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FACTORS CONTRIBUTING TO NON-ADOPTION OF VALUE ENGINEERING METHODOLOGY FOR BUILDING SERVICES

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Abstract

The procurement of building services (BS) constitutes a great challenge in the construction industries of both developed and developing countries. Adoption of value engineering (VE) methodology could aid BS components selection at design and installations stages. However, the methodology is not appropriately used by the project team during design and installation of BS. Leading to overdesign, poor quality specification, lack of team work and unreliable budget estimate. The main objective of this paper is to determine the factors preventing the adoption of VE in the procurement of BS projects. A questionnaire was design to collect information on 18 generic factors contributing to non-adoption of VE. The questionnaire was administered to randomly selected practitioners in clients', contracting and consulting types of organisations in Malaysia. The result shows that lack of understanding of VE by clients organisations, lack of request for the services, and inadequate time to conduct the study are the most important factors deterring adoption of VE for building services. The factors analysis of result for the 18 variables produced a four (4) factors result as: Non-involvement of stakeholders; education and traditional practice; resistance to change, and lack of experience about VE. It is essentially important for industry clients to understand the importance of adopting VE so as to ensure that time required for the study are pre-planned and budgeted for at project inception

Keywords: Building services, practitioners, value engineering.

1.0 INTRODUCTION

Malaysia is a rapidly transforming and multi – sector economy aspiring to be among the industrialised nations by year 2020. In order to achieve this goal set, a number of economic transformation rolling plans have been put in place to meet up with the dual challenge of open market and globalisation, the Malaysian Construction Industry Development Board (CIDB) launched the Construction Industry Master Plan (CIMP 2006 – 2015) which comprises of implementation plans and strategies requiring step change in mind-set and culture of industry stakeholders. The need to bring together all players along the construction industry supply chain to collaborate in delivering cost effective solution is a major requirements (CIDB, [1]. More important is the increasing effort being placed on cost control in both public and private sectors in the country, there has been a renewed interest in the concepts of value engineering. For instance, the CIDB in collaboration with the Economic Planning Unit (EPU) have proposed the need to adopt value management methodology in Malaysian construction industry. To this end, EPU in 2009, through a circular named "Value Management Guidelines Circular 3/2009" required the implementation of value management on all future projects from RM50 million and above. This study is

therefore set to investigate the application of value engineering methodologies in the design and installations of building services projects in Malaysia so as to determine the factors contributing to its non-adoption.

Building services (BS) is a term that covers all the mechanical and electrical (M&E) services systems that are installed to afford us the desired comfort levels in a building. It is the design and installation of building services that allows end-users to achieve desired comfort level from the space created in buildings for different types of accommodation. If the services are not given the required consideration at the early design stage, it could lead to more cost being incurred by clients, disputes and increase in project delivery time [2]. Building services is an important subsector of the Malaysian Construction Industry accounting for about 40 percent of the total cost of buildings [3]. The industry stakeholders [4,5 6] have expressed concern on the need to improve on the construction cost management and procurement process of BS so as to ensure that the completed project meets clients' value criteria and executed within the pre-contract budget.

This study argues that VE is a methodology that could be adapted to aid building services components selection at design and installation stage [4] but the methodology is not appropriately adopted to optimise the benefits of VE on building services. Although, value management/engineering is a philosophy that has not been fully embraced in Malaysia construction industry and little has been written by researchers in this field [7]. Specifically how the philosophy can be adopted to improve the procurement of mechanical and electrical services components. Therefore, the aim of this paper is to investigate the extent of implementation of value engineering methodology in the design and installation of building services in Malaysian construction industry. The main objective is to determine the factors deterring its adoption.

Interestingly, findings from this study will enable construction industry stakeholders to understand the key factors preventing the adoption of VE methodology during the design and installation of BS. This will assist them in developing appropriate strategies to overcome the barriers.

2.0 LITERATURE REVIEW

A great deal of unnecessary cost is created by the fragmented nature and complex inter-relationship in the construction industry. This problem of the industry has a significant impact on building services which are one of the fastest developing forms of technology within the industry [6]. However, considering the current trend of technical complexity, population growth, greater life aspirations, and 24 – hour global business regime, the cost of building services in relation to total cost of building will be on the increase [9]. Therefore, there is need for a shift away from traditional way of delivering building services to a delivery process that really meets the needs of business, society and the environment. According to [10] one creative way to achieve this is to integrate the needs of users, operators, and statutory requirements in the presence of specialist building services engineers, suppliers and installers, in the early stages of design process.

The identification and definition of exact client requirements is paramount in achieving client perception of value for money [11]. This can be achieved by applying the principles of value engineering (VE) at the early stage of a building project [12].

2.1 Value Engineering

Value engineering (VE) is defined as an organised effort directed at analysing the function of goods and services for the purposes of achieving basic functions at the lowest overall cost, consistent with achieving essential characteristics [12]. VE employs multi – disciplinary team and draws upon the collective viewpoints, experience as well as their knowledge at the early stage of design process to identify high cost function with improvement potential to achieve client requirements [11]. However, for the design and installation of building services, VE are rarely adopted by practitioners' to aid decision making during design [7]. Based on literature review, the traditional problems affecting the procurement of building services could also be responsible for this. According to [13], the problems are generally grouped under design related problems, coordination problems and cost management problems which are further explained in the following sections.

2.2 Design Related Problems

Michie [12] found that architects' training in building services is limited and the services consultants are always appointed late during design. Michie, further observed that, little emphasis is given to the problems of services integration and coordination in the services engineers training. Similarly, the background and training of the services engineer has been limited in terms of his role within the building team and an appreciation of architectural problems. [8] stated that most M&E work involves element of design by downstream supply chain. However, they are not usually reflected in contractual relationships according to [10]. In addition, the services consultants provide preliminary information to the Architect for functional and spatial integration. However, this is often requested late in the design, after appointment of the contractor, the consultants design role is usually limited to approval of the contractor's development of installation drawings and details [13, 14, 17].

2.3 Coordination Problems

This has to do with clashing of services works on site (for instance, plant rooms, duct layout). The architects' practical training on the subject of building services is less than optimum; therefore, they have difficulty in fulfilling the coordination role giving the increasing content and complexity of engineering services [13]. In the opinion of [16] coordination problems can be summarised as: Design related problems; coordination problems and procedural problems, they further outlined the probable areas of conflict resulting from lack of coordination as follows:

- Services conflicting with the structural frame
- Discrepancies in dimensioning as stated on different drawings
- Improper reservation of holes
- Conflicts between two or more services
- Differences between the dimensions of the actual equipment and those in the detailed design
- Differences in the location of equipment
- Improper arrangement for the sequence of works
- Difficulties in the identification of access points and services
- Difficulties in the support and fixing of services
- Insufficient space for the completion of adjacent finishing works and
- Difficulty in inspection, commissioning and maintenance.

RICS [17] pointed out that, that, even where the design team appreciates the importance of coordination, constraints such as cost; communication between services disciplines; inadequacy of services drawings; the time available within the design process and the practical knowledge of the design staff, usually prevent them. In another study, [18] identified Conflict between VE and design team, non-consideration of result of VE workshop by client, lack of understanding of the principle behind functional analysis, knowledge imbalance and difficulty in achieving cultural change among VE team. In the work of [19] lack of time to complete the study, poor communication and insufficient coordination between parties, outdated standard and specifications, habitual and prejudicial thinking, lack of expertise and unnecessary restrictive design criteria, excessive changes and lack of information has been identified as impediments to the implementation of VE.

3.0 RESEARCH METHODS

A comprehensive literature review provide an in – depth practical understanding of value engineering. Brainstorming session with 5 researchers confirmed or rejected some of the variables earlier identified as significant and suggested others variables not included. A total of 18 variables were identified and a questionnaire was designed based on the variables. The questionnaire was prepared in 3 sections. The first section contained 4 nominal questions on background informations. The second section comprises of 5 ordinal questions on the level of understanding and application of value engineering methodology in building services design and installations. The third section contains 2 ordinal questions on the potentials of and factors preventing application of value engineering in building services procurement. The questionnaire was designed with the purpose of establishing the most important variables that contributes to non-adoption of value engineering methodology for building services. Respondents were therefore requested to rate their agreement with each of the 18 variables identified from literature review on a five point Likert scale from 1 = strongly disagree to 5 = strongly agree. Respondents were also requested to state and rate other factors considered not included in the questionnaire that affects contribute to non – adoption of VE for building services design and installations. The sample population comprises of 239 practitioners drawn from Clients' Contracting and Consulting types of organisations in Malaysia. Questionnaires were sent both by mail and post to 239 randomly selected practitioners. The survey was conducted in Malaysia. The questionnaire was completed within a period of 5 months and data analysis was carried out using Statistical Package for the Social Sciences SPSS) version 20

3.1 Responses and Respondents' Profile

From the 239 questionnaires sent out, 77 responses were received within five months. Three (3) of the

questionnaires were not properly completed and could not be analysed and therefore discarded. Resulting in effective response rate of 31%, therefore, only the remaining 74 properly completed questionnaires were analysed. A total of 27% of the respondents are from clients' organisations, while 24% are from contracting organisation and the remaining 49% are from consultancy type of organisations. The years of construction experience of the respondents are 1-5 years (15%); 6-10 years (7%); 11 – 15 years (24%); 16 – 20 years (32%); and 20 years and above (22%). About 78% of the respondents have more than 10 year's construction experience. This observation suggests that the data collected from these respondents are reliable.

4.0 DATA ANALYSIS AND DISCUSSION OF RESULTS

Data analysis was carried out using the SPSS software package version 20. The statistical t – test of the results was first carried out to understand the pattern of response to the questions based on the sample ratings. The hypothesis H_0:$\mu = \mu_0$ and the alternative hypothesis H1: $\mu > \mu_0$ was set out. Where μ is the population mean. μ_0 is the critical rating above which the variable is considered to contribute to the factors contributing to non – adoption of VE for building services. In this study, μ_0 was set at 3 because in the rating scale, all ratings above 3 are considered as a contributory factor. Table 1 shows the t – test results with the significant level set at 0.05. In addition to the t-test result, factors analysis of the 18 variables was conducted to establish further relationship among the variables. The result of the factor analysis is shown in Table 2, comprising of the factor loadings, commonalities, percentage variance explained and eigenvalues for the extracted factors.

Table 1 Mean ratings and t- test results

Rank	Reference	Factors Contributing to Non-adoption of VE for Building services	Mean	t-test	p-value
1	NONAD2	Lack of understanding by client organisations	4.7748	28.494	.000
2	NONAD10	Clients don't often request for the service	4.3694	15.142	.000
3	NONAD13	Inadequate time to conduct the study	4.1081	13.001	.000
4	NONAD6	Resistance from design consultants	4.1982	12.531	.000
5	NONAD1	Value management skills are unavailable	4.2613	11.637	.000
6	NONAD11	Client's don't often pay for the services	4.2162	11.017	.000
7	NONAD5	Additional time and cost required to train clients' team/participants	2.0991	10.499	.000
8	NONAD4	Lack of sufficient knowledge base by building services practitioners	3.7838	8.154	.000
9	NONAD7	Non cooperative attitudes from other participants	3.6216	7.490	.000
10	NONAD16	Late involvement of building services design consultants	3.9550	6.534	.000
11	NONAD12	Clients reluctance to give support to ideas generated	3.6939	6.008	.000
12	NONAD8	Low commitment from building services sub-contractors	3.4234	4.361	.000
13	NONAD14	Inadequate time to test appropriateness of the ideas generated	3.4595	4.045	.000
14	NONAD18	Non-involvement of building services contractors	3.4054	3.918	.000
15	NONAD15	Non - involvements of specialist designers	3.5586	3.229	.002
16	NONAD17	Non-involvement of building services component manufacturer	3.3604	2.892	.005
17	NONAD3	Lack of theoretical basis to underpin the field of value engineering in higher institution of learning	2.8198	2.220	.028
18	NONAD9	Clients Reluctance to release useful information	3.0721	1.807	.073

4.1 Findings of t-test result

As can be seen in Table 1, the t – test result revealed that 16 out of the 18 variables identified actually contributes to non – adoption of VE for building services. Meanwhile the 3 most important variables based on the t –test result are:

i. Lack of understanding of the importance of VE by clients;
ii. Clients do not often request for the services; and
iii. Inadequate time to conduct the study.

This shows that, lack of understanding of the importance of VE by clients with mean rating of (4.77 and t-test value of 28.494) and clients not requesting for the service with mean rating of (4.36 and t –test value of 15.14) are the most important factors contributing to

non – adoption of VE for building services. This finding agrees with previous studies which considered that top management support is a fundamental requirement for implementation of value management on construction project [7,20]. Successful adoption of value engineering methodologies on a construction project is largely dependent on clients' perception of the anticipated benefits in relation to cost

Table 2 Results of factor analysis

Reference	Variables	Factor loading	Communalities (h^2)	%variance explained	Eigen value
	Factor 1: Inadequate stakeholders involvement			13.368	2.406
NONAS11	Client's don't often pay for the services	.611	.422		
NONAD14	Inadequate time to test appropriateness of the ideas generated	.654	.598		
NONAD16	Late involvement of building services design consultants	.556	.623		
NONAD17	Non-involvement of building services component manufacturer	.758	.560		
	Factor 2: Education and traditional Practices			**11.595**	**2.087**
NONAD3	Lack of theoretical basis to underpin the field of value engineering in higher institution of learning	..678	.589		
NONAD5	Additional time and cost required to train clients' team/participants	.834	.726		
NONAD12	Clients reluctance to give support to ideas generated	.630	.691		
NONAD13	Inadequate time to conduct the study	.532	.522		
	Factor 3: Resistance to change			**11.506**	**2.071**
NONAD2	Lack of understanding by client organisations	.507	.571		
NONAD6	Resistance from design consultants	.506	.653		
NONAD7	Non cooperative attitudes from other participants	.562	.530		
NONAD8	Low commitment from building services sub-contractors	.509	.570		
NONAD15	Non involvements of specialist designers	.785	.664		
	Factor 4: Lack of experience about value engineering			**11.339**	**2.041**
NONAD4	Lack of sufficient knowledge base by building services practitioners	.644	.577		
NONAD9	Clients Reluctance to release useful information	.618	.591		
NONAD10	Clients don't often request for the service	.472	.722		

4.2 Results Of Factor Analysis

The factor analysis carried out revealed that 15 out of the 18 variables can be classified into four factors. The four major factors contributing to non – adoption of VE are shown in Table2 and includes: (1) inadequate involvement of stakeholders; (2) education and traditional practices; (3) resistance to change; and (4) lack of experience about value engineering.

4.2.1 Inadequate Stakeholders Involvement At Design Stage

The global objectives of VE includes: to provide an experience in multi-disciplinary problem solving; develop team work; introduce and apply the structured methodology of VE to real world problems [21]. Therefore, a multi-disciplinary approach is an important element of VE. Therefore, to successfully implement value engineering all project stakeholders must be involved early on the project as follows [22]:

i. Pre-design stage to structure the problem in hand, to ensure that the building decision is the best solution for this problem and to structure the strategic brief.
ii. Briefing stage to identify client requirements, needs and wants and to structure the strategic project brief
iii. Design stage to optimise designs and to ensure that the design is aligned with the

stakeholders' requirements, needs and want to structure the project brief.

Therefore, it is important to note that the need to manage the relationships between clients, building services consultants and contractors, as well as specialist designers and installers cannot be neglected on building services project to achieve clients' desired value. Basically, because, designers may not be fully conversant with the complex interface that exist between different building services components and in the design of buildings. As some of the components are proprietary brands that need input from specialist contractors and specialist designers. If they are not involved, the design consultants may fail to understand the implications of design choices for components and their installations including space requirements. Ironically, these specialists are usually not readily available during design, and when they are available they do not often give their best advice.

Apparently, the ability to form and improve on clients requirements becomes extremely difficult and the cost of change increases. Active involvement of all the necessary parties during VE will lead to great savings from unnecessary costs usually incurred owning to industry fragmentation. In addition, to enhancing continual value improvement building services organisations and installing contractors, according to [7], collective value engineering of building services will lead to:

i. Improve communication and team working;
ii. A shared understanding among key participants;
iii. Better quality project definition and design briefing; and
iv. Increased innovation.

4.2.2 Education and Traditional Practices:

The factor is a reflection of the current level of practice. It is indicative of the fact that, for value management to be adopted routinely on construction projects, including building services design and installations, and thereby transforming the current industry practices. There is need for a well-structured education and training to underpin the practices of value engineering in the industry. This is required to improve the current practitioners' knowledge and reduce reluctance to change. This could be achieved by a proper integration of value management principles in the higher education curriculum and provide a kind of on the job training for the current industry experts. Because, problem solving which is one of the cardinal objectives of VE is an aspect that students need to develop throughout their career, as the VE methodology provides a heuristic whereby students can foster an improved confidence in their abilities [20,21].

Evidence exists to show that VE specialists were teaching some form of value courses in the United States in the 1970s [20]. Although, the details of course offered by this schools were not provided by Zabych, but, according to [21] some form of value training was happening in about 43 colleges and universities. So the notion of academic programme dedicated to VE is not new. Establishment of education programme to provide theoretical basis to underpin VE will ensure that practitioners have sound knowledge base and this will change the practitioners' negative perception of value management and their traditional honest wrong beliefs on practice approach. According to [24] a structured approach to value engineering training will have the following benefits:

i. Provide an experience in multi-disciplinary problem solving.
ii. Develop team work.
iii. Introduce and apply the structured methodology of VE to real world problems.
iv. Communication skills as measured by ability to fully describe a familiar object.
v. Familiarity with the concept of team work / ability to plan collaborative work for a team.

4.2.3 Resistance to Change

Resistance to change is one of the factors that contribute to non-adoption of value engineering methodology according to the result of factor loading. This finding is in line with [25], in the study of private sector perception of value management in Malaysia. They found that the consultants have negative perception of value management; thinking that it will reduces their fee on projects. This could also be one of the reasons why the methodology is no adopted for building services, since the consultants are client's representatives and are in position to advice the client on the need for value management of engineering services.

It is important to understand that resistance to change can significantly impact value engineering effort if it is not well managed. Therefore, to overcome this challenge adequate attention must be given to human relations. The following have been suggested as useful rules of conduct to minimise resistance to change among VE members [7, 10, 22]:

i. Create awareness among VE team on the nature and objectives of project;
ii. Encourage team effort among participants
iii. Respect the chain of authority, organisation culture, and personal characteristics of participants;
iv. Consult with those that are affected with the proposal generated
v. Listen to people's opinions and suggestions, and
vi. Respect the opinions of others

4.2.4 Lack Of Experience About Value Engineering

VE is considered as a problem solving technique that capitalises basically on team-work, function analysis and creativity [26, 27]. Therefore, the practice of VE

requires good command of other supportive skills, such as work discipline and communication skills. Although the concept of value management is not new in Malaysia and the associated benefits of adopting it is recognised, but the adoption on construction project is still at infant stage. As the implementation of value management on construction projects was only institutionalise for adoption on federal government projects whose value exceeds RM50 million in 2009 [20]. This seems to explain the reason why expert in the construction sector do not have adequate knowledge of value management. It is, therefore important, for industry stakeholders to consistently ensure that VE methodology is adopted on both public and private sector projects so as to increase the experience of industry experts.

Application of value engineering on multiple projects will also provide industrial training opportunities for students in higher institutions of learning to gain practical knowledge. To overcome this challenge, there is need for a strategic collaboration between all professional bodies in the construction industry to ensure that Continuous Professional Development (CPD) in the form of workshops and seminars targeted at appreciation and application of value methodology is put in place. Evidence abounds in literature that the application of Value management in form of Value analysis started over 50 years ago in United States, in the early 60s in the UK. Although, the practice of VE in the construction industry of these countries have reached maturity but they started in the form of CPD programmes and on-the –job training programmes for professionals [23,28].

5.0 CONCLUSION

This study have identified and classified the significant factors deterring the adoption of value engineering methodology on building services projects as shown in Table 2. This has mainly fulfilled the objective of this study. The factor analysis employed to categorise the variables have produced a four (4) factors solutions. Under non-involvement of stakeholders, four variables have been identified which includes: clients don't often pay for the service; inadequate time to test the appropriateness of ideas generated; late involvement of building services design consultants; and non-involvement of building services component manufacturer.

Under education and traditional practices, four factors loaded here as: lack of theoretical basis to underpin the field of value engineering in higher institution of learning; additional time and cost required to train clients' team/participants; and inadequate time to conduct the study. Resistance to change has five variables as: lack of understanding by client organisations; resistance from design consultants; non-cooperative attitudes from other participants; low commitment from building services sub-contractors; and non-involvement of specialist designers. Lastly, lacks of experience have three factors which include: lack of sufficient knowledge base by building services practitioners; clients' reluctance to release useful information and clients' do not often request for the service. However, for value engineering to be applied routinely on building services projects, it is important to integrate the basic principles in of VE in the higher institution curriculum. This will ensure that students are better prepared to make the transition to the industry and become team member that can manage VE methodologies.

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