provide any supplementary criteria that could influence the selection of GBMs, but not included in the questionnaire provided. A five-point Likert scale (1= least agree to 5= extremely agree) is used to rate GBMs criteria, widely used in various previous studies [1], [5], [50].

D. Data Collection

The survey's targeted respondents were the professionals involved in GBMs selection, such as contractors, designers, architects, consultants, and clients. This research employed a convenience method of sampling. To obtain accurate and adequate data collected, the survey respondents must include various stakeholders to ensure a homogeneous and sufficient population sample. The questionnaires were subsequently distributed to various companies in the Malaysian building industry. In February 2020, a total of 210 surveys were distributed. A reminder was sent to complete the questionnaire to increase the response rate. A total of 79 questionnaires was returned accordingly after excluding the invalid responses. The analysis was then based on 73 valid responses, which showed a 34.8% response rate. Therefore, the response rate was accepted according to most questionnaire surveys in the construction industry, agreed at a standard rate between 20 % and 30% [51].

E. Data Analysis Method

The valid data obtained were analyzed using the Statistical Package for Social Sciences (SPSS version 25) and Microsoft Excel software. First, the validity test was conducted using the Kaiser method. By this method, there is a value called eigenvalue, which should be greater than 1. The equivalent value below 1 is inadequate and, therefore, inappropriate for factor analysis [52]. The varimax rotation method was applied after the primary factor analysis to determine the linear combination of the original factors so that the variance of the loading is maximized. However, the reliability rating scale (1-5) was examined using Cronbach's coefficient alpha. The range of α value for Cronbach is from 0 to 1, and the higher value gives a higher degree of internal consistency. Finally, a ranking analysis was performed using a scatter plot of mean and standard deviation scores to determine the importance of GBMs criteria for materials selection [53].

III. Results and Discussions

A. Profiles of Respondents

The collected data from the questionnaire survey of this study showed that the highest number of respondents are with years of experience between 5 and 10 years is 27.4%, followed by those with years of experience between 10 and 15 years is 26.0%, and the lowest of respondents is 12.3% with less than five years of experience. According to respondents' professional field, architects and geotechnical engineers have the highest percentage were observed with 46.6% and 30.1%, respectively, as illustrated in Fig. 2. Concerning the current position, directors, senior managers, managers, design engineers, and site engineers account for 8.2%, 24.7%, 35.6%, 15.1%, and 16.4%, respectively.

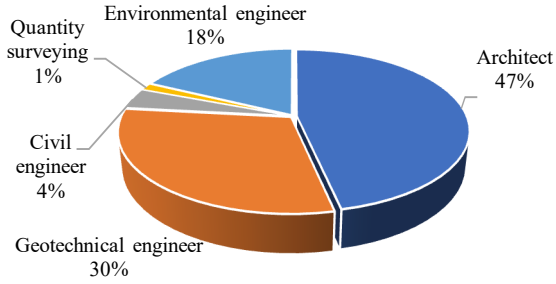

Fig. 2 The professional field of respondents

The questionnaire surveys were received from clients/ developers 30.1%, consultants 37.0%, and contractors 32.9%. Moreover, most of the respondents are aware of GBMs selection, as shown in Fig. 3. It can be concluded from the respondents' profile that the respondents are very experienced and played an essential role in GBMs selection. Therefore, the view of these experts is essential and dependable on evaluating the GBMs criteria.

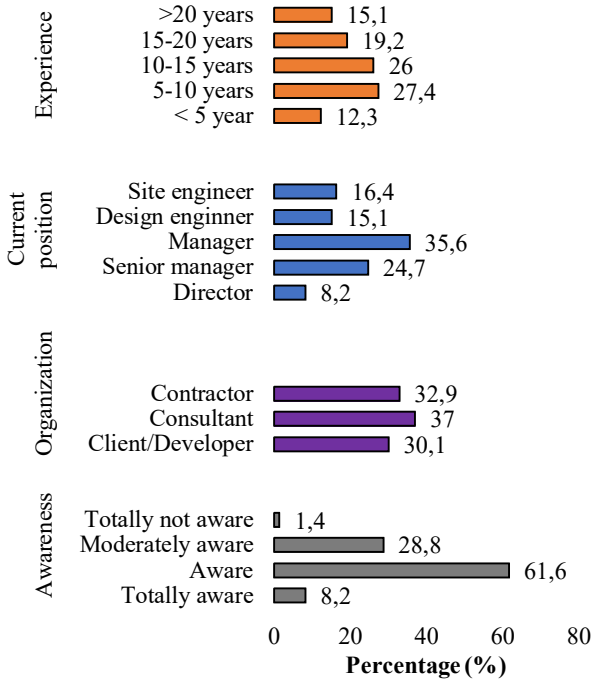

Fig. 3 Profile of respondents

B. EFA for Sustainable Criteria

Following the interview with experts, EFA analysis was conducted to check the themes, and it is measurements obtained from the literature review and the interview sessions. Factor analysis was used to analyze the interrelation structure between the criteria. The factor analysis was carried out using SPSS version 25. It is carried out in two stages: factor extraction and factor rotation.

A validity test is performed according to Kaiser's method before factor analysis. In this method, an eigenvalue below one is considered insufficient and unacceptable for the factor analysis. The survey data's appropriateness was assessed in the Kaiser-Meyer-Olkin (KMO) and the Bartlett sphericity test. The value above 0.5 on the KMO index and the sphericity

check of Bartlett where ($p<0.05$) suggest the adequacy for factor analysis of the data set [19]. The correlation matrix was first examined in the factor analysis to determine the correlation among the criteria. If any of the variables had enormous correlations or cross-loading, they were ruled out. The results analyzed shown that the KMO sample adequacy value was 0.828, higher than 0.5. The Bartlett sphericity test and the associated significance level were 8431,239 and 0,000, respectively.

The interactions are referred to as group loadings. The more latent variable contributes, the higher value of absolute loading. The components extraction was based on the total variance, which indicated eigenvalues of 1 and more. Therefore, three components explain a total variance of 84.76%. Table II presents the factor loading of each variable in the rotated component matrix. However, the coefficient of reliability also analyzed, and it is usually varying from 0 to 1.

TABLE II
FACTOR LOADING OF GBMS CRITERIA

Variable	Components		
	Economic	Social	Environmental
E2			0.842
E6			0.814
E3			0.810
E8			0.656
E9			0.851
E1			0.849
E4			0.792
E5			0.745
E7			0.832
EC6	0.869		
EC4	0.806		
EC3	0.696		
EC2	0.677		
EC5	0.906		
EC8	0.833		
EC7	0.857		
S6		0.839	
S10		0.779	
S3		0.816	
S11		0.702	
S12		0.653	
S5		0.847	
S8		0.794	
S4		0.792	
S1		0.785	
S2		0.683	
S9		0.752	

The internal consistency of reliability for the criteria is more excellent on the scale parameter when the α value is closer to one. The α value 0.7 is the acceptable lower limit [54]. Cronbach's α values for the criteria of environmental, economic, social, and all are 0.889, 0.877, 0.928, 0.957, respectively. The conclusion that all α values are acceptable and the scale of the internal consistency criteria is excellent. Overall, the result from the EFA analysis shows that a total of three latent groups have been extracted to present the GBMs criteria. The following parts discussed the descriptions of these latent factors.

1) Environmental Criteria: The first component presented the variable directly contributing to the "Environmental", such as the impact of materials on air quality, healthy interior environment, waste management, and production and transportation activities. The building industry has a massive effect on our environment [8]. Since building materials contribute to the environmental impacts, the consideration of environmental criteria has become significant.

The building industry is struggling to adopt sustainable practices and seeking new strategies [10]. Environmental criteria are important to support design decisions and choices of the right materials and should complement overall strategic sustainability goals. Depending on the environmental criteria established for material selection, the sustainability of a building can be achieved. However, suitable natural resources and raw materials would be useful to achieve the environmental goals [54]. The building industry is recognized as one of the most consumers of energy and therefore creates tremendous environmental pressures [4].

Furthermore, it noted that specific resources are minimal, and residual stocks should be carefully handled [55]. The building industry is considered one of the major consumers of natural resources. Therefore, sustainable buildings significantly reduce the contribution of the excessive use of natural resources and raw materials.

2) Economic Criteria: The second component presented the variable directly contributing to the "Economic". Therefore, this latent group presented variables such as operation and maintenance cost, financials and economic risks, the societal cost of materials, and investment cost, which support stakeholders in the decision making during the selection of the materials with consideration of the concept of life cycle cost and the project's budget. Stakeholders concentrate on the early recognition of the building projects' financial sustainability due to the rising to produce environmentally friendly buildings. Enhancing the cost efficiency of buildings is considered a significant interest to all stakeholders [56].

The sustainability principle for the building industry aims to encourage maximum productivity with less financial costs [57]. The budget for construction projects is considered a significant parameter [58]. However, it is important to note that the quality of life is a primary concern of the green building assessment, leading to sustainable economic developments [59]. The definitions of life quality described by positive links to nature are comfort and convenience. Subsequently, to meet the sustainable economic, the life quality of materials should be considered. Meeting stakeholders' needs and life expectancy of materials are the variables listed under this component.

3) Social Criteria: The "Social" component is associated with ease and ability to integrate with other materials, resistance against natural contamination and habitat disasters, isolation of noise pollution, and ease of construction. The quest for equilibrium that meets several performance goals is one aspect of building design. The performance definition offers a logical framework for planning, constructing, dynamic, and adaptable to developments and changes [36]. A structure that does not recognize the importance of system interface and performance capability could result in an incompatibility system, malfunctions, and obsolescent risk.

The maintenance and risks of a possible decline in the income are arising from the loss of tenants, which adversely affect the building's financial viability [37]. Therefore, it is significant to consider the performance requirements for building materials. Identifying performance criteria during the selection of the materials leads stakeholders to meet the target of performance capability.

Furthermore, consideration of social benefits during the selection of the materials is significantly essential. Social aspects are different tools in achieving sustainable building projects. A different value must be considered for supporting the use of local materials. Applying the health and safety of buildings helps to meet sustainability, which reduces injuries and accidents during and after the construction process, resulting in the reduction of insurance premiums of construction companies [60]. Hence, social benefits criteria take a place to achieve buildings sustainability.

C. Ranking the Importance of GBMs Criteria

After exploring the GBMs criteria for materials selection by EFA analysis, ranking analysis has been performed to assess the relative importance of these criteria based on survey results. The criteria were ranked according to their relative importance using a scatter plot of mean and standard deviation scores [53]. The statistical means, standards deviations, and ranks of the mentioned criteria are presented in Table III.

TABLE III
FACTOR LOADING OF GBMS CRITERIA

Criteria	Analysis of mean and standard deviation scores			
	Mean	SD	Ranking by category	Overall ranking
Environmental criteria				
E6	3.890	0.774	1	1
E5	3.795	0.865	2	7
E1	3.918	0.878	3	9
E8	3.493	0.884	4	10
E2	3.589	0.925	5	14
E7	3.507	0.945	6	21
E3	3.699	1.023	7	26
E4	3.438	1.054	8	27
E9	3.781	1.096	9	29
Economic criteria				
EC8	3.890	0.792	1	2
EC5	4.288	0.823	2	4
EC3	3.603	0.829	3	5
EC2	3.671	0.851	4	6
EC7	3.904	0.900	5	12
EC1	3.603	0.909	6	13
EC4	4.014	0.935	7	18
EC6	4.205	0.942	8	19
Social criteria				
S4	3.740	0.800	1	3
S7	3.616	0.876	2	8
S8	3.658	0.885	3	11
S1	3.671	0.929	4	15
S12	3.548	0.929	5	16
S5	3.726	0.932	6	17
S9	3.548	0.943	7	20
S10	3.356	0.948	8	22
S6	3.507	0.959	9	23
S3	3.699	0.982	10	24
S11	3.315	0.998	11	25
S2	3.658	1.083	12	28

The degree of agreement between the respondents on the parameters is the standard deviation, while the relative value of others is the average [61]. The standard deviation values of the sustainable criteria of the GBMs are less than or around one, which indicates some consensus among the respondents.

Considering the environmental criteria, the results are as follows: E6 > E5 > E1 > E8 > E2 > E7 > E3 > E4 > E9. Waste management was ranked as the top priority, and it was also the highest among all criteria. Fatimah *et al.* [62] mentioned that the companies promote waste management and environmental actions as major actions for materials selection. This was followed by water consumption and the potential for recycling and reuse, respectively.

Krauklis *et al.* [63] agreed that recycling and reuse materials positively contribute to resource efficiency. Lam *et al.* [64] stated that negative effects on the climate have been central to climate change since the past decade. Environmental resources are enormously consumed to meet the growing urban demands. In addition, the method of making improper materials into the atmosphere that are harmful releases of CFCs [30]. Now, the task of managing the environment safely in conjunction with urban requirements is growing. Sustainability is involved here, which is necessary for managing resources to meet present and future needs and for choosing eco-sustainable materials to minimize greenhouse gas emissions into the interior air of buildings [65].

Hence, sustainable environment criteria should be considered while selecting construction materials. This observation shows that the environmental category is considered important in relation to the other categories in the Malaysian building industry.

In relation to the economic criteria, the results are as follows: EC8 > EC5 > EC3 > EC2 > EC7 > EC1 > EC4 > EC6. The life expectancy of materials, meeting stakeholders' needs, and operation and maintenance cost were ranked as the first, second, and third levels of importance. Moreover, the life expectancy of materials was ranked as the second important level among all criteria. Bashtannyk *et al.* [65] agreed that the economic criteria would impact the life cycle cost and maintenance to avoid materials replacement. The choice of appropriate green material for building on a site is an investment mode, as no maintenance costs are required during climate changes for materials [66]. On the other hand, the stakeholders need to consider that it is important to achieve their goal during materials selection. Mathiyazhagan *et al.* [8], it is a significant concern of materials to satisfy the users' needs. On the other hand, the life expectancy of material is nearly important to meet stakeholders' needs. Also, the durability of materials is indirectly enhancing the maintenance and life cycle cost [19].

Meanwhile, the results from the social category are as follows: S4 > S7 > S8 > S1 > S12 > S5 > S9 > S10 > S6 > S3 > S11 > S2. The health and safety creation takes the first level of importance and the third place among all criteria, followed by the use of local material and labor availability with the second and third level of importance. Fatimah *et al.* [62] mentioned that site safety improves social life by providing a clean and safe working environment. Furthermore, labor availability improves the construction work by enhancing the cost and time saving [10]. Nevertheless, using

local materials is a criterion often considered associated with job creation due to a growing understanding of its consequences [19]. The consideration of social aspects during the selection of the materials provides a safer working environment. Therefore, the sustainability of building projects will be enhanced and improved.

From the results, it can be concluded that each respondent agreed that all criteria are critical by indicating that all mean scores were >3. However, each respondent had a different perception of each criterion's importance based on the standard deviation scores. Building projects greatly influence the economy, society, and the environment over their whole life cycle [3]. There is a need for strategies to have a strong view of the project's uptake situation and realize the many alternatives to achieve sustainability [67]. The GBMs criteria for selecting materials are recognized as being able to achieve sustainability for construction projects. The analysis identified all respondents agree on all criteria' positive influence for the GBMs selection by performing the scatter plot of mean and standard deviation scores. This demonstrates the importance of the sustainable criteria of the GBMs selection to stakeholders in the Malaysian building industry.

D. Implementation of the Study

The research offers a range of theoretical and practical applications at the academic and industry level. The implementation of building projects through the same mechanism as the inability to acknowledge reform could be part of the primary reason for the failure to make progress in the construction sector's performance within the nation of Malaysian. To overcome these issues, stakeholders must be able to adopt innovative new philosophies, particularly those specifically affecting the implementation of projects. Therefore, this study indicates no adoption of the GBMs criteria for material selection, the need to follow the GBM criteria for material selection in Malaysia's building industry. For this to happen, stakeholders must be informed, through lectures and workshops, of implementing new ideas that will enable projects to succeed. This action makes it easier to resolve the client's misapprehension of the GBMs requirements for material selection. Consequently, the perspectives obtained from this study would provide owners or employers with an appreciation of the key obstacles that impede the adaptation of the GBM criteria for material selection. Building practitioners must also be qualified in the philosophies, principles, and tools laid forth in the GBM guidelines to select materials procedures.

The respective building stakeholders' bodies in Malaysia should also hold regular training seminars for their participants on the GBM requirements for content selection. They should include the same in their ongoing appraisal of professional development. The government also plays a major role in the execution of public projects and creating and regulating regulations and policies across various sectors. The government will also encourage the GBM standards to procure materials used by creating regulations and legislation to facilitate its implementation in the country of projects in the building field. Building industry companies cannot enforce the GBM standards for content procurement at the business level.

Similarly, workers cannot be educated without senior management instruction. Appropriate enforcement processes for these measures must also be established to ensure compliance. Finally, by the proposed essential criteria created by this analysis, a standard for the project team in the Malaysia construction industry can be developed to manage the successful project by adopting GBM criteria to efficiently select materials.

IV. CONCLUSION

Like many other developing countries, Malaysia has faced enormous difficulties in delivering high-quality housing infrastructure and carrying out large-scale construction programs. GBMs guidelines for content collection should be adopted to mitigate this situation. As a result, this is the primary goal of this research. Three main criteria and 32 sub-criteria were identified based on the three sustainability pillars. Questionnaire surveys were distributed to various stakeholders in the Malaysian building industry to get the perceived value of the criteria and determine the relative importance of the GBMs criteria.

The results from the questionnaire survey through EFA analysis confirm GBM criteria' categorization under three sustainability pillars (environmental, economic, and social). An analysis of the ranking showed that all criteria to be relevant in the selection of building materials. A ranking analysis has been used to rank the GBMs criteria. The ranking analysis shows the significant criteria in the environmental cluster, which are waste management, water consumption, and potential for recycling and reuse. Meanwhile, material life expectancy, meeting stakeholders' needs, and operation and maintenance costs were ranked as the top three under the economic category. Also, health and safety, use of local material, and labor availability were ranked as the top three sub-criteria in the social category.

This study adds to the body of expertise in this area by providing essential inputs for researchers to enhance their interpretation of the GBMs criteria for selecting materials and lays a solid basis for future studies on the GBMs criteria for selecting materials. The results from this study would be helpful to improve sustainability studies and application within this country since it suffers from low environmental performance.

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