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Factors Analysis-Based Studies on Effectiveness of Graduate Architects in Building Contract Administration (BCA)

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Abstract

Graduate architects play a vital role in building contract administration (BCA) when architects are assigned partly of their tasks to graduate architects due to being unable to cope with the massive development in the nation. Hence, graduate architects' capability in BCA affected the project team and the project delivery process. This study aims to identify factors that affect graduate architects' work performance in BCA associated with housing projects. A comprehensive literature review was conducted to establish the questionnaire to test 127 practising graduate architects in Malaysia. Data collected from the survey are evaluated using principal component analysis to understand the crucial factors affecting graduate architects' work performance. The variables within the factors are tested to confirm the reliability and validity of the constructs. Four types of knowledge with 19 indicators were extracted after iteration. The result from the study showed that the types of knowledge required by graduate architects to work effectively in BCA are communication and relationship management knowledge, design management knowledge, project management knowledge, and claims and legal matters knowledge. The contribution of this study is to improve graduate architects' work performance in BCA. Educators may utilise this study to enhance the syllabus according to market niche and nurture graduate architects to become a catalyst in the construction industry.

Keywords: graduate architect, building contract administration, knowledge, factor analysis

1. Introduction

The primary objectives of the individual appointed to administer a building contract include delivering the project safely, to specified quality standards, on time, and within the employer's budgetary constraints (Cunningham, 2016). The building contract administrator (BCA) has two distinct functions: an agent and a certifier (Bin Zakaria, Binti Ismail, & Binti Yusof, 2013). The role of building contract administrator commenced when the building contract between the employer and contractor was in place (Chong, Balamuralithara, & Chong, 2011). The most popular and widely used standard building contract throughout the private sector is the Pertubuhan Akitek Malaysia (PAM) form of contract, where the architect traditionally fills the role of contract administrator (Bin Zakaria et al., 2013).

Recently, many studies related to housing projects have been investigated due to the increasing number of housing projects experiencing delays for various reasons (Mezher & Tawil, 1998). Mezher et al.(2018) identify that consultant-related related is one factor in delays in housing projects. Other studies also verified that many housing projects suffered disastrous outcomes linked with the attitudes of professionals from the intricacy and the magnitude of the work, multiple prime contracting parties, poorly prepared, unsure about roles and responsibilities, inadequate planning, financial issues, and communication problems (Alaghbari, Kadir, & Salim, 2007). These factors derail a project, leading to complicated litigation and arbitration, increased costs, and damaged business relationships.

Consultants are led by the building contract administrator (Bin Zakaria et al., 2013). The building

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contract administrator's task is to orchestrate and motivate the project team to deliver the best possible performance individually and as a team member (Thomas & Ellis Jr., 2007). This task is complicated by the nature of traditionally procured building contracts, where project teams are assembled by members who have little or no previous experience working alongside each other (Mydin, Sani, Salim, & Alias, 2014). Individuals suspect each other's motives and have diverged, conflicting objectives that delay the project. Hence, the administrator must have an effective strategy to ensure the project delivers as committed to the employer. Ideally, The building contract administrator should be carried out by someone with expert technical knowledge of the construction process, strong leadership qualities, and highly developed interpersonal skills (Katz, 2009).

An architect is the building contract administrator since he is the designer of the project and the person who has a better understanding of PAM contract and communication among the team, able to conduct proper planning and monitoring and consist special skills to lead and handle problems at construction sites (Yadollahi, Mirghasemi, Mohamad Zin, & Singh, 2014). Indeed, a GA may be appointed to play the leading role in building contract administration. This may occur when there is a lack of architects in Malaysia and subsequently encourage the architects to delegate their supervision and monitoring duty to their representatives, which is the GA permitted under Uniform Building By law-5 (UBBL, 2013).

Based on research carried out by Khodeir (2020) aimed at disclosing the attributes of graduate architects from the Malaysian industry's point of view, employers have often given negative criticism regarding the attributes that graduates have at the early stage of their careers. Architectural firms are dissatisfied with the quality of the graduates and still note that they have to re-train fresh graduates to make them fit for their jobs before starting their practice (Khodeir & Nessim, 2020). Incidents of missing scope, unclear or insufficiently detailed work, contradictory information, incorrect dimensions or unbuildable details, uncoordinated systems, and other failings plague design professionals and vex owners; coordination errors resulting from a team of consultants preparing documents from three or more disciplines are always presented when graduate architects involved in administering building contract (RIBA, 2020). Consequently, the building contract administrator will bear the legal responsibilities as misconduct/negligence is taken as a serious offence under the provisions of the Architects Act 1967.

Therefore, this study examines the knowledge required for graduate architects in BCA to increase their professional development. To achieve this objective, the types of knowledge were first identified through a literature review, followed by a questionnaire survey with 127 practising graduate architects, and analysed with factor analysis to categorise the result into significant themes. The significance of this study is that housing projects delayed caused by consultant-related factors will be minimised, and the findings also contribute to the body of knowledge on the features of job satisfaction for graduate architects.

2. Literature Review

2.1 Building contract administration

The administration of a contract is necessary to ensure the contract is performed according to the articles of agreement and conditions of the contract and within the framework of related laws and the practices of the construction industry (Bin Zakaria et al., 2013).

Building contract administrators refer to people who ensure the contract between employer and contractor is executed and adhered to the contract terms (Cunningham, 2016). They undertake any necessary design changes, advise on any particular program and sequence of work implications, advise on any costing for their field of expertise, produce and supply design documentation, inspect works to ensure design/specification met by the contractor, prepare documents to issue instructions under the building contract, coordinate and advise on the adequacy of information provided, certify the number of interim payments to be made by the employer to the contractor, approve the quality of materials or goods or of the standard of workmanship (Cunningham, 2016). In addition, the administrator's task covers orchestrating and motivating various consultants and contractors to deliver the best possible performance individually and as team members (Ostime, 2019; Ricchini, 1979).

In a PAM contract, the contract administrator is the architect (Tan, Low, Sum, & Chee, 2010). They undertake the decision-making, advisory, and information roles in the context of the PAM contract forms and contribute to achieving the primary project objectives (Tan et al., 2010). Building contract administration scope of work can be categorised as project governance and start-up, contract administration team management, communication and relationship management, quality and acceptance management, document and record management, financial management, changes control management, claims and disputes resolution management, control risk management, and contract closeout management (Ricchini, 1979). Since the scope of work as a building contract administrator is vast, the involvement of graduate architects is required to reduce the workload of architects.

2.2 Graduate architect

As illustrated by LAM, a graduate architect (GA) is a person who holds a qualification recognised by the LAM or sit and pass the Part I and Part II examination before being qualified to be registered as a graduate architect with LAM (Malaysia, 2006). They act as assistants for architects and carry out tasks such as understanding client design briefs, coordinating with designers, preparing and submitting drawings to authorities, and arranging and preparing schematic/tender/construction/ contract drawings (Chappell & Dunn, 2015). Besides performing as assistants in the design phase, graduate architects also assist admin building contracts on behalf of architects during the construction phase (Malaysia, 2006).

2.3 Underperformance of Graduate Architects in BCA

Graduate architects support the building contract administrator in housing projects. The employer relies on them to properly manage and control the construction activities on site (Hayes, 2014). However, they are among the graduate architects who have poor planning, poor communication and coordination, lack of system, misunderstand the process, lack of skills, unclear roles, lack of training, and lack of performance measurement, which cause inefficient construction processes, delays, reworks, un-necessary variations, poor communication among team players, conflicts and disputes for both employer and contractors (Yadollahi et al., 2014).

Traditional methods imposed by computer-aided design (CAD) in the development of new projects have evolved towards the use of Building Information Modelling (BIM) methodologies, enabling the control of different aspects such as design, construction and monitoring of a building (Arayici et al., 2011). The documentation for the construction of buildings has been classified into three main phases: the manual phase, the digital phase and the BIM phase (Diaz, 2016). Each phase needs a period of adaptation between the project stakeholders in the construction sector. This is where graduate architects cannot cope due to a lack of skills and training for BIM-oriented projects. As a result, investments in the construction industry suffer damages when the graduate architects in BCA do not adequately perform (Mari, Srirangam, Gunasagaran, Kuppusamy, & Ang, 2019). The types of knowledge required in BCA must be identified to assist the graduate architect in elevating their work performance.

2.4 Types of Knowledge Required for BCA

Project success depends on the performance of the graduate architects entrusted to execute the project (Walker, 2015). Previous studies identified 38 types of knowledge to be competent to support building contract administrators (Alias, Ahmad@Baharum, & Idris, 2012). Mistakes and pitfalls can be avoided by engaging a graduate architect who is knowledgeable and appropriate for the job. Understanding the types of knowledge required in BCA will encourage graduate architects to acquire that knowledge to enhance their work performance (Harmon & Stephan, 2001).

Types of knowledge required by graduate architects in BCA had been categorised into five themes: to instil claims and legal matters management knowledge, project management knowledge, communication and relationship management knowledge, design management knowledge, and quality and assessment management knowledge.

2.4.1 Claims and Legal Matters Management Knowledge

Most standard-form contracts provide mechanisms and contain clauses explaining the process of giving notices and the likely consequences for failure to deliver, as stated in the contract (Abotaleb & El-Adaway, 2017). Therefore, most construction contracts require written notice for changes, differing site conditions, extra work, or other events that may affect the contractor's time and cost performance (Hamzah, Khoiry, Arshad, Tawil, & Che Ani, 2011). Graduate architects familiar with claims and legal matters knowledge would be able to advise contractors/employers to fulfil the conditions of the notice clause by responding promptly to prevent unnecessary disputes.

A complete and robust claim document is essential in presenting a claim and resolving disputes (Ahmed, Tahir, & Ismail, 2019). For solid documentation, the information should be contemporaneous, documenting and closing out the work as it is performed; information should be consistent and transparent (Harmon & Stephan, 2001). The claim must be supported with all the required documents in dispute with a simple, complete, and comprehensive approach. The documents mentioned earlier refer to charts, graphs, drawings, photographs, and videos of completed work, testing conducted, quality control activities, detailed pricing of the claim, specifications, special conditions, specific instructions, contractor's calculation, project diary with record the weather,d manpower, visitors, and contractors on site, key deliveries and notable event (Harmon & Stephan, 2001). The problem resolution will respond more effectively if all the above considerations are appropriately addressed.

2.4.2 Project management knowledge

Construction projects naturally grow in scale, involving vast numbers of professionals, long life cycles, complex interfaces, highly specialised knowledge, and experiential feedback (Alaloul, Liew, & Zawawi, 2016). Project management was developed to address these challenges by facilitating project implementation and delivery. PMBoK proposed ten knowledge areas for project management, and Construction extension proposed an additional four that consist of project integration management, project scope management, project time management, project cost management, project quality management, project human resources management, project communication management, project risk management, project procurement management, project stakeholder management, project safety management, project environmental management, project financial management and project claim management (Alaloul et al., 2016). The Project Management Body of Knowledge Guide (PMBoK) concepts and

areas are useful in devising better project management solutions.

2.4.3 Communication and relationship management knowledge

Most communication during a construction project is spent on speaking and listening, with less time on reading and writing (Emmitt & Gorse, 2006). Reluctant communicators are unlikely to hold influential positions or be perceived by the team members as leaders. Graduate architects in BCA who coordinate the team should enable, foster, and create the understanding and trust necessary to encourage others to follow a leader (Dainty, Moore, & Murray, 2007). As a project develops, the graduate architect must improve communication and relationship management knowledge to become more effective. There are three types of communication: core communication, managerial communication, and corporate communication (Wahyuni, Masih, & Rejeki, 2018).

2.4.4 Design management knowledge

With the increasing building production and technical complexity, the number of design specialists involved rises, leading to the need to manage the design process (Cooper & Press, 1995). In this context, they are mainly interpreted as the management of information handling between the participants in the design team. This knowledge includes planning the design process backwards from when these deliverables are due to be released to the client or contractor (Wang, Tang, Qi, Shen, & Huang, 2016). A master program is produced and distributed to the design team, who plan their work within the framework of the master program. In addition, design management knowledge also includes concurrent working, targeted solution workshops, and timely design reviews, which encompasses design planning, scheduling, and control (Ling, 2004).

2.4.5 Quality and assessment Management Knowledge

Quality and assessment management knowledge are to concur issues such as lack of proper planning during the design phase, under reinforcement, not adhering to project specifications, lack of use of standard materials, use of unqualified professionals, insufficient management staff, and the team responsible for controlling quality, errors owing to poorly detailed design, speedy construction and ignorance (Oyedele & Tham, 2007). The benefits of implementing quality and assessment management knowledge are improved communication problems, minimised mistakes, reduced rework and wastage of materials, and exercised better control over main contractors and consultants (Burati Jr., Farrington, & Ledbetter, 1992). Thus, productivity, profitability, and market share gradually increased, which enabled contractors to meet employers' requirements.

3. Research Methodology

3.1 Selection of Respondents

In this research, a purposeful sampling method was adopted to gather more detailed information regarding the perception of types of knowledge required by graduate architects in BCA for housing projects in Malaysia. To select respondents for purposeful sampling, a particular criterion has been identified. The criterion for selecting respondents is as follows: a graduate architect who has worked two years and above in the construction industry, in the BCA during the construction phase and who manages strata housing projects. While the following were excluded: those who do not meet the inclusion criteria and those who are unwilling to participate in the study (Chen, Nakatani, Liu, Zhao, & Xie, 2020).

Purposive sampling was used to select an accessible population of 2444 graduate architects registered under the Board of Malaysia as of December 2020. In accordance with the Architect's Act 1967, graduate architects are defined as those with Part II accreditation in Architectural education and are registered with the Board. Based on Krejcie and Morgan's (1970) table for determining sample size, for a given population of 2444, a sample size of 331 would be needed to represent a cross-section of the population. However, Sekaran and Bougie (2009) noted that the return rates of online survey questionnaires are typically low. A response rate of 30% is acceptable for the research (Sekaran & Bougie, 2016). The response rate for online surveys should not be less than 30% to ensure its adequacy (Hoxley, 2008). Therefore, the minimum sample size for this research was set at 100.

3.2 Pilot study

The literature review formed the basis of the questionnaire. A pilot study was carried out before finalising the main questionnaire. The ten experts selected include experienced professional architects who have managed housing projects for over ten years. This preliminary pilot survey assisted in offering the respondents the opportunity to add further types of knowledge required beyond the points identified in the literature to construct a robust list of types of knowledge for graduate architects in BCA for the final questionnaire. The final version of the questionnaire was done after modifications and shortenings according to the comments obtained in the pilot study.

3.3 Distribution of the final questionnaire

The questionnaire was distributed via a link emailed to 313 selected participants in March 2022. The

email address was obtained from the Architect Association website. After one month, 27 completed questionnaires were returned. Reminder emails were sent to respondents who had yet to reply. The following month after the reminder, the number of completed questionnaires increased to 130. Filtration was undertaken to scrutinise the questionnaire that could be used to form a database for the final data analysis. One hundred and twenty-seven questionnaires were identified as appropriate for the final data analysis. Table 1 shows the response rate for the present study.

Table 1: Response rate

Item	Description	Frequencies
1	Number of questionnaires sent out	313
	Total questionnaire returned	130
3	Incomplete questionnaire returned	3
4	Complete questionnaire returned	127
5	Valid percentage returned	**40.58%**

In this study, close-ended questions that include multiple choice questions and Likert-scale questions were used. Saunders et al.(2009) stated that close-ended questions are simple and easy to answer for respondents while assisting the researcher in coding the information easily for data analysis (Sekaran & Bougie, 2016). Researchers arrange the choices on a continuum in Likert-scale questions, with extreme positions at the endpoints. A five (5) point scale is the most used scale in the questionnaire (Sekaran & Bougie, 2016). For this questionnaire, the importance of each type of knowledge was rated on a five-point scale, where 1 represents 'strongly disagree', and 5 represents ‘strongly agree’.

4.0 Result and Analysis

The collected data were analysed using IBM SPSS Statistics 28.0 Software and descriptive to gain insights. SPSS was used to assess the data's reliability and examine the types of knowledge required to improve BCA. Descriptive analysis was used to assess the respondents' demographic profile and better understand the sample composition.

An analysis of the graduate architects' profile in Table 2 showed that 50% have construction experience spanning 5-9 years, and 45% of the graduate architects have construction experience of over ten years. This suggests the respondents have sufficient industry experience to provide valuable insights into graduate skill expectations and observed competencies. Further, the result showed that 60% of the graduate architects have five or more housing projects, suggesting that the graduate architects are actively engaged in BCA. The graduate architects' profile results revealed that 36% were 30 years and below, 31% of the respondents were in the 31-40 years age bracket, and 33% were above 40 years of age. Regarding the duration of employment, 10% have had 1-5 years of BCA work experience, 65% between 6 – 10 years, and 26% of the respondents have worked in BCA work for more than ten years. Hence, they are expected to be conversant with BCA's graduate architects' knowledge requirements.

Table 2: Analysis of Respondents' Background Profile

Years of Experience in architectural practice	**Frequency**	**% of total**
Below 5 years	6	5%
5-9 years	63	50%
10-14 years	31	24%
15 years or above	27	21%
Total	**127**	**100%**
Age	**Frequency**	**% of total**
25 – 30 years	46	36%
31 – 40 years	39	31%
41 – 50 years	24	19%
Above 50 years	18	14%
Total	**127**	**100%**
Number of housing projects involved	**Frequency**	**% of total**
Below 3	26	20%
3	16	13%
4	9	7%
5 or above	76	60%
Total	**127**	**100%**
Years in building contract administration work	**Frequency**	**% of total**
1 – 5 years	13	10%
6 – 10 years	82	65%
11 – 15 years	1	1%
16 – 20 years	30	24%
Above 20 years	1	1%
Total	**127**	**100%**

4.1 Data Screening - Mean & Standard Deviation

The respondents’ input was screened against careless responses and outliners. The careless response pattern for which a respondent might indicate the same response option for several consecutive items, while outliers indicate different or dissimilar observations. Careless responses were

measured through standard deviation and group rating compared to average factor ratings. Table 3 presents the mean scores (M) and standard deviations (SD), which summarise the central tendency and dispersion of the variables related to the work performance of graduate architects.

Table 3: Mean (M) and Standard Deviation (SD) of variables (n=127)

Variable	Mean (M)	Standard Deviation (SD)
Instil claims and legal matters management knowledge	4.43	0.55
Instil project management knowledge	4.50	0.65
Instil communication and relationship management knowledge	4.04	0.69
Instil quality and assessment management knowledge	4.38	0.61
Instil design management knowledge	3.95	0.65

There are five types of knowledge to be instilled to enhance the effectiveness of graduate architects in BCA. To instil claims and legal matters, management knowledge had a mean score of 4.43 (SD=0.55). This means that respondents agreed that instilling legal knowledge in graduate architects will assist in resolving the majority of the certificate claims and dispute issues. Instil project management knowledge had a mean score of 4.50 (SD=0.65). Respondents felt that this knowledge would assist the graduate architects to be more organised and systematic in BCA. Instil communication and relationship management knowledge had a mean score of 4.04 (SD=0.69). This result reflects that knowledge in networking for graduate architects is crucial in teamwork. Instil quality and management knowledge had a mean score of 4.38 (SD=0.61).

Respondents agreed that quality assessment knowledge is essential for graduate architects to assess contractor's submission and ensure the end product is constructed per design intention. Instil design management knowledge had a mean score of 3.95 (SD=0.65) because respondents felt that graduate architects capable of furnishing workable design details are important for construction. A total of 127 respondents rated the group that the data points tend to be close to the mean of the factor (i.e. standard deviation was <1.00- clustered around the mean) within each corresponding group. Therefore, the normality test would be used to test distribution.

4.2 Data Normality

A normality test was conducted to assess the data distribution. The normality of data for this research was examined by Skewness and Kurtosis. Skewness measures the balance or lack of balance in the data. Kurtosis exhibits normal distribution and measures its symmetry or lack thereof. Based on a study by Garson (2012), data is considered normal distribution when the skewness value is near zero and the kurtosis falls within the range of ±3.0. Table 4 summarises the skewness and kurtosis values for each variable.

Table 4: Summary of skewness and kurtosis

Variable	N	Skewness		Kurtosis	
		Statistic	Std. Error	Statistic	Std. Error
Instil claims and legal matters management knowledge	127	-.702	.215	.192	.427
Instil project management knowledge	127	-1.14	.215	.932	.427
Instil communication and relationship management knowledge	127	-.537	.215	.555	.427
Instil quality and assessment management knowledge	127	-.571	.215	-.593	.427
Instil design management knowledge	127	-.413	.215	.257	.427

The skewness values ranged from -0.413 to -1.14, indicating a negative skewness and a longer left tail. The kurtosis values ranged from 0.932 to -0.593, indicating a leptokurtic distribution with heavier tails than a normal distribution. All the variables fall under the acceptable range of ±3.0. Therefore, the variables meet the benchmark for normal distribution of skewness and kurtosis, and the variables demonstrate approximate normality, allowing for further statistical analysis and interpretation.

4.3 Reliability analysis

Reliability analysis (Cronbach's alpha reliability coefficient) was performed to measure the

consistency of variables and scales using SPSS. The alpha coefficient does not assume data normality and is based on the average correlation between the attributes and the number of total attributes. The value of Alpha varies from 0 to 1, and a higher value indicates greater internal consistency. The higher the value of Cronbach's Alpha beyond the threshold of 0.6, the more confidence is shown for these obstacles/root causes/ measures (Nunnally, 1978). All items and variables were reliable in measuring the intended constructs, enhancing the confidence in the validity of the data obtained as consistent and dependable as shown in Table 5.

Table 5: Reliability Coefficient of Research Instrument

Variable	No. of items	Cronbach's Alpha (α) (n=127)
Instil claims and legal matters management knowledge	6	0.73
Instil project management knowledge	7	0.73
Instil communication & relationship management knowledge	10	0.84
Instil quality and assessment management knowledge	6	0.73
Instil design management knowledge	9	0.63

In the sample (n=127), the variables demonstrated high internal consistency, with Cronbach's alpha values ranging from 0.60 to 0.84. This indicates that the items measuring the types of knowledge required by graduate architects in BCA consistently captured respondents' replies. From the result in Table 4.4, all Cronbach's alpha coefficients are above 0.6, hence acceptable, making all factors reliable.

4.4 Preliminary Analysis

Factor analysis was initially performed on all 38 variables related to the types of knowledge required by graduate architects in BCA. To ensure suitability for conducting factor analysis, this research used the Kaiser-Meyer-Olkin (KMO) index and Barlett's test of sphericity. The KMO test measures the adequacy of a sample in terms of the distribution of values for the execution of factor analysis. Bartlett's test of sphericity must be significant ($p<0.05$), indicating the presence of relationships among variables, and the KMP index should have a minimum value of 0.50 (Pallant et al., 2016) to indicate an adequate level of sampling adequacy. Both of the tests' acceptable values should be greater than 0.5.

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin measure of sampling adequacy		.802 (p>0.5)
Barlett's test of sphericity	Approx. Chi-Square	211.339
	df	10
	Sig.	.000 (<0.05)

Table 6 shows the results of the KMO measures and Bartlett's test. The KMO value is 0.802, which is above 0.5. This indicates a good level of sampling adequacy. Barlett's test had an approximate chi-squared value of 211.339 with 10 degrees of freedom. The associated p-value is 0.000 ($p<0.05$), indicating that the correlation matrix significantly differs from an identity matrix. Both tests indicated the suitability of the variables for factor analysis.

4.5 Factor Analysis

Factor loadings are the correlations of the variables with the factor. High factor loading implies that the factors and variables are critical. The eigenvalues and the percentage of variance approach were used to determine the number of factors. In the eigenvalues approach, factors with relatively large eigenvalues are ignored. One criterion that has been suggested is that the eigenvalues for a factor greater than 1.00 should be retained. For the percentage of variance approach, all factors extracted should account for at least 60% of the total variance. Based on this rule, the initial eigenvalues for this research are referred to.

Principal components factor analysis with Varimax rotation conducted on the 38 controllable variables produced four underlying components. Table 7 shows the factor loadings of these controllable variables on these four components. The factor loading is the correlation coefficient between an original variable and an extracted component. The larger the factor loading, the greater the variable contributes to the component. Usually, factors with loadings greater than 0.5 are considered significant in contributing to the interpretation of the component. As shown in Table 7, all factor loadings extracted were more significant than 0.5. The extracted four components were renamed based on the results of the analysis.

In summary, the four components were summarised as follows:

Component 1 consists of six variables: electrical engineering (FL=0.856), mechanical engineering (FL=0.834), geotechnical engineering (FL=0.742), structural engineering (FL=0.714), civil engineering (FL=0.707), and quantity surveying (FL=0.558). These variables are closely related to the knowledge required for coordination purposes. Therefore, this component can be termed communication & relationship management knowledge. This component accounts for the most significant variance (45%) among all the components.

Component 2 includes seven variables: interior design (FL=0.779), financial planning (FL=0.715), valuation study (FL=0.699), landscape (FL=0.625), building material (FL=0.609), environmental studies (FL=0.574), and construction methods (FL=0.501). These variables all emphasise the knowledge required when graduate architects manage design. Hence, this component is termed design management knowledge.

Component 3 has three variables: architecture (FL=0.782), project management (FL=0.725), and town planning (FL=0.681). This knowledge is crucial for graduate architects when managing housing projects. Consequently, this component can be considered project management knowledge.

Component 4 comprises three variables: feasibility studies (FL=0.820), authority approving process (FL=0.708), and IT construction (FL=0.484). Disputes could be minimised if graduate architects conducted feasibility studies and IT construction and were familiar with the authority approving process. Thus, this component is called claims and legal matters management knowledge. This knowledge accounts for the least variance (5.74%) among all the variables from a statistical point of view.

5.0 Discussion of Findings

Instil communication & relationship management knowledge

Instil communication and relationship knowledge has the highest factor loading voted by respondents as several problems always arose during each project no matter how thorough the briefing process, how clear the drawings were, and how good the site management was. In every case, the problem could be related to a communication breakdown where one party fails to convey his or her intentions to another, which leads to misunderstanding and associated problems that such a state may bring about (Emmitt & Gorse, 2006). How the project participants communicate through formal and informal communication channels is critical to a successful project (Dainty et al., 2007). The faster graduate architects communicate effectively, the faster they establish good working relationships, hence the stronger the likelihood of a successful project. Communication channels between parties depend on how the building team is comprised and the procurement route selected, particularly between client and design team members, design team members, design team and construction team and construction team members (Rahman & Gamil, 2019).

Table 7: Factor loading for types of knowledge for graduate architects in BCA

Components	Code	Types of knowledge	Factor loading (FL)
Communication & relationship management knowledge	MM6	Electrical engineering	.856
	MM5	Mechanical engineering	.834
	MM8	Geotechnical engineering	.742
	MM7	Structural engineering	.714
	MM4	Civil engineering	.707
	MM9	Quantity Surveying	.558
Design management knowledge	MM14	Interior design	.779
	MM15	Financial planning	.715
	MM16	Valuation study	.699
	MM13	Landscape	.625
	MM12	Building material	.609
	MM17	Environmental studies	.574
	MM11	Construction methods	.501
Project management knowledge	MM2	Architecture	.782
	MM1	Project management	.725
	MM3	Town planning	.681
Claims & Legal matters management knowledge	MM19	Feasibility studies	.820
	MM18	Authority approving process	.708
	MM20	IT Construction	.484

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalisation. a. Rotation converged in 8 iterations.

Graduate architects who manage the project must be aware of group dynamics and responsibilities throughout the project's diverse stages. Seven measures to ideal communications according to Dainty et al. (2007) are: careful assembly of a multi-skilled team with managerial, technological, and analytical abilities; removal of artificial barriers, designers become part of the site management team; use of management tools to ensure programming and progress data is continually revised and available to all parties; abolition of conflicting interests through incentives to minimise defensive action; adequate resources for obtaining information held off-site; limit disruption brought about by other projects; record all events and actions for later analysis and feedback into future projects.

Instil design management knowledge

Clients are demanding better value from contractors to deliver a physical artefact. The need to manage design activity has been recognised for some time, whether in industrial product design, architecture, or, more lately, construction (Best, 2006). Management of architectural design is essential to deliver design intent and optimising value to project stakeholders (Wang et al., 2016). This type of knowledge could be instilled through establishing links with various stakeholders to facilitate open communication to assist necessary information to be effectively integrated into the design process, team building, effective communication, timely responsiveness, partnering with the employer to fully understand the employer's expectations and requirements, partnering with designers to solve complex technical problems, especially for handling design changes, adopting optimisation design initiatives and improving constructability (Cooper & Press, 1995).

Instil project management knowledge

Project management is an exercise in control over quality, schedule, and costs that includes the following aspects of management: integration, scope, time, cost, quality, human resources, risk, communication, and procurement (Alaloul et al., 2016). Project management knowledge in academic programs covers many of the outlined knowledge areas (Levy, 2018). This knowledge is important for graduate architects to deliver the owner's physical development within the constraints of cost, schedule, quality, and safety requirements. Besides that, the graduate architects should obtain information such as finance and accounting, sales and marketing, strategic planning, tactical planning, operational planning, organisational behaviour, personnel administration, conflict management, personal time management, stress management, economic analysis, social trends, political developments, IT advancements, legal framework, statistics, probability theory, and risk to effectively deal with the many forces that bear on the construction process (Gido & Clements, 2014).

Instil claims and legal matters management knowledge

This knowledge is crucial for graduate architects to understand the contents of the documents and the spirit of the contractual relationships (Ahmed et al., 2019). A detailed understanding of the claims and legal matters is essential to minimise the construction risks that may lead to unnecessary problems such as disputes, claims, litigation, shoddy works and reworks, and even loss of future business relations (Vidogah & Ndekugri, 1997). The effects of construction disputes are detrimental as they may cause project delays, undermine team spirit, increase project costs, and damage continuing business relationships (Odeh & Battaineh, 2002).

To instil this type of knowledge is through a better understanding of contract documents such as sincerity in contracting, the drawing must be precise and checked by all parties, clarified in the contract document for better understanding, the employer's requirement is stipulated, contract document was written in simple language, contract document is precise, objective and practical, qualified personnel to prepare the contract document, regulatory requirement stipulated, minimise the use of complicated legal phrases, familiar general condition of the contract, and simplify construction work specification.

Results show that respondents prefer project management knowledge more efficiently than claims and legal matters knowledge for graduate architects. This result is aligned with previous findings from Heagney (2016) that graduate architects' master's in project management knowledge will have a profound impact on project performance. Results showed that instil claims and legal matters knowledge is the least effective knowledge for graduate architects to perform in BCA. Under the claims and legal matters knowledge, the authority approving process is a must-know for graduate architects. This result agrees with Rahim (2004) that the authority approving process is necessary for graduate architects as it will affect the overall master program planning. Their finding is parallel with findings by Marzukhi (2020), who confirmed that authority submission is a lengthy process and some various forms and permits that need to be submitted and obtained respectively before construction.

6.0 Conclusion

Graduate architects play a central role in building contract administration. Their performance affected the entire project team. Thus, graduate architects

need to work effectively in BCA. This paper has presented the results of types of knowledge required by graduate architects in BCA associated with housing projects. A total of 38 knowledge variables were identified through literature. Based on the knowledge variables, a questionnaire was designed to gather data from the practising graduate architects. Data were analysed using factor analysis to understand the requirement to be effective in BCA. Results suggested that 19 knowledge variables could be grouped into four categories of knowledge types. Factor analysis results show four types of knowledge required for a graduate architect in BCA: to instil claim and legal matters management knowledge, design management knowledge, project management knowledge, and communication and relationship management knowledge.

Instilling communication and relationship management knowledge is efficient in BCA for graduate architects. According to Zerjav and Ceric (2009), this is categorised as tacit knowledge that could be gained through experience. Best (2010) pointed out that instil design management is the ability to translate design intent to building end products. Cooper (2009) added that design management knowledge is crucial for graduate architects to correctly convey end users' feedback to designers for future improvement.

The research findings would enable architects to focus on the types of knowledge required by author upon reasonable request.

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graduate architects in BCA and develop appropriate strategies to successfully nurture them to be more effective in their work performance. In addition, BIM assists in addressing the issues. Therefore, further research into designing a building contract administration framework to improve graduate architects' performance in BCA is required, which serves as a guideline emphasising construction-related needs and competencies for graduate architects' professional development.

This research utilised the quantitative approach based on a survey questionnaire to identify the types of knowledge required by graduate architects in BCA. The quantitative method is known to lack insight into thoughts and accuracy. This, however, could be mitigated by a triangulated data collection process, which utilises multiple data sources, including semi-structured interviews, documentation reviews, and focus group studies.

Data Availability Statement

Some or all data, models, or codes that support the findings of this study are available from the corresponding

Declaration of Competing Interest

The authors report no declaration of interest.

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