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The Malaysian AEC Professionals Work Culture Could Improve Organizational Team Productivity during Industrialized Project Delivery

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ABSTRACT

There is miscoordination in Malaysian construction project delivery resulting in many variation orders (v/o) in the industry. Hence, the Construction Industry Transformation Program 2016-2025 (CITP) is developed to facilitate the future of Malaysian construction industry. This paper presents the results of study on factors in Malaysian architecture-engineering-contractor (AEC) professionals work culture that could improve Malaysian organizational team productivity during industrialized project delivery. This is a case study involving observation and interviews of 14 participants in a Malaysian organization to identify the cultural criteria for successful AEC collaboration. The investigation covers work culture preferences, the inflows and outflows of tacit knowledge through interdependent tasks, and the collaboration processes and related technologies used. Results indicate that four operating characteristics occur in Malaysian building projects. Integration of culture knowledge with Building Information Modeling (BIM) in projects could alleviate better productivity. Finally, this study recommends potential work culture criteria that could uplift Malaysian AEC technology, skill, competencies and expertise, and provide higher incomes commensurate to the construction workforce.

Keywords: AEC, cultural knowledge, integrated design management, knowledge management, sustainable design informatics, work culture

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INTRODUCTION

Many developing countries are experiencing significant escalation of variation orders in their building projects (Mhando, Mlinga, & Alinaitwe, 2017; Kazaz, et al., 2012; Mohammad, et al., 2010). Among the significant causes of variation orders in

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projects are change of design by owner and consultants (Dixit et al., 2017; Memon, et al., 2011), lack of professional experience in handling projects (Doloi et al., 2012), poor coordination (Yong & Nur, 2012) and information, and payment delays (Kikwasi, 2013). Arain and Low (2005) highlighted that these variation orders were 65.29% sourced from the architectural variations that occurred during the design development and contract implementation stage. Here, the study foresees that design changes are a crucial factor in escalating the number of variation orders in project.

Buswell et al. (2007) saw that application of BIM would support industrialized productivity process. It could be enhanced when professionals' collaborative culture apply technological and professional components to reduce waste. Malaysia is interested in utilizing BIM and industrialized construction to facilitate the Construction Industry Transformation Program 2016-2025 (CITP 2016-2025) as a means to direct the future of Malaysian construction industry. There are many attempts by Malaysian Government to encourage Malaysian AEC practices to adopt BIM via the government's pilot projects (Latiffi *et al.*, 2013). The professionals' collaborative culture such as using 2D conventional drawing method aggravates the variation orders in building projects. Without a supporting collaborative tools and processes, AEC professionals are having further miscoordination resulting in escalation of variation orders in building projects. Here, the study identifies a problem gap that needs to be addressed which is miscoordination due to professionals' collaborative culture from design development (DD) to contract implementation stage (CI) resulting in many variation orders (v/o) in construction industry. Therefore, the objectives of the study is firstly, to determine the level of AEC professionals' collaborative culture using CAD visualization tool in construction industry; secondly, to analyze the factors supporting AEC professionals' collaborative culture in improving productivity in industrialized projects; and finally, to propose an AEC professional collaborative cultural model to reduce time and delivery waste during design process in industrialized project.

The paper first introduces the background of the study. Then, the paper presents the literature study on AEC organizational team performance, productivity efficiency, and AEC's work culture. Then, the case study research methodology used is described followed by the results and discussion. The study uses Horii (2005) cultural model-Practice and values dimension to build the study's discussion and includes a conclusion on BIM as professionals' work culture, knowledge management, and knowledge flow as well as the implications of this study.

BIM Work Culture

Many seminal literature anticipate that BIM could be the new work culture for the AEC industry. BIM is believed to be the extended version of the Virtual Design and Construction (VDC) due to similar tenets, components, and procedures (Sacks et al., 2010). Derived from the Product, Organization and Process (POP) model (Fischer & Kunz, 2004), VDC could furnish multidisciplinary AEC professionals with explicit connections of people functional processes (Jin et al., 1995; Nissen & Levitt, 2002), 4D CAD visualization of schedules, delivery dates, and activities (Kam et al., 2003). VDC uses Industry Foundation Classes (IFC)–an interoperable international standard allowing smooth information exchange between tools for visual interoperability and *n*D's (Lee et al., 2005) to support accurate decisions for solutions to conflicts (Bouchlaghem, et al, 2005; Fischer & Kunz, 2004).

During fabrication, CAD models are linked to CAD numeric control (CNC) machine to produce speedy, accurate products whether in mass production or small quantities (Knight & Sass, 2010). Hence, they help reduce waste and variation orders. Kam and Fischer (2004) described the POP models as an active visual communicator during the early phase of design for project team members to be aware of the sequenced planned work, schedules, and conflicts. Therefore, the study posits that the POP models could identify early anomalies in assembly and agrees with Kam et al. (2003) that having a visual communicator could increase non-professional awareness and knowledge flow to appreciate design concepts, design rationale, constructability and field issues. The authors agree with Ibrahim and Nissen (2007) that in a complex dynamic environment such as fabrication-construction deliveries, knowledge flow is crucial to eradicate anomalies and re-work between team members. Kam et al. (2003) supported that designers' accurate properties of the product models could enable other team members to re-use data and embed accurate information in their software application to coordinate fabrication process, thus, minimizing rework. Consequently, the authors agreed that IFC in POP models would allow smooth interoperability of data between team members, cut half of the documentation time, and convey accurate information, hence, minimizing rework in the subsequent assembly process.

Productivity Efficiency

Hofstede (1997; p. 10) regarded culture as several layers of mental programming within themselves, corresponding to different levels of culture. These layers are personality, culture, and human nature (Hofstede, 1997). Another layer of culture in societies comprises national culture differences, cultural differences according to region, religion, gender, generation and class, and organizational culture. The authors posit that much of organizational culture is more likely to be influenced by AEC professionals' characteristics such as complacency with 2D traditional method (Fischer, 2006) to deliver projects. This trait is inherited from their earlier tertiary training and previous experiences during projects (Ibrahim & Pour, 2010; Rahimian & Ibrahim, 2011), hence, making them reluctant to accept new ways of delivering projects.

Many scholars highlight that construction waste is getting higher due to lack of professional awareness (Poon, Yu, & Jaillon, 2004), less defined professionals' responsibilities in handling waste (Osmani, Glass, & Price, 2006), and professionals' attitude and behavior in waste management (Begum et al., 2009). Waste in this context is inefficient use of resources and capital which add cost but do not add value to product (Koskela, 2000). Ohno (1988) categorized seven types of industrial waste namely: 1) overproduction, 2) inventory, 3) extra processing steps, 4) motion, 5) defects, 6) waiting, 7) transportation, and 8) making-do waste (Koskela, 2004). Industrialized waste production is influenced by cultural knowledge. The authors also agree with Knight and Sass (2010) that cultural and social factor play equal roles to make these technologies be accepted and validated in the construction industry. Additionally, a study by Abdul Ghafar et al. (2013) posited that organization would depend on teamwork culture, method of knowledge transfer for discontinuous membership in a building project, and further enhancement of professional education programs. Herewith, we can consider that adaptation of CAD technologies together with professional culture in the early stage of design, could promote effective productive practices to reduce industrialized waste.

AEC Work Culture

The authors see that culture is the prominent factor influencing an organization's productivity. The authors use Horii (2005)'s cultural performance model to analyse the impact of culture in organization. In the culture performance model, Horii suggested two cultural dimensions in organization to be measured: 1) practices dimension- the factors linked to organization structure, level of communication formalization in organization's coordination, control and rules; and 2) values dimension− the behaviour patterns in decision making and communicating information that influence the organization's structure and leadership style.

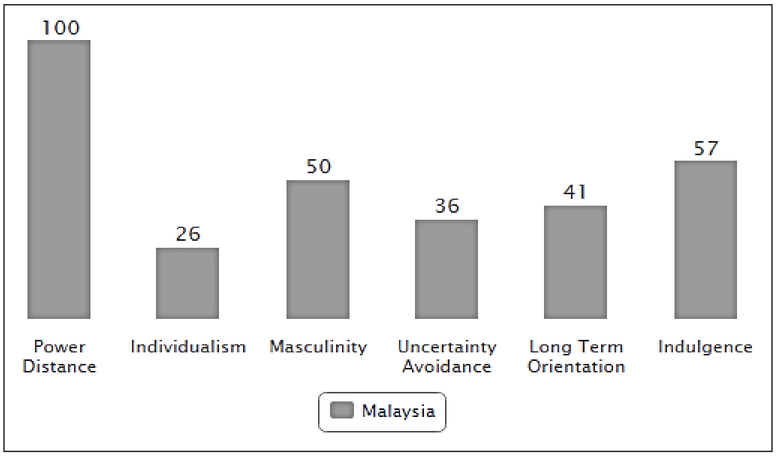

Figure 1. Hofstede's National Culture Model of Malaysia (Hofstede, 2017)

Horii's study posited that organization performance was controlled by national culture preferences such as the Power Distance Index (PDI), Uncertainty Avoidance (UAI) and Individualism Index (IND) (Hofstede, 1997). For instance, a particular national background would prefer to a particular configuration because it fits their implicit norm model and cultural preferences (Figure 1). Hofstede's (1997) high Power Distance Index (PDI) countries are most likely to practice centralization, organization, communication, and non-divisionalized hierarchical configuration (Burton & Obel, 2004) while the level of formalization in an organization is reflected from PDI− (UAI) dimension and low UAI countries prefer to standardized outputs. On the other hand, low Individualism Index (IND) countries would feel uncomfortable in challenging goals but comfortable when they have their mentor's consensus during challenging goals processes. This implicates that AEC professionals could also have their own implicit work culture preference that would affect their of beliefs and values in delivering projects

Studies have found that epistemological characteristics–combination of complex, uncertain and equivocal environment–are conveying poor tacit information to team members especially during formal documentation and negotiation for approval process (Ibrahim & Paulson, 2008). In addition, deficient understanding of interdependencies in multiple workflows (Ibrahim & Nissen, 2007) are hampering knowledge flow and effective assembly of discontinuous members. For instance, the specialist contractor in the fabrication process is denoted as a discontinuous member—coming into the team when needed and leaving when task is completed. This implies that fabrication waste production is likely due to a combination of cultural knowledge differences between professionals and weak interdependent monitoring over the complex multiple workflows. This is making the discontinuous member suffer from knowledge loss phenomenon, hindering the fabrication efficiency, thus, causing unnecessary wastage. The authors speculate that amalgamation of BIM with professional culture and firm monitoring over complex discontinuous membership workflow in the early stage of design could prevent knowledge loss, thus, reduce industrialized waste. In turn, it would facilitate productivity efficiency. In view of the above, the study posits that cultural knowledge and technological support could allow smooth interoperability, ensure accurate information, and minimize rework in subsequent fabrication process towards inhibiting unnecessary wastage.

METHODS

The study employs case study research method and refers to Yin (2009) in developing the case study research design. To further answer the logic of the study's Case Study Research Design (CSRD), the five components proposed by Yin (2009) are used as shown in Table 1.

In building unbiased interpretation of data, the study uses Yin's four test of validation in CSRD. (Refer Table 2)

Table 1
The five components of logic to CSRD (Adapted from Yin, 2009)

Components	Logic
1. The study's question:	The main research question (MRQ) is: How can visualization technology improve productivity efficiency for reducing construction waste? According to Yin (2009) when a research question starts with a how or why, it confirms the appropriateness of use of case study research methodology in a research indicating the essential use of case study as a research technique.
2. Proposition statement:	The study's theoretical proposition: With competent technological support, productivity can be improved by enhanced understanding of cultural knowledge (work culture, knowledge management and professional collaboration) between professionals during design phase, hence, affecting production of waste in industrialized construction. According to Yin (2009; p. 28) "each proposition directs attention to something that should be examined within the scope of study". Propositions could descriptively help explain the systematic and verifiable steps of the theoretical proposition to examine the key components. This proposition is motivated by Abdul Ghafar, et al. (2013) and Abdul Ghafar, Ibrahim and Shari (2014) work culture and cultural knowledge theory in reducing industrial waste.
3. Unit of analysis.	The unit of analysis is a single project team that is Project M. In the study, Project M team has 14 team members consisting of architect, mechanical and electrical engineer, civil and structure engineer, quantity surveyor, sub-contractors, and developer with experiences ranging from a minimum of one to more than twenty years. The project complexity was based on project's characteristics of multidisciplinary practice, practice's attributes (such as organizational style, authority, formalization of communication and organizational hierarchy), the use of BIM technology in delivering project, and comprehension of professionals' value preferences (such as task coordination and decision making).
4. The logic linking data to proposition.	From the theoretical proposition, the study would logically show how it rationalizes the correlation between theoretical operational constructs to consolidate the technique in obtaining data from field work. The theoretical proposition presented six theoretical operational constructs for the study to work on in relation to the CSRD. The operationalized constructs are work culture, knowledge management and professional collaboration. Refer to Table 3.
5. The criteria for interpreting the findings	The study anticipates that 60% of time and delivery waste could be reduced when productivity efficiency value is high (80%), when technology (BIM) and culture (*work culture, knowledge management and professional collaboration*) is controlled.

Table 2
The CSRD tactics for four steps of validation (Adapted from Yin (2009))

Tests	**Case study tactics**	**Phase of research in which tactics occurs**
1) Construct validity	■ Multiple source of evidence - **Participant-Observation**: Identified cultural criteria for successful collaboration to reduce waste. - **Documentation**: Established tacit area and task interdependency during DD-CI; identified collaboration process and technology to reduce industrial waste. - **Archival records**: used minute meeting documents to identify number of rework and miscoordination	Data collection

Table 2 *(continue)*

Tests	Case study tactics	Phase of research in which tactics occurs
2) Internal validity	■ Confirmation of all participants	Data analysis
3) External validity	■ The theoretical proposition was replicated in the second case and the finding affirmed the same result	Research design
4) Reliability	■ Used case study protocol for case	Data collection

Table 3
Operational variables of the constructs

Construct	Definition	Sources of evidence	Result
Work culture	Work etiquette– *4D visualization communication, level of detail, interoperability*– of an organization to support dynamic collaboration and decision making in project in reducing waste	Literature Review (LR) Participant Observation	Identify culture criteria based on practices and value attributes
Knowledge management	Efficient method of tacit knowledge transfer during workflow process to reduce construction wastage	LR Participant Observation	Establish tacit knowledge area
Professional collaboration	Utilization of visual communication techniques between stakeholders in reducing construction wastage	LR Participant Observation	Identify collaboration process

Interview and Participant Observation Protocol

The participant-observation technique is used in the mixed commercial-residential project in Shah Alam, Malaysia (Project M). Data was collected in September to November, 2014 and reported to the gatekeeper who gave the first author access to documents and human resources in the offices. The first author was involved in everyday (Monday to Friday) office activities from 8am until 5.30pm. The major sources of data are the archived minutes of meeting records, interviews, and observation. Fourteen (14) participants were interviewed and the interviews were transcribed before the end of the day with each interview lasting about 1 hour. The first author would then report to the gatekeeper weekly on the findings. Feedback from meetings with the gatekeeper would redirect the first author when needed. Each of the questions was inferred based on categories or theme found during the interviews. From there, the identification of similarities and dissimilarities in the results were discussed. The interviews explored the professionals' collaboration approach, while participant observation technique was used to identify the BIM knowledge management and work culture of the respective teams.

RESULTS

This section reports the results of the interview and observation data. Then, it discusses the interview and observation findings. Ibrahim & Paulson (2008) have identified five sequential phases in the building deployment life cycle: 1) *Feasibility*−this is the phase where the developer ascertain to go/ not to go for the project; 2) *Entitlement*−gaining official permission to build within government jurisdiction; 3) Building permit−acquiring building permit to construct facility on a property; 4) *Construction*−constructing physical works on site; and 5) *Property Management*−premise operation period. The results showed that Project M has multiple and sequential phases occurring in its project's life cycle deployment (see Figure 2). In Project M, the authors noted that dual concurrent and sequential phases transpired during the design development phase and determining target market to secure bank loans for purchasers. To chart the workflows, the authors adapted Ibrahim & Paulson (2008) life cycle workflow diagram. The workflows were divided into the aforementioned life cycle phases and activities were mapped according to case study findings. Figure 2 illustrates the multiple interdependent links between the AEC's workflow and the developer's workflow. Project M showed multiple concurrent and sequential phases in the property development lifecycle and hence, have multiple interdependencies tasks in the workflow. This exhibits two environment factors identified by Ibrahim & Paulson (2008): 1) multiple concurrent and sequential workflow, and 2) multiple interdependencies tasks.

Data shows that Project M used traditional procurement throughout the building deployment. The study charted the full-time equivalent (FTE) for each team member from each project with an estimation of eight-hour a day in a five work week value. Table 4 highlights the varying number of memberships in different phases. This finding suggests the third environmental factor- the highly discontinuous memberships as opined by Ibrahim & Paulson (2008). The 14 staffs from Project M are similarly high indeed because the property developer relied on external consultants to design and its internal staff to review drawings during the sequential phases of feasibility-entitlement, building permit and construction.

The authors further observed the typical Project M's project definitions pertaining to similar professional phases as indicated in Table 5.

From the observation, 90% of the Project M's team members particularly architects, engineers and contractor utilized 2D-CAD drawings to issue design and construction drawings. New team members have difficulty in retrieving information from bulks of drawings. The new Project M's team members would complete their project cognition by referring personally to a "senior" member to gain information from who was present before. Project M has a lot of "socialization" thru design coordination and technical meeting in

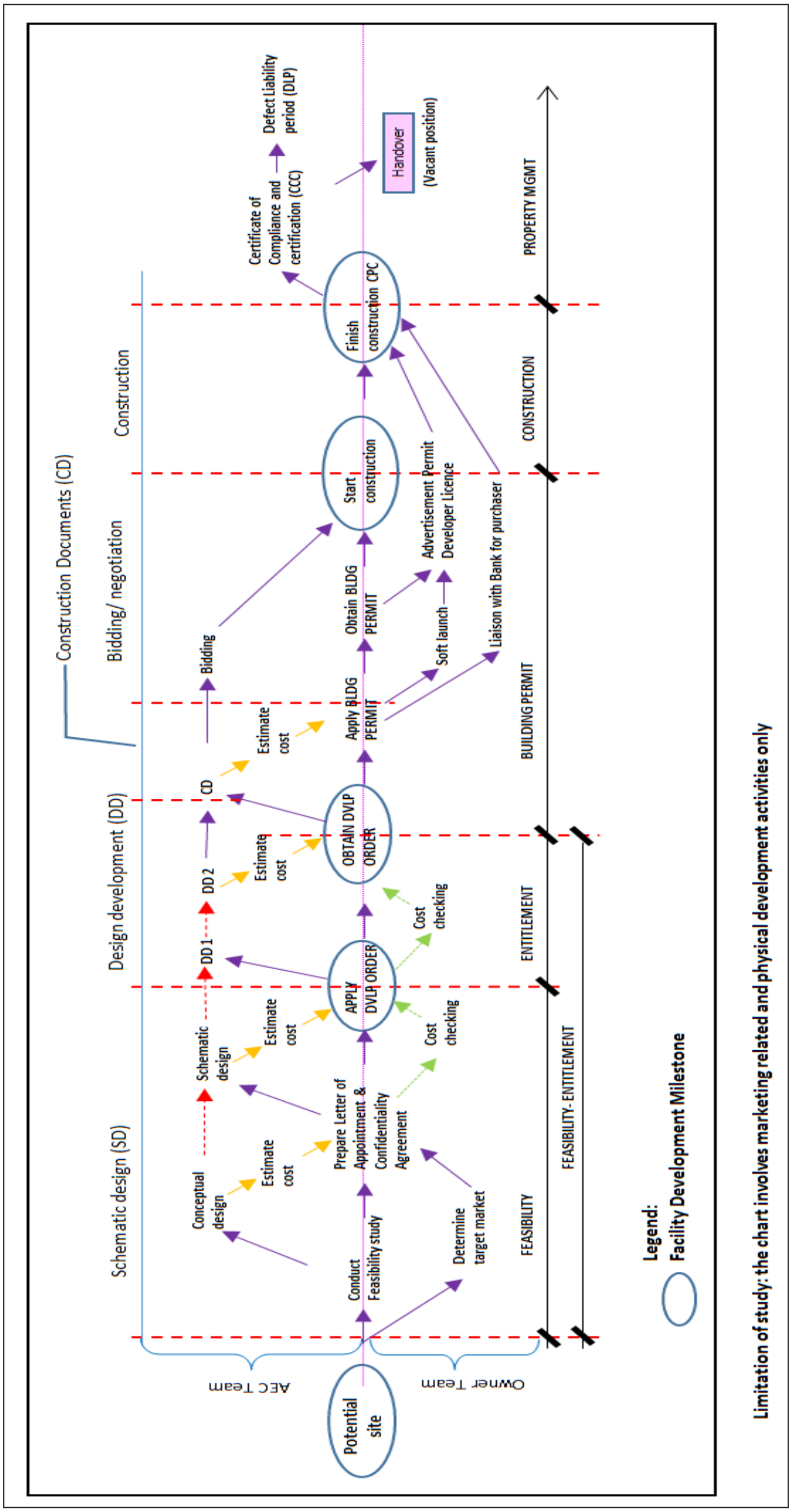

Figure 2. The Project M Development Lifecycle Workflow (Adapted from Ibrahim & Paulson, 2008)

Table 4
Project M's staff position, FTE and allocation for different facility development life cycle phase in a project development (Adapted from Ibrahim & Paulson (2008))

Agent's position/Phase	FE	BP	CO	
Phase **Agent**	**LAM:** **SS-DD**	**LAM:** **DD, CD,CI**	**LAM:** **CI**	
Developer				Traditional Procurement
Development Manager	0.25	0.25	0.25	
Dep. Sr. Manager	0.33	0.33	0.33	
Sr. Exec. Development 1		1.0	1.0	
Sr. Exec. Development 2			1.0	
Exec. Development 1	1.0	1.0	1.0	
Exec. Development 2			1.0	
Sr. Exec. Contract			1.0	
Sr. Mngr. Sales & Marketing			1.0	
A-E consultants				
Architect		0.33	0.33	
Planner	1.0			
Landscape Architect			0.5	
C&S Engineer	0.33	0.33	0.33	
M&E Engineer		0.2	0.2	
Quantity Surveyor	0.25	0.25	0.25	
Total membership per phase	6	8	13	

Table 5
Equivalent project activities terminologies of Project M

The Project M's Project terminologies	Description
Schematic design	Refer to Figure 2
Design development	
Contract document	
Building design approval	

every alternate week, lasting five hours each session. "Socialization" is a way to interact to transform tacit knowledge to explicit knowledge among individuals in an organization (Nonaka, 1994). Project M's team members used 2D drawings in PDF format to depict anomalies during constructions and transferred them in the File Transfer Protocol (FTP) network for other team members to retrieve latest information about the project. Project M used e-filing system in the intranet to archive documents. These anecdotes showed that tacit knowledge dominates during the earlier phase where a skilled manager obtains this knowledge through socializing, discussion, and internalizing with team members. At the same time, this skilled manager would ensure explicit knowledge movement is sufficient among other team members using emails and collocated discussion in the succeeding life cycle phase. In summary, the results and analysis of the participatory-observation study provide evidence that Project M exhibits the four operating environmental characteristics similar to USA projects outlined by Ibrahim and Paulson (2008). Table 7 illustrates the organization dimension in Project M.

The result from using Horii (2005) cultural performance model are mapped in Table 6 to show Project M's normative team culture.

Table 6
Summary of practices dimension in Project M (Adapted from Horii (2005)

Practices Dimension	Project M's team Culture
Centralization	Centralized authority
Formalization	High level of formalization
Organizational hierarchy	Multiple level of hierarchy
Task control style	Control by process
Values	
Decision making	Group-based decision making (consensual)
Communication	Group-based communication

For result validity, the authors used four tests of validity–*construct validation, internal validation, external validation and reliability* (Yin, 2009). For *construct validity*, the authors use multiple sources of evidence from participant observation, documentation and archival records while for *internal validity*, the authors do pattern matching which uses independent variable and dependent variable from the hypothesis to test results and compare them to the baseline model. As for the *external validity*, the authors use replication logic of the case studies to seek generalization; and finally, for the *reliability validity,* the authors used case study protocols for both of the cases. However, the study did not cover the financial matters of the project due to prior confidentiality agreement.

DISCUSSION

This section discusses how BIM work culture profoundly affects Malaysian professionals' productivity. The discussion starts with the operating characteristics followed by the influence of work culture on project performance.

Operating Characteristics

In an earlier study by Ibrahim and Paulson (2008), they established four operating environmental characteristics existing in

USA project team. The finding indicates that these operating characteristics: 1) multiple concurrent and sequential workflow; 2) multiple interdependencies tasks; 3) discontinuous member; and 4) regressive knowledge flow in a life cycle existed in most organizations around the world, therefore, indicating that there are other factors that influence project productivity. The authors believe that culture could be the salient factor that surpasses the environmental operating characteristics, influencing organization's productivity. This is supported by Horii (2005)'s study that different countries have particular cultural driven normative system which affects majority of the project's performance and information processing. Therefore, the authors propose looking further in the culture factor of a project's organization.

Influences of Work Culture on Project Performance

The authors conclude that culture is the prominent factor influencing an organization's productivity. The study concurs with Horii (2005)'s cultural performance model practice dimensions that the degree of involvement of top manager in its organizational structure, formalizing coordination control and rules in organization; and standardized work processes are among the factors that could support Malaysian AEC work culture to uplift their competencies and expertise.

CONCLUSION

The authors conclude that the four operating characteristics are occurring in similar fashion in Malaysian building projects. The authors also found that using BIM as the knowledge management system and professional collaboration in building project can alleviate a project's information-processing and decision making to another level. Anomalies and clashes can be easily detected and the team could comprehend tasks responsibility ensuring better project productivity. The presence of discontinuous membership in project life cycle could make the "continuous" member create effective and efficient knowledge in various stages and structural phase of the project deployment (Ibrahim & Nissen, 2005). The authors argue that the culture factor is the prominent factor that influences professionals' behavior surpassing the operating environmental characteristics. Since organizational structure is part of the organization's culture, this suggests that an organizational fit would further determine the efficiency and effectiveness of knowledge flow (Hammah & Ibrahim, 2015). The authors are proposing BIM technology to be integrated with cultural knowledge to efficiently accelerate a project's productivity. The authors posit that the culture knowledge of organizations has a profound effect on the project's performance and productivity. The authors define culture knowledge as the factor of work culture, knowledge management, and professional collaborations. In line with Abdul Ghafar et al. (2014) the authors hypothesize that when time and delivery waste is high, productivity efficiency would reduce when BIM and culture are controlled. The study posit that this *BIM behaviour* would contribute in recommending a cultural knowledge theory for enabling developing countries like Malaysia to have successful partnership with developed countries. Further study is recommended to understand how these cultural dimensions would affect the organizational productivity. Understanding the differences in culturally-driven normative system is becoming important in professional collaboration since it would help reduce misunderstanding and miscommunication due to differences in operational systems while managing global projects.

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