OBLITERATE BUILDING DEFECTS: QUANTITATIVE-METHOD PILOT TESTING ON HOW STATISTICAL ANALYSIS AUGMENTING INTERIOR SPACE

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ABSTRACT

The approach in doing the pilot test defects census is by having a quantitative research method through Google Form survey where 21 participants (n=21) final numbers have been responded. Sixteen building's interior components with defects causal factors have been identified, and the recent version (v24/v26) of SPSS statistical software has been used to test those LS results. The tests were done, including α (Cronbach alpha), Kurtosis, Mean, Median and St. Deviation equations and Skewness table analysis. The result pointed out that it is vital to devise the importunateness of having the pilot test statistical census analysis in frolicking the centralised role in beating building defects efficiently, at least from the academic research point of view. This way, the statistical result can force the construction players to pay greater attention to all aspects of construction processes. Future research could develop a pilot test on the Government's role in performance measurement systems curbing building defects from a strategic approach. Pilot studies are a crucial element of a good study design. Conducting a pilot study does increase the likelihood of research's success. In addition, pilot studies fulfil a range of essential functions and can provide valuable insights for other researchers. Hence, the practical implication is that defects can be efficiently reduced, and better-finished buildings can be achieved. The outcome of this research is significant in its own right and serves as a platform for future research.

Key words: Building defects, construction defects, quantitative method, pilot test, SPSS.

INTRODUCTION

The Government of Malaysia (GOM) has spent millions of Ringgits on building new buildings such as schools, hospitals, and government offices to ensure the Government's best services. As a rapidly developing country and is approaching the status of a developed nation by 2020 alongside the IR4.0 era, the GOM indirectly spent a substantial allocation of budget to ensure the internal and external conditions of these government-owned buildings are at their best. A total of financial provisions held to perform maintenance on these buildings are hugely allocated to be in the best condition. It should be noted that other than constructing and maintaining the facilities, the GOM must spend much money to fill the interior of the said buildings.

Each building must be constructed with various items ranging from all types of furniture to computer main-frame gadgets worth tens of thousands of Ringgits located inside each building. Cases where the Parliament building was leaking due to heavy rains in April 2005 due to failure of the roofing's waterproofing system and damaged valuable timber furniture inside the Parliament building. It happened again in May 2008; due to RWDP overflow, it is very concerning. According to (Kubal, 2008), 90 per cent of all water intrusion problems occur within 1 per cent of the entire structure's exterior surface area building. Even the most notable examples of buildings, including Frank Lloyd Wright's Fallingwater and Philip Johnson's Glass House, and though these sites have become meccas for modern aesthetes, they are not without their faults. Built without today's advanced technology, many modernist structures suffer from leaky roofs at best and structural instability at worst, much to the dismay of the people who commissioned them (Allen, 2016) (Bussagli, 2005).

LITERATURE REVIEW

When doing the literature research for this topic, most of the resources found either through books or Q1 and Q2 online indexed journals explained how related the defects on the construction of the buildings. The standard of the approach depends on how well the structures are being built concerning the minimum percentage of RFI or RFQ received in facing defect problems. Buildings represent, amongst other things, are energy, labour and material. These cannot be replaced or can only be replaced at a high cost. The severe economic recession, the energy crisis, and the awareness that finite resources have led to the realisation that existing buildings are a valuable commodity to be conserved. Regardless of their historical or architectural merits and besides, new buildings must be designed and built to last (Konya, 1986).

Other than the building must last, they must be designed according to the client's program. Then, the architect must translate the building's program into a practical, economic and beautiful building (Myller, 1966). However, a significant number of defects happened when the proposed buildings programmed used not according to the practical programmed design. Next, the future problem is hard to define, and the new building must be flexible and adaptable so that it may fit into the changing needs of the community it serves (Schlichter & Danylchenko, 2014) (Hinks & Cook, 2002). Therefore, to relate to the scopes of the study, other

than the high value, lasting built, and correct building usage (as mentioned in this sub-topic), the research scope is to question why people think there is still a high rate of defective work arising out. In effect, successful construction projects do not happen by accident.

METHODOLOGY

Pilot testing on mix-method data collection (n=21)

For this study, the research framework has been designed to tackle the pilot test to formulate further and better more detailed structured questionnaires during the comprehensive Quantitative Method approach research with better structured and improved sets of questionnaires survey. First, there are five main categories in developing the statistics by identifying the most defected internal spaces and their space of property damaged value due to the building defects problem. Next are on where the defects are coming from, primarily focusing on the water leakage defects problems; criteria triggered to the existence of the building defects. The last one is to identify the waterproofing materials used the most in rectifying the defects due to the leakage defects taken as one of the popular categories of building defects.

A pilot study asks the same questions but has a specific design feature: future research or part of a prospective study is conducted on a smaller scale in a pilot study. The pilot study is a preliminary study that aims to investigate whether crucial components of the primary research, usually a Randomized Controlled Trial (RCT), will be feasible. The approach has done for the first five questionnaires keen into Quantitative method style. As a result, it seems much more realistic, and the method can easily fit to enhance the Quantitative approach during the second stage, as mentioned before. Adding to the above, this pilot test stage focuses more on the Qualitative Research method with three more unstructured questionnaires. This last part is not part of the SPSS analysis compared to the five questionnaires as before. Only questionnaires no. 1 and 2 propositions have been analysed for this paper, while questionnaires no. 3, 4 and 5 will be elaborated in the following article due to the limitation of journal content factor. Those propositions are tested in the sense of coming up with a yes or no answer or counting instances that fit and those that do not (Rasli, 2006) (Wan Muhammad Amir W. Ahmad, Nurfadhlina Abdul Halim, Nor Azlida Along @ Mohamad, & Mohd Pouzi Hamzah., 2014). For additional questionnaires, no. 6.7 and 8 will be fit-in to the text where appropriate with the feedback data found from the respondents.

Respondents' project value range

(Olanrewaju, Khamidi, & Idrus, 2010) mentioned that defect classifications are a vital strategic task to create urgent afford to sort out critical problematic defects. For questionnaires 1 and 2 (as well as to Q3-Q5), all the respondents highlighted that most of the projects range from low budget rectification jobs (RM5,000 to RM50,000) to the mid-size new and renovation projects ranging from RM51,000 to RM500,000 in value. The top 10% of the task also involved major new projects valued at roughly RM501 000 to RM1 000,000.00 or ≥RM1M. All acquired data was filed within ten years period hence 2009 until 2019, involving actual on-site waterproofing related projects, as most of it stated in the selected building construction journal. Most latent and non-latent leakage defects still have chances to be rectified in good order if the techniques have been done correctly (Talib, Ahmad, & Sulieman, 2015).

ANALYSIS AND FINDINGS

Statistical tool Leakage Defects analysis on Most Defected Interior Spaces

To answer the quantitative research questions and meet specific research objectives, the sample characteristics of the dependent and independent variables and the hypotheses developed should be analysed using various statistical techniques (Rasli, 2006), as shown in the series of tables below. Thus, for this purpose, the first two parts of the nine questionnaire components of the pilot test are formulated for analysis purposes. QC#1 has nine-building components using 7 Likert Scale values, while QC#2 has 16 building components using 5 Likert scale values. A six-point scale raised during the analyses process forces choice, giving better data results.

Each of 16 and 9 building components has been analysed using state of the art statistical programmed to help determine its hypothesis correlations during the next stage of the research with qualitative method use as for the approach. (Abowitz & Toole, 2010) indicated that qualitative propositions, however, are similar to hypotheses only that they address issues involving what and how questions which were determined during the 2nd phase of the research. All these have been indicated in Table 1 to Table 3. Qualitative propositions, however, are similar to hypotheses only that they address issues involving what and how questions (Rasli, 2006). (Wan Muhammad Amir W. Ahmad et al., 2014) stated that most of the current research needs robust and reliable numerical results to reflect the findings of the analysis.

Next, with an $\sum N = 21$, 9 categories of the building's interior components have been identified from the respondents' feedback (see Table 1). The idea is to determine which internal spaces have impacted the defects, focusing more on the building leakage defects. Most of the respondents understand the rainwater problem or the damp-rising and high-water table problems in maintaining the structures from the Std. Deviation (SD) statistic, living, dining and kitchen area had the most no with 2.31455 indicated that this space has the most defect problems on the building leakage issues.

Table 1: Statistical tool analysis on leakage defects affecting the interior space

Most Defected Interior Space

	N Statistic	Range Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	Kurtosis Statistic	Std. Error
Lobby	21	6.00	1.00	7.00	4.1905	2.11232	-1.343	.972
Bedroom	21	6.00	1.00	7.00	4.8571	2.03189	-.300	.972
Toilet	21	6.00	1.00	7.00	5.7143	1.52128	3.765	.972
Living, Dining & Kitchen	21	6.00	1.00	7.00	3.5714	2.31455	-1.581	.972
Office_work_area	21	6.00	1.00	7.00	5.1905	2.15914	-.566	.972
Planters_box & Terrace	21	5.00	1.00	6.00	2.7143	1.18924	2.096	.972
Recreation room, Store &_M&E room	21	6.00	1.00	7.00	3.4286	1.71963	-.702	.972
Computer, Weapon Storage & Laboratory	21	6.00	1.00	7.00	4.4286	1.85934	-.968	.972
Hotel room, Hall & Parking	21	6.00	1.00	7.00	4.9524	2.20173	-.642	.972
Valid N (listwise)	21							

The higher ≥SD means that the numbers are more spread out, while the lower ≤SD implies that most numbers are average. No two is affected by the hotel room and the building's hall space, like a ballroom area of a hotel building and the parking space area customarily located at the basement or ground level with an SD score of 2.20173. With an SD score of 2.15914, an office or the working space of the buildings place 3rd on the SPSS surveyed. It seems that most of the areas that were hit by the leakage defects concerning especially the leaking rainwater. For example, the office space typically has a problem with leakage defects located on top of the building, with most having CFR (Concrete Flat Roof) on top. This space is generally allocated for the CEO and a condo or penthouse space of the buildings. From the experience and interview sessions, most of the house's living, dining or kitchen area foresee the leakage defects, mainly from the wet area leak where the toilets are located on top. It also applied to the highest hotel room and where the wet areas usually affected the ballroom hall or the internal parking space. The finding is also leaning toward most SWC using the correct leakage rectification technique and unappropriated waterproofing materials.

With $\bar{x}$ = 5.7143, the toilet area was analysed as the most problematic building component facing leakage defects within any building. Next to no. 2 for the mean statistic with 4.9524 goes to the hotel room, hall and parking, and the bedroom for no.3 with $\bar{x}$ score is 4.8571. Furthermore, the toilet space also holds ≥ three at 3.765, indicating the dataset has more massive tails than a normal distribution than normal kurtosis distribution, which is =3 (see even at Table 2 for reliability test). For the reliability test, Cronbach's alpha (α) is the most common measure of internal consistency ("reliability"). It is most commonly used when researchers have multiple Likert questions in a survey/questionnaire that form a scale and wish to determine if the scale is reliable. For this statistic analysis, having seven items and 2 Cronbach Alpha (α) of each scale, r=.738 indicated that it is >.70. The general rule of thumb is that a Cronbach's Alpha of .70 and above is excellent and reliable. This means that the closer each respondent's scores are on .70 and .80, the more reliable the test measure (and the higher the coefficient of stability will be). Below this value (r <.70), the internal consistency of the typical range is low. Thus, the finding proved that the construction for the wet areas located especially within the inner space of the structure must be done in extra care materialistically or detail during the construction time. (Ismail, Ani, Razak, Tawil, & Johar, 2015) indicated rainwater leakage is the main factor contributing to building defects for terrace houses.

To summarise from the statistical analysis above is that 6 out of 9 in the individual statistical analysis of each nine factors indicated that the respondents agreed that most of the mentioned building components face severe building leakage defects. That is only focusing on the waterproofing defects of the building components where there are still defects happed to other areas focusing on other defects criteria. Building's interior component can be considered an essential part of the building as people spend more time inside the building than the outside. Of course, the building must be designed interestingly to get rid of the boring feels, but it is the internal spaces. They are much more critical thus requires particular attention, especially to achieve quality inner freedom. It is impossible to design and build any building without sufficiently considering the available materials, climate and location and how they will affect the interior and exterior (Bussagli, 2005) (Ching, 2018).

Table 2: Reliability testing on the most defected interior spaces by way of Cronbach Alpha(α)

Reliability Statistics on Most Defected Interior Space

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.738	.706	7

Statistical tool Leakage Defects analysis of the value on the Defected Interior Spaces

According to (Ching, 2018), interior spaces within the buildings are defined by the architectural elements of structure and enclosures- columns, walls, floors, and roofs. However, all these interior components require proper construction detail to make them work. The findings from the statistics indicated that the building details are necessary to avoid wrong information allowing the defects to happen. (Olanrewaju et al., 2010) (Ahluwalia & Hegazy, 2010) mentioned that lift failure, faulty electrical systems and particularly roof damage were defects that surveyed considered highly critical and that required urgent maintenance intervention. Among the nine components mentioned, toilet space mainly located within the interior of the building surveyed as the most affected space and mostly with leaking defects detail problem. One of the difficulties of latent defects is building internal leakage syndrome and, for example, detailing on the roof problems letting much rain and damaging valuables inside a building. Interior detailing the interior portion of the building can also be identified as early as from the design stage, and the inaccurate interior design detail surely can invite water leakage. Another example of common interior construction defects in buildings are damp or dampness within the structure. The damp inside a building can be rising damp for older government-owned buildings (Douglas & Ransom, 2013).

On the other perspective, building designers' decisions affect the long-term quality and life cycle cost of buildings. Unfortunately, designers' decisions are usually latent and hard to detect at the early stage of construction. Furthermore, the reduced level of commitment is cited by (Oyedele, Jaiyeoba, Fadeyi, & Fadeyi, 2012) (Al-Hammad, Assaf, & Al-Shihah, 1997) among design professionals and inadequate technical knowledge are among severe factors ranked within the universal setback on defect issues. The work on these data and variables indicated that severe building defects cases keep repeating, and these practices involve a considerable amount of money wasted.

Table 3: Statistical tool analysis on leakage defects concerning the value of the damage to the interior spaces

Descriptive Statistics of Leakage Defects damage value on interior spaces

	N Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	Skewness Statistic	Std. Error
Lobby_area	21	1.00	5.00	2.4762	1.07792	.465	.501
Bedroom	21	1.00	5.00	2.6667	.96609	.395	.501
Toilet	21	1.00	3.00	1.4762	.60159	.861	.501
Living_area	21	2.00	5.00	3.3810	.66904	.481	.501
Dining_area	21	2.00	5.00	3.0952	.88909	.272	.501
Kitchen	21	1.00	3.00	1.7619	.70034	.368	.501
Office_work_area	21	1.00	3.00	1.5714	.67612	.788	.501
Planters_box_& terrace	21	1.00	5.00	2.2857	1.23056	.995	.501
Recreational_gym_space	21	1.00	5.00	2.8095	1.20909	.214	.501
Store_room	21	1.00	4.00	2.4762	.98077	-.103	.501
Mech_&_Elect_room	21	1.00	5.00	2.1905	1.16701	.845	.501
Computer_mainframe_area	21	1.00	5.00	2.1905	1.36452	.926	.501
Laboratory	21	1.00	5.00	3.8095	1.12335	-.992	.501
Hotel_room	21	1.00	2.00	1.4286	.50709	.311	.501
Multipurpose_hall	21	1.00	5.00	3.0952	1.26114	.135	.501
Enclosed-parking-space	21	1.00	5.00	2.3333	1.31656	.764	.501
Valid N (listwise)	21						

To answer the quantitative research questions and to meet the specific research objectives, the sample characteristics of the dependent and independent variables as well as the hypothesis developed should be analysed using various statistical techniques (Abowitz & Toole, 2010) (Mchugh, 2013) (Siebken Schultz, Jørgensen, Bonke, Mikael, & Rasmussen, 2014). SPSS v24 statistics from the table schedule indicated that a building space identified as a computer main-frame area where the hi-technology of the machine with a significant number in economic value read SD 1.36452 stay top in the list (see Table 3). It is interesting to note that the computer main-frame room located right under the CFR (Concrete Flat Roof) having a tremendous CFR waterproofing system happened right after the warranty period. Maintaining with the ∑N=21, 16 SPSS labels have been identified; the qualitative unstructured interviews were done where more internal space has been recognised for the analysis. The following result found on the enclosed parking space with SD=1.31656 and the multi-purpose hall space with SD=1.26114 stayed at ranking no.3. The problems seem to be the concrete joint system gaps due to the building movement allowing water penetration and the expired building sealant connection for the parking area defects. The multi-purpose hall has problems once the plaster ceiling shows leakage brown tone images shaped like mushrooms.

Table 4: Reliability testing on the leakage defects value of the interior spaces by way of Cronbach Alpha (α)

Reliability Statistics on Leakage defects value on the interior space

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.838	.806	6

The next column factor of the statistic shows on $\bar{x}$ with rating 3.8095 concerning the laboratory space facing the condition of the most problematic defect followed by $\bar{x}$=3.3810 for the living room in no. 2 positions, then no.3 with $\bar{x}$ = 3.0952 for the dining area. The statistical refers to the average used to derive the central tendency of the data in question. The hotel room that received the lowest $\bar{x}$=1.4286 and lowest SD=.50709 indicated the low SD means that most of the numbers are close to $\bar{x}$. The last one is on the skewness for symmetry distribution measurement analysis, where a normal distribution will have a skewness of 0. For this case, the nearest is coming from variables of the storeroom, laboratory, and the multi-purpose hall, with each of them having a value of -.103, -.992 and .135 each. Multi-purpose hall actual has the most balance skewness, as seen in Table 3. For Table 4 statistical analysis, having six items and with 2 Cronbach Alpha (α) of each scale, r=.838 indicated that it is >.80. The general rule of thumb is that a Cronbach's Alpha of .70 and above is excellent and reliable, and if the Cronbach Alpha number is >.80, the test is adequate and still reasonable. Lastly, (Talib, Boyd, Hayhow, Ahmad, & Sulieman, 2015) indicated that building spaces with wet areas around them, above, down or by the sides, have the most rick facing BLS.

CONCLUSION

Typically, the building has a primary and secondary line of defence against water penetration (Hinks & Cook, 2002). However, buildings do leak. Assessing the building leakage defects may represent the most challenging part of constructing a proper standing and completed building project. With a total of 23 identified building components to be analysed using 5 to 7 Likert scale measurements, both main tables indicated that even for the pilot testing stage, 6 out of 9 tables on detecting defected interior space study leaning towards on the agreement 65% found leaking defects from the total nine internal building spaces. Intending to use a 6 Likert Scale survey if at any point a neutral is desired, the "slightly agree" and "slightly disagree" can be averaged together.

Summary from Table 3 indicated even further that the respondents had given active feedback, stating that many damages are happening and directly eat out the humongous budget on defects matter. 14 out of 16 components analysis indicated that building defects, regardless of the leakage defects as an example, need to be looked at much more seriously. Leakage defects even play a tricky game as sometimes people can see the defects with the naked eyes and sometimes not; it is a latent and non-latent defects game. People think the external of the building must look fabulous and spent more time developing it but somehow forgot how the internal space has been bombarded with all kinds of defects comets from all angles and require the 'players' it is time to change mind-set. The most challenging space for the facilities manager is to maintain the wet area; primarily, it is located right inside the building. However, if not tackled correctly, toilets, *wuduk* space, shower area, or even a rooftop swimming pool, these internal defects can become problematic and create an irritating sense to the occupant, thus devaluing the property at the same time. Moreover, maintaining wet areas demands serious attention to avoid building defaults (Ishak, Chohan, & Ramly, 2007).

Based on Table 3, the list of the interior spaces (total of 16 in numbers) indicated a whole range of space sizes depending on the respondent's project involved. Of course, these spaces are not the same; for example, toilet space may be minor compared to the computer main-frame room or the laboratory space. However, the cases to stipulate the defect leakage scenario and help determine (through the research instruments; in case here through face to face or online interviews) on the most and least leakage defects problem survey.

This research is an example of initial unique pilot case studies dealing with the current issues on building defects involving interior design, building design and architectural themes at the same time. It applied multi-disciplinary research in the built environment perspective dealing with the affected internal space, identifying the leakage defect sources, and tracing the factors on why these defects are still happening. As well as combining the dramatic economic value loss with identifying on the list of the most common materials used focusing rectification of leakage defects details. (Meor Hasan et al., 2016) (Douglas & Ransom, 2013) stated that the top anti-defects strategy improves workmanship quality. It captured the active construction players (use ∑N=21) actively contributing to rapid national development. The data was found through the Likert Scale 5 to 7 measurements scale with the frequencies and variables statistical analysis of the updated SPSSv24. Only strengthen the Mean, SD, Skewness and Kurtosis descriptive and analytical results where 1,000 building defects can be easily traced from the systematic 16 parts building essential components.

The next phase of the study is to refine the pilot test and further do the more comprehensive structured survey in a quantitative method approach to testing the fine-tuning conceptual model and the series of identified Research Questions (RQ) and Objectives (RO). As well as to prove the organised hypotheses (RH). (Snyder, 1984)(Groat & Wang, 2002) urges the researcher to create knowledge in the built environment-related field, determine fruitful areas for inquiry, and relate the findings to the broader body of knowledge. We should view the survey in the most explicit terms but never reject particular investigation forms out of ignorance of the methods. Thus, the research somehow contributes a significant body of knowledge in obliterating building defects niche through its quantitative pilot testing method. It has further strengthened how statistical analysis can augment a building's interior space.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the financial support provided by the Ministry of Education (MOE) Malaysia and physical support by Universiti Sains Malaysia under the RUI Grant Scheme (FRGS) No. 1001/PPBGN/8016034.

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