VALUE CONSIDERATIONS OF ADOPTING BIM IN FM

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ABSTRACT

Building Information Modelling (BIM) is expected to streamline the key processes of construction, and promote innovation throughout the building/product life cycle. Since most buildings have been designed for long lifecycles, the facilities management (in-use) phase is significant. Therefore, use of BIM in facilities management (FM) offers the promise of much benefits to project stakeholders. Even though strategic level benefits of BIM to FM are recognised, limited attempt has been made to understand its application at operational level.

This paper aims to establish the "value" of BIM in FM. The study explores the key aspects of value theories through a thorough literature review and empirical data from 15 interviews to identify the human value consideration of BIM in FM. The background of this paper discusses the nature of built environment by bringing evidence for the value factor embedded in buildings beyond price. Wider benefits of BIM in facilities management are noted, however its implementation within FM phase is limited. The findings of research explain the critical value considerations for BIM in FM by considering the value of BIM at operational level. The research contributes to the current knowledge by presenting the key link of basic human values with operational level BIM expectations.

Keywords: *Basic Human Value Theory; Building Information Modelling (BIM); Facilities Management (FM); Value In-use.*

1. INTRODUCTION

Building Information Modelling (BIM) is a popular information creation and management tool within the Architectural, Engineering and Construction sectors (McGraw-Hill, 2009). The capabilities of BIM are widely used during the design stage to manage and validate building design (Vanlande *et al.,* 2008). Although the application of BIM is dominant in early stages of a building construction (i.e. Concept, design stages), owners and facilities manager have good potentials in achieving benefits of through-life BIM adoption (Eadie *et al.,* 2013; Howard & Björk, 2008). However, the overall benefits of BIM are not completely identified and construction project stakeholders are still struggling to make decisions on possibilities for adopting BIM within their project execution plan (Barlish & Sullivan, 2012).

Research in psychology proves that people make choices based on the basis of fulfilling psychological needs (Deci & Ryan, 2000) which are identified as values. Therefore, this research aims to reveal the reasons behind the slow adoption of BIM during the facilities management stage, by studying the psychological needs in FM concerning BIM. Benefits of BIM are reviewed and compared with an advanced and empirically proven human value theory. Value perceived in buildings is studied first to set the credibility of applying human value theories to motivate decision on BIM adoption. This study identifies the broad term of BIM as the combination of information, technology and process of creation and management of digital footprint of a facility as a step forward into smart cities.

Recognising construction as an ancient human activity emphasise the sociological aspect of the construction. It is a discipline close to human lives and therefore build upon human needs. Construction was initiated to fulfil the basic need for shelter to protect from changes in climate. Contradictorily, living in the 21st century,

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construction is another specialised activity take place out of everyday life. This study attempts to bring forward the human element of built environment which is underestimated in time, cost, quality culture in construction. This is achieved by focusing on the current trends in adopting Building Information Modelling (BIM) in built environment.

2. RESEARCH METHODOLOGY

Research methodology explains the logical thought process followed to reach the research output (Sutrisna, 2009). This paper presents a part of a research project which aims to evaluate the impacts of implementing BIM in FM, especially the human value considerations of such implementation. To begin with, a literature review on built environment and BIM has been conducted to gain an insight on how value of BIM is being interpreted. Having identified the knowledge gap in terms of the absence of an explanation as to the low level of BIM implementation in FM, the study was taken forward by following a qualitative methodology. Following a snowballing sampling method, 15 interviews were conducted with operational level facilities managers using open ended interview questions to identify FM's perspective towards BIM. As role of FM is multidisciplinary, the designation given for this role at each organisation tend to differ. All interviews were based on the primary question of "*How can BIM be valuable to your daily operations?"* and prompt questions were asked to direct the interviewee towards the key question.

Qualitative research is used to study complex situations due to its capability to reach rich data (Sutrisna, 2009). In qualitative research, philosophical view point is important in order to understand the assumptions and reliability of the findings. This research is based on a critical realism philosophical view. Critical realism merge the positivism and constructivism to identify the truth (Fletcher, 2017). Accordingly, the researcher takes the view that there is a single reality but multiple explanations. Data collection and analysis methods have followed the grounded theory strategy to capture the multiple explanations. Therefore, 15 interviews were analysed using three stage coding method recommended in grounded theory. With critical realism comes the assumption that theory makes reality more accessible (Fletcher, 2017). Therefore, findings were matched with the Schwartz's Basic Human Values theory understand the FM perspective of BIM. As the Facilities Managers are not at the capacity or position of making the decision of procurement of BIM, this study is limited to understanding underline motivations of taking forward BIM into operational phase of a facility. Also, previous research has emphasised the limitations of economic value considerations of BIM due to lack of whole life cycle experience to quantify its benefits (Becerik-Gerber & Rice, 2010). Hence, human value theory is being utilised over economic theory.

3. NATURE OF BUILT ENVIRONMENT

The core purpose of this study is to bring new insight into the existing knowledge pool to improve the creation and operation of the built environment. To begin with, this topic builds up the background of the study by exploring what it is meant by "built environment", how it evolved and nature of the 21st century built environment. This complete exploration is expected to take out the conclusions made studying only the tip of the iceberg. There is a remarkable difference between early construction which was identified as an ancient human activity of creating shelter into what is constructed in first century in the third millennium. The importance of studying this difference is to understand the decay of core values interacted between humans, natural environment and built environment. The research on anthropology of built environment hold evidence to how construction of space move from shelter to representations of the social order (Ashworth, 2011; Lawrence & Low, 1990). The development of human needs changed the forms to accommodate them. Built environment is not any more accommodating functional requirements but perceived value (Ashworth, 2011). In contrast, some literature argues that development of the built environment is purely based on material and technology advancement.

The modern construction of built environment is being pushed forward with the technology advancements, limitations in resources and possibility of implementing complex designs giving less concerns towards core human concerns. Since broader spectrum of complex human needs are narrowed down to quantifiable measurements of cost, quality and time in today's construction industry; it is a question whether the stakeholders understand the underpinning human needs communicated through cost, quality and time (Horne *et al.,* 2014). Rapoport (1982) presents an interesting study on meanings of built environment defined by different user groups. One of the examples it presents is the findings of a survey done in France on preference

for living in small-detached houses. It holds evidence to how building user express the meaning of space around the house through "clean air". Revisiting the house spacing over the time shows how knowledge and technology has influence the decision but, with the uncertainty of whether technology have compromise the human needs over ease of implementation (See Figure 2). Giving priority to understand the human element of the built environment, this broader view of the built environment is then narrowed down to means of creation and use of information in built environment to focus on the element of the study.

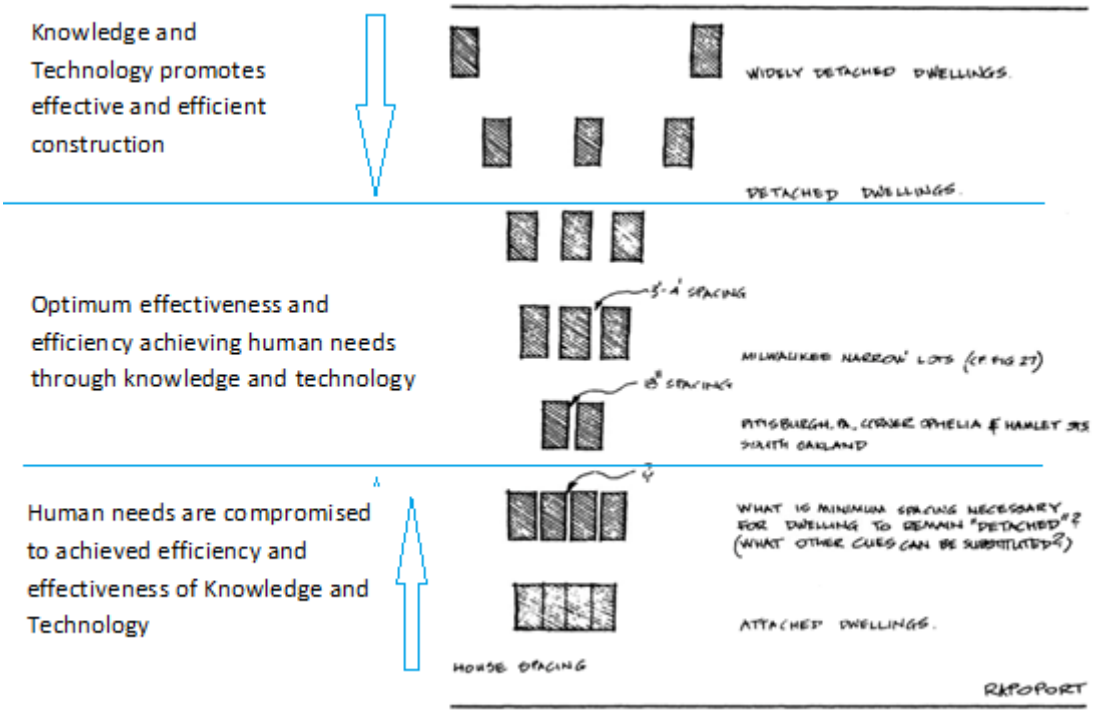

Figure 1: Space Necessary for Meaning of 'Detached'

Source: Adapted from Rapoport (1982)

With the development of the human civilisation and construction capabilities, the purpose of construction was gradually changed from constructing a means of shelter into a communication medium and representation of social value. Studying through the building anthropology confirms that built environment has value which is not completely appreciated by price (Horne *et al.*, 2014).

In an extensive sense, built environment refers to any form of man-made alteration to the natural environment (Lawrence & Low, 1990). This includes forms of products (buildings) such as dwellings, shopping malls, theatres that are enclosed space and roads, parks or plaza that is a defined space but not necessarily enclosed. Most of those products are designed for long lifecycles and in-use phase takes considerably a long duration. To build such products, proper processes/systems are required. The technology advancement helps this by inventing several tools, mechanisms and processes time to time, and BIM is seeming as one of the latest.

4. HUMAN VALUE CONSIDERATION OF BIM IN FM

The concept of "value" took the interest among scholars since the beginning of social science research (Schwartz, 2012). Value is described in many ways and most common descriptions could be categorised as either value in exchange or value in-use. Becerik-Gerber and Rice (2010) presents perceived value of BIM through analysing tangible benefits and costs which can be monetised. However, most of these research on value does not provide a precise description what is meant by value. One of the key characteristics of values is that there are common features in value as well as a distinguish difference. On the other hand they work in a circular structure where one value motivates the other (Schwartz, 2012). Although 'value' is an everyday term, this nature of value is what makes it complex to pin down what it means every time when the term value is used in communication. Studying similarities of values help defining values. Schwartz (2012) explains six features common to all values;

Values are beliefs: Values are deep rooted with feelings. A person who recognise independence as an important value, is delighted when they can enjoy freedom and arouse when their independence is threatened. This leads to both positive and negative behaviour based on the emotional charge.

Values refer to desirable goals: Values motivate actions. When social acceptance is an important value, one will act and behave to gain social acceptance at all circumstances.

Values transcend specific actions and situations: Obedience and honesty may be relevant values in work place but these values are not limited to workplace decisions. This is one of the features distinguish between norms and attitudes which are usually refer to specific situations or objects. For example; one who value lowest cost will make decisions based on price in both personal matters as well as business engagements regardless.

Values serve as standards or criteria: Values guide the people to decide what is good or bad, worth doing or avoiding. However, this logic between values and everyday decisions are rarely conscious. People are only aware about the contribution of values when the judgement to be made has conflicting implication for different values one believes in.

Values are ordered by importance: People prioritise the values based on their character or ordered system of priorities build person's character. These priorities change with the context. Hierarchy is another key feature that distinguish values from attitudes and norms.

Relative importance of multiple values guide actions: Choices made are typically implications of more than a single value. It could be purely combination of values gained as well as combination of values gained at the expense of another. This emphasise the importance of recognising values of FM in order to influence their motivation towards adoption of BIM in FM.

The efforts made on understanding value of BIM in monetary terms has identified that it is too early to determine the tangible value of BIM as it is still in initial stages (Becerik-Gerber & Rice, 2010). Therefore, understanding the value of BIM cost savings may not provide the reasons for immediate adoption of BIM in FM. Creating knowledge on how BIM caters existing human needs in short term is being recognised as a timely solution. Schwartz's theory of basic human values identifies ten basic human values which are empirically proven to be common among cultures (Schwartz, 2012).

Table 2: Ten Basic Human Values

Self-direction	Independent thought and action which allows to be creative, explore and choose
This value is motivated in humans as intelligent subject. It seeks for self respect, privacy, freedom and promotes creativity. Self-direction is a commonly seen value which influence most of the actions and decisions. In BIM terms; It is similar to the general explanation. As an example, adopting BIM because it allows creativity	
Stimulation	Excitement, novelty and challenge in life
This is derived in relation to self direction. People make choices to make life exciting and varied. The choices which satisfy this need is valued. This is again might find contradictory with Tradition as people value to commit to what they know. In BIM terms; Exciting opportunities open through BIM adoption. For example, being nominated for best practice awards or overseas training opportunity	
Hedonism	Pleasure and gratification for oneself
This comes from the person-centered needs. Ability to satisfy one's needs motivated to make choices. In BIM terms; ability to make user's life easier is a motivational factor to adopt BIM	
Achievement	Personal success gained through demonstrating competence according to social standards

Skills and competences are required for survival and resource generation. Performing to achieve survival and resource generation brings social recognition. Therefore, people act and make choices to gain social recognition. In BIM terms: Skills and competence gained through BIM is a value and recognition as a BIM expert	
Power	Social status and prestige
The most simple explanation of this value is need for dominance over resources and people. In 21st century this is more seen through developing social status. Although this finds similar to the "Achievement" value, "Power" focus on preserving the social esteem while "Achievement" is towards active engagement to gain social esteem. In BIM terms: Power held by having undocumented knowledge about the building	
Security	Safety, Harmony and stability
This value refers to the individual interest of safety such as being clean as well as wider interest towards national security. In BIM terms: Stability with current system is valued over unknown BIM	
Conformity	Restrain of actions and impulses likely to upset or harm others
This informs the natural tendency to act in a way that violate social expectations. Conformity is a motivational factor to self discipline and politeness In BIM terms: This could be defined as honor line manager's non-BIM agenda although that's not ones preference	
Tradition	Respect, acceptance and commitment of the customs and believes according to one's culture/religion
Every person has his own beliefs. Practices and ideas. Common beliefs bring groups together and they express their unique worth. It is a form of subordinating to social expectations in terms of culture and religion rather to persons as it is in "Conformity". In BIM terms: Generational difference in acceptance of technology	
Benevolence	Looking after and developing the welfare of those with one is personal contact
Expressed through the voluntary concern towards others' welfare. Primarily within the family and extended society. This value promotes people to be honest, forgiving, responsible and loyal. Where as in conformity is acting forgiving and responsible to avoid negative outcomes. In BIM terms; adopting BIM purely because of understanding its value as the right thing to do	
Universalism	Understanding, appreciation and tolerance of whole universe (people and nature)
As a survival mechanism to avoid life threatening conflict from people and destruction of the resources from the nature. The realization of this value is only perceived with the experience of resource scarcity or encounter of others beyond their group or at a natural disaster. In simple terms this could be paraphrased as appreciation of social justice and world peace. This value content the subtypes of inner harmony and spiritual life. In BIM term; adopting BIM for recognizing its wider good through universal application and waste reduction	

Schwartz's human value theory was initially developed to present the universal aspect in basic human values. However, human value theory is now being applied in different disciplines to identify human factor in the subject studied (Hicks *et al.,* 2015; Mills *et al.,* 2009). Indeed, research conducted applying Schwartz value theory in construction industry (Mills *et al.*, 2009; Panahi *et al.,* 2016) prove the applicability of the theory in understanding complex social reality in construction industry.

5. BENEFITS AND BARRIERS OF BUILDING INFORMATION MODELLING (BIM)

Building Information Modelling (BIM) is a set of digital tools and processes used primarily in design and construction stages (Kensek, 2015). Based on this definition, Kensek (2015) explains the critical role of BIM in FM pointing out the potential gains from BIM that FM can expect. Some research highlight the benefits of

BIM for FM related to specify function; for instance, in terms of how BIM improve the quality of life of building user (Aziz *et al.,* 2016). Gerrish *et al.* (2017) discuss the ability of BIM to contribute to both design and operation of buildings through visualisation and information management. BIM is still underutilised therefore, complete package of BIM offer is yet to understand (Becerik-Gerber & Rice, 2010).

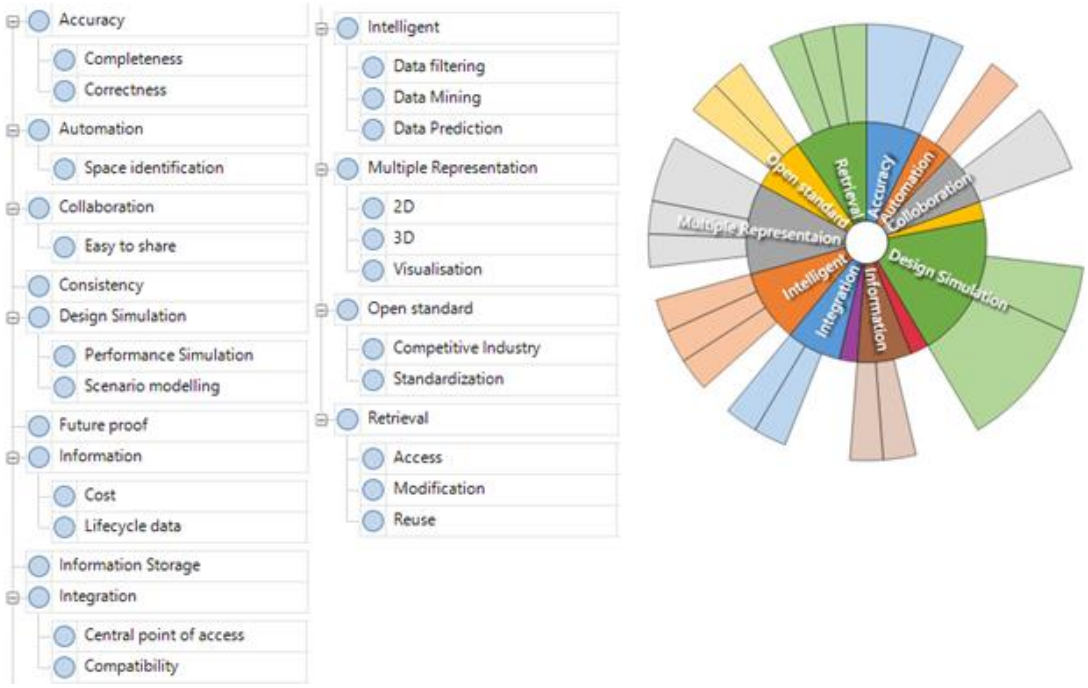

Figure 2: Literature Analysis on BIM Benefits

Figure 2 illustrated the thematic analysis of the literature discussing BIM benefits. The analysis is conducted using NVivoPro 11. It is evident that BIM offers a strong way forward specially with the Smart Cities agenda. However, most of the literature discuss the generic benefits of BIM. Although the study included majority of FM related BIM literature (Aziz *et al.*, 2016; CRC Construction Innovation, 2007; Gerrish *et al.*, 2017; Kassem *et al.,* 2015); each of them discuss on how to use BIM in a ways that offers benefits to FM rather attempting to understand what FM expects from BIM. In terms of barriers to implement BIM in FM; lack of tangible benefits, knowledge on implementation, technological issues with interoperability and skill shortage are highlighted (Kassem *et al.*, 2015). Generational differences, steep learning curve and pull and push between those who are ready to adopt and not, have also been identified as barriers to implementation of BIM in general (Becerik-Gerber & Rice, 2010).

6. FINDINGS AND DISCUSSION

Findings from literature and interviews were merged to develop the value model (Figure 2). As illustrated on the model; in this research, BIM is recognised as a bridge of information, technology and process that were acting in silos before introducing BIM. Interviewees confirming the literature findings on BIM definitions repeated these elements of BIM. For example; the quotation below is from an estate manager explaining the reasons for having not adopted BIM so far.

"..no BIM skills within the staff. We already have 4 or 5 different software packages in use for FM but no one to look after them…Possibly need a strategic manager to manage these systems and update the information….we get promised to give the information but we never get - we get patchy information"

This emphasise that BIM is immediately recognised as technology and then for information it carries. Each of these elements of BIM are referred with its' features when discussing barriers and benefits. For example, Information element carries features such as data, visualisation and information recreation. Another key pointed out in interviews was that, with adoption of BIM, availability of data is expected to increase however, the accuracy of data is not being guaranteed. Extraction from a project manager's interview quoted below holds evidence for this practical barrier in continuous use of BIM.

"We struggled to get all these information most often. We expect the consultancy we employed to check that information to ensure that they are right…. Quite often they have spend time on getting the information, won't spend anymore time checking the accuracy… occasionally when we go out for maintenance, these information aren't correct."

Likewise, data gathered through interviews emphasised that all elements of BIM tend to have promoting as well as challenging aspects in the process of adoption of BIM in FM. However, the manner which each individual or organisation distinguish between challengers and enablers differed with its' characteristics. Market leaders such as contractors with FM service branch tend to see the opportunity in BIM challenges while late adopters doubt the assurance of BIM enablers.

On the other hand, it was noticed from the interview data that facilities managers' expectation on receiving full BIM complied building is purely contractor's responsibility. This is emphasised in previous extraction from project manager's narrative; *"We expect the consultancy we employed to check that information to ensure that they are right"*. This pattern of passing of responsibilities among stakeholders were noted throughout interviews.

In contrast, according to capital project information delivery plan explained in PAS 1192-2; information delivery begins from client's side by producing Employer Information Requirement (EIR) (Manning, 2014). Therefore, facilities manager goes around the value model as an information provider as well as an information user. This emphasise the importance of recognising the value of the role played at each stage.

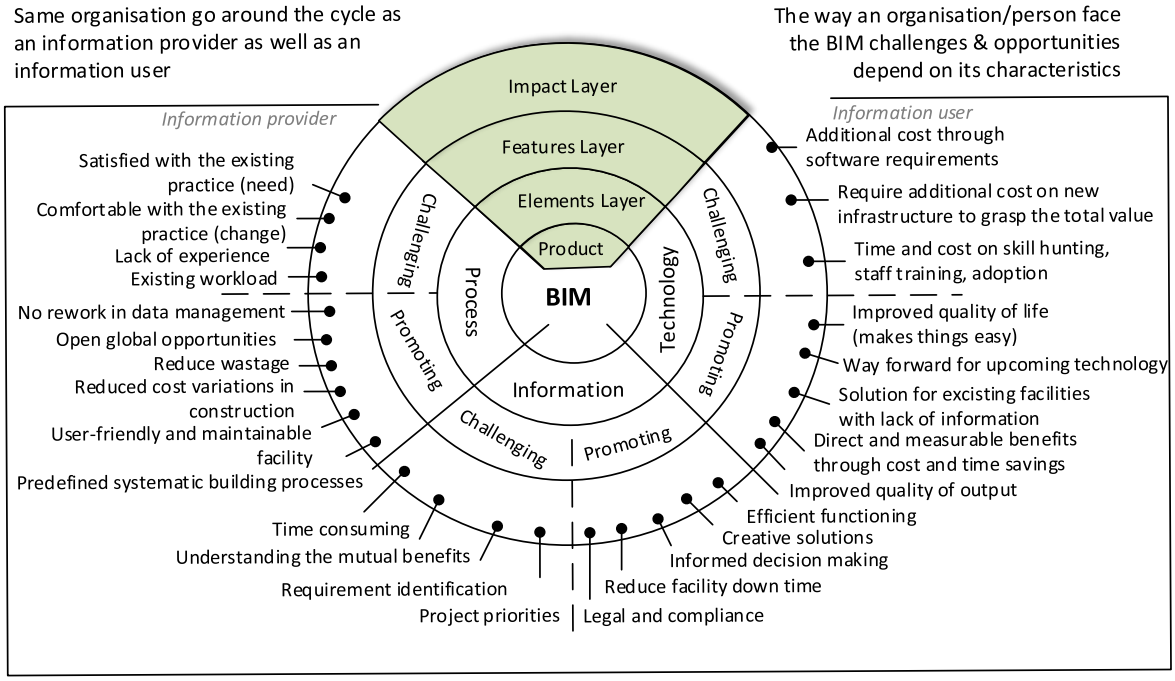

Figure 3: Conceptual Value Model of BIM in FM

Enablers of BIM implementation among operational level facilities managers gathered through interviews aligned with the general BIM benefits that were found through literature review. However, the interviewees discussed a different set of challengers. Although, it is possible to argue that challengers are also similar to the generic BIM barriers; the open-ended interview questions gave them the opportunity to explain it rather limiting their idea by ticking the most relevant barrier on a given list.

Once the value model was developed; challengers and enablers discussed by the respondents were reviewed along with Schwartz'S basic human value theory to understand the potential relationships between psychological needs and BIM values.

A simple content analysis reveal that ultimately what people are trying to achieve through adopting BIM is to satisfy their psychological needs. For instance, mapping the BIM enabler *eliminate rework* with basic human value *Hedonism* explains that less work, less stress is an open path to enjoy life. Which means adopting BIM is not to reduce rework in order to utilise that time on some other office based work but for personal pleasure. However, this is still a benefit even in organisational level form waste reduction and allowing space for staff

to be creative. New knowledge to add here is that not to underestimate or ignore personal motivations as it helps to create a win-win situation.

The exciting disclosure was that there is a clear reflection of human values and challengers in adopting BIM in FM. All most all the respondents began their view of barriers with cost and project priorities at first emphasising these factors are key ones while leaving skill shortage and lack of experience towards the end. Looking at this through human values reveals the manipulation of responses to fulfil the values of *power* and *achievement.* In conclusion, overlaying the basic human value theory help grasping true meaning of benefits and barriers of adopting BIM in FM.

7. CONCLUSIONS

BIM in FM is becoming one of popular considerations within the built environment process improvements. Having studied the literature on BIM benefits and argument on lack of adaptation of BIM in FM; the work presented on this paper aims to reveal the social value considerations of limited adoption of BIM in FM. Almost all the work done in BIM holds evidence for its positive contribution to the industry and promising benefits to be achieved. However, FM has not taken into BIM as anticipated.

The paper reveals an attempt to understand the values held by operational level facilities managers. It matches BIM benefits with universally recognised human value theory to map the expectations of technology with basic human values. Overlapping basic human values with BIM benefits helped to develop a clear picture on why that long list of benefits of BIM makes no sense to FM. The findings confirm previous research findings that BIM is not designed to cater the FM needs but all its key features are purely in benefit of design and construction needs. Therefore, adopting BIM in FM will not solve FM needs immediately but have to structure the FM needs to fit with BIM capabilities.

In contrast, the full BIM experience as it was designed was in benefit of FM and long term users involved throughout building life cycle. In depth studies of structure of values shows that sometimes values conflict with each other while others support each other (Schwartz, 2012). This knowledge on values brings new insight towards human classification on benefits and barriers. When values are the deep rooted cause of motivation towards this classification; the new knowledge recognise barriers as benefits which are not yet met.

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