knowledge management and engineering.

CONCLUSION

This article focuses on the Qatar BIM assessment main campaign that was designed based on an integrated approach to BIM. It was conducted in order to assess BIM competencies among practitioners within the local industry market. A considerable amount of data was obtained during this assessment campaign that permitted to get a general overview of the measured BIM competencies. This insight will help as a reference for the competency-based BIM educational framework which is currently under development. So, national universities have to calibrate their curricula to support the BIM level rising

need. This article has highlighted two types of competency topics as well (easily transferrable and most valuable) that should be taken into account when providing BIM education. Research work regarding the implementation of the framework will be sought in the near future.

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