International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

PAPER ID: 11A16C

WHY ARE BUILDING DEFECTS STILL HAPPENING IN MALAYSIA?

Roslan Bin Talib [1*], Mohd Zailan Sulieman [2]

[1] *Interior Architecture Programme, School of Housing, Building & Planning, Universiti Sains Malaysia 11800 USM Pulau Pinang, MALAYSIA.*

[2] *Building Technology Programme, School of Housing, Building & Planning, Universiti Sains Malaysia 11800 USM Pulau Pinang Malaysia, MALAYSIA.*

ARTICLEINFO

Article history:
Received 02 January 2020
Received in revised form 04 August 2020
Accepted 25 August 2020
Available online 24 September 2020

Keywords:
Internal space; Latent defect; Leakage defects; Pilot test; Building Leakage Defects (BLD); Building construction; Building damage.

ABSTRACT

This paper explores the pilot testing stage survey on the building defects problem focusing on the leakage defects. Nine research questionnaire categories have been developed, and three of them have been analyzed using SPSS®24 for this script. The design research approach uses Qualitative Research Methodology (Qualitative RM) and the finding is based on the descriptive statistical analysis patterns, Building Leakage Defects (BLD) remain a big problem to the construction scenario in this part of the world and may also happen to the other part of the globe and need serious attention to sort them out systematically. The pilot survey uses the existing and latest information survey data from the interview and communication processes from active construction players on real projects located in the most developed part of the region. The findings are considered worth the knowledge value as it can be used as a guide in developing a better guideline framework, especially to curb-down BLD and help to formulate quality building types.

Disciplinary: Construction Methods, Materials and Technology.

1 INTRODUCTION

UK's Charted Institute of Building (CIOB) stated that building defect costs the industry annually more than the combined profits of companies in the sector quoted in an article in September 2018. CIOB's claim on their recent research suggesting that better quality on construction management could save the industry up to UK £12 billion (pound) a year. CIOB's quality commission was launched in 2017 amid a spate of building failures including public office buildings, more than 80 Scottish schools and general complaints about building defects in new houses built by the British Government developers. Low quality of buildings affects the property market, and it needs money to

*Corresponding author (Sultan Daud Khan). Email: sultandaud@nutech.edu.pk

get it into a marketable level with a proper maintenance schedule.

Malaysia's construction scene is no different in terms of handling building defects. The scenario becomes worse when it is involved with the defects originating from water leakage, especially the rain. As Malaysia is located within the tropical regions, rainwater always becomes a challenge to the construction players in dealing with leakage defects syndrome. The Government of Malaysia (GOM) used to spend RM100 million (1USD = RM4.20) to do the roofing rectification works in dealing with the repeated leakage in 2010. The prominent historic building was built in 1967 used to have the same leaking problem in 2008 and affected the valuable property inside the notable parliament building like its classic timber furniture and hi-tech sound system. Kuala Lumpur International Airport 2 (KLIA2) new airport reportedly spent another extra of RM270 million to do all the defects rectification work in 2016. In 2007, three new blocks of GOM buildings were unable to continue to be occupied even after the just-completed construction within three months period due to defects problem. In the July 2019 report, the PGA Police housing quarters in Ulu Kinta, Perak facing serious leaking issues each time the weather is raining. The quarters were built in 1967-1981 by GOM initially having 27 blocks with 10 and 12-floor blocks while currently three blocks unsafe to occupy due to lacking proper maintenance especially to handle the Leakage Defects Syndrome (LDS) problem.

Thus, this paper focuses on the most common defects in Malaysia, which is Building Leakage Defects (BLD). Leakage defects require special attention among the construction players and strategies must be drawn on how to overcome or minimize them systematically. General defects occur either because of poor design or low-quality workmanship or because the building was not constructed according to the plan or because it has been subject to factors not allowed for the design (National Building Agency, 1979). These primary causes may operate singly or in combination and result in defects indicated by changes in the composition of materials; in the construction itself; in the size, shape or weight of materials or parts of a building; or solely in appearance.

2 LITERATURE REVIEW

Most literature found either through books or Q1/Q2 online indexed journals explained how related the defects on the construction of the buildings. The standard of the premises depends on how well the structures being built concerning the minimum percentage of RFI or RFQ received in facing the defect problems. Buildings represent, amongst other things, are energy, labor, and material. These either cannot be replaced or can only be returned at a significant cost. The severe economic recession, the energy crisis and awareness that resources are finite have led to the realization that existing buildings are a valuable commodity to be conserved, regardless of their historic or Architectural merits, and besides, that new buildings must be designed and built to last (Konya, 1986).

Other than the building must be made to last, and they must be designed according to the client's program. The architect must translate the building's program into a practical, economy, and beautiful architecture (Myller, 1966). However, a high number of defects happened when the proposed buildings programmed used not according to the practical application designed. Next, the problem of the future is hard to define; the new structure must be flexible and adaptable to minimum defects so that it may fit into the changing needs of the community it serves (Myller, 1966). Glover (2002) stressed that a lot could be learned about the history of the building within the roof space and in most old houses, the primary defects are likely to be found either at the top or at the bottom. Great care should be exercised when moving about within the roof.

3 METHODOLOGY

3.1 PILOT STUDY APPROACH –INITIAL TASK USING QUANTITATIVE METHOD

To start with, there are five main categories in developing the statistics with identifying the most defected internal spaces and its space of property damaged value due to the building defects problem (see Table 1). The next three categories are the one that has been discussed in this paper, which is on where the defects coming from primarily focusing on the water leakage defects problems. Number (no.) four criteria triggered to the existence of the building defects and the last one to identify on what waterproofing materials used the most in rectifying the defects due to the leakage defects taken as one of the popular categories of building defects itself (see Tables 3, 4 and 5).

Table 1: Pilot testing structure: 5 plus 4 questionnaire components: Mix methods approach.

INTERVIEW QUESTIONS- TARGET INDUSTRY PLAYERS ON CONSTRUCTION FIELD-For Pilot testing											
1	Defects **affected internal** area	Lobby/ Entrance	Bedroom	Toilet	Living/Dining /Kitchen	Office/ work areas	Planters box/ Terrace	Other spaces /Pls specify	Other spaces /Pls specify	Other spaces /Pls specify	Other spaces /Pls specify
	Please tick/write										
2	Estimated **value (RM)** damaged										
3		ROOF									
	Source of leaking Please tick/write>>	Flat concrete	Tile Roof	Thermal moist	Exterior wall	Underground/ Lift Pit	Window, door, floor	Others/ Pls specify	Others/ Pls specify	Others/pls specify	Others/Please specify
4	**Defects criteria/factor**	Design factors/ Poor detailing	Wrong method	Wrong material	Poor workmanship	Lack of innovative methods	Vandalism	Material aged	Environmental impact	Others/ Pls specify	Others/ Pls specify
	Pls tick/write>>										
5	**The material used to solve leaking**	Coating layers	Cementitious chemical		P.U. grouting	Fiber	EPDM Roof Membrane	V-groove with polymer modified mortar for concrete		Water plug	Others/ Pls specify
	Pls tick/write>>										
6	What recommendations can you make about incorporating your system in defects busting practice?										
7	How do you envision a complete defects-free guideline framework that should work and help the industry players?										
8	How does your system intervention contribute to the framework of the defects-free guidelines?										
9	Do have anything else to share? **Green practice/using green material**										

The approach has been done for the first five questionnaire categories keen into quantitative method style as a result seem much more realistic, and the method can easily fit to enhance the quantitative approach during the second stage as mentioned before. Adding to the previous statement, this pilot test stage encroaching to more on qualitative research method style with four more

*Corresponding author (Sultan Daud Khan). Email: sultandaud@nutech.edu.pk

unstructured questionnaires where this last part is not part of the SPSS analysis compare to the five questionnaires as before. For this paper, only questionnaires no. 3, 4 and 5 propositions have been analyzed while questionnaires no. 1 and 2 already been elaborated in Tabil et al. (2015). Those propositions (no. 3, 4 and 5) 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). Questionnaires no. 6, 7, 8 and 9 will be fit-in where appropriate with the feedback data found from the respondents.

For questionnaires no. 3 and 5 (as well as to no. 1 and 2), 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 ranges from RM51,000 to RM500,000 in value. The top 10% of the task also involved major new projects value roughly from RM501, 000 to RM1,000,000.00 (RM1 million). All acquired data was filed within ten years period 2009-2019 involving real on-site waterproofing related projects as most parts of it stated in the selected building construction journal. Most of the latent and non-latent leakage defects still have chances to be rectified in good order if the techniques did correct (Talib et al., 2015).

Further through literature research is done, the pilot test has also been formulated as part and parcel from a set of 'Research Questions' alongside Research Objectives and identified hypotheses as shown in Tables 3, 4 and 5. To answer the quantitative research questions and to meet specific research objectives, the sample characteristics of the dependent and independent variables as well as the hypotheses developed should be analyzed using various statistical techniques (Rasli, 2006) as shown in the series of tables. Thus for this purpose, the first two parts of the nine questionnaire components of the pilot test are formularized for analysis purposes. Questionnaire no. 3 having 15 variable components using 7 Likert Scale value while questionnaires no. 4 and 5 having both 11 correlation components using 5 and 7 Likert scale value.

Each of 15, 11 and 11varience components have been analyzed using state of the art statistical program to help determine its hypothesis correlations during the next stage of the research with qualitative method use as for the approach. (Rasli, 2006) 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 3 to Table 5. Qualitative propositions, however, are similar to hypotheses only that they address issues involving what and how questions (Rasli, 2006). Ahmad et al. (2014) stated the majority of current research needs robust and sturdy numerical results to reflect the findings of the analysis.

3.2 RESPONDENTS

This study with the pilot testing method, 21 responses received from 50 targeted audience contacting through email and social media which are WhatsApp's, Facebook, Twitter and histogram together with fix line telephone call and mobile telephone calling methods have been implemented. Most direct face-to-face interviews have also been done, especially around Penang with a few in Kuala Lumpur and Selangor State. Table 2 indicated the respondents' profession concerning the building industry focusing to the logistic location of the company within the western edges of the West Malaysia peninsula, stretching from Melaka, Negri Sembilan, Kuala Lumpur, Selangor and Penang-Kedah area. A couple of responses were received from the State of Johore as well as from the State of Perak. The highest category of respondents was received from Waterproofing Contractor Specialist (WSC) with a total of 6 with maximum respondents received from Penang, the northern part of the Malay Peninsula. From 21 feedbacks received a total of 10 derived from Penang which is the highest.

Table 2: Respondents' tabulation for the pilot testing stage.

Title	Kuala Lumpur	Putrajaya/ Cyberjaya	Klang Valley/ Selangor	Melaka	Negri Sembilan	Perak	Penang	Kedah	Position Role/as/ TOTAL
Project Manager (Engineer)							1		1
Project Manager (Arch)							1		1
Asst. Project Manager				1					1
Main Contractor	1	1					1		3
WSC- Waterproofing Specialist Contractor	2		1				3		6
Interior Designer	1						1		2
Registered Architect	1						1		2
Facility Manager							1		1
Senior Site Supervisor (Architect)								1	1
Project Engineer (Mechanical Engineer)					1				1
Project Engineer (Electrical Engineer)						1			1
Project Quantity (Quantity Surveyor)							1		1
Logistic/ TOTAL	5	1	1	1	1	1	10	1	21

4 RESULT OF ANALYSIS

4.1 LEAKAGE DEFECTS ANALYSIS ON SOURCES OF LEAKING

Next, with $\sum N = 21$, 15 categories of the building's interior and exterior components about Building Leakage Defects (BLD) have been identified from the feedback of the respondents (see Table 3). The idea is to determine which internal and external spaces have been had the impact of the defects focusing more on the BLD. Most of the respondents understanding on the rainwater problem or on the damp-rising and high water table problems in maintaining the structures. From the SD statistic, spaces that having roof using roofing tiling type had the most no with 2.32 indicated that this space was having the most source of defect problems on the building leakage issues. The higher $\geq$SD means that the numbers are more spread out while the lower $\leq$SD implies that most of the numbers are close to the average. Questionnaire no. 2 is affected the space using the metal roofing with SD score of 2.29. With SD score of 2.23, the water tank part of the building place 3rd in allowing the water leakage due to its water tank problem as shown in this SPSS®24 statistical analysis surveyed.

From the statistic, rainwater gives significant problems, especially when it comes to the roofing part of the buildings such as the BLD over tile or metal usage as for the roofing building components. It seems that most of the areas such as the interior components of the building identified for this survey as the internal wet areas as well as the ceiling part are also affected to be as the leaking source list. For example, the office space is usually having a problem with leakage defects located on top of the building with mostly having metal or tile roofing on top. Typically, these spaces are allocated for the CEO office, a condo unit or a penthouse space located at the most top of the buildings.

On the other hand, from the experience and interview sessions, most of the hotel's rooms or apartment units foresee the leakage defects mostly from the wet area leak where the toilets are located

*Corresponding author (Sultan Daud Khan). Email: sultandaud@nutech.edu.pk

on top. It also applied to the highest building units and where the high wind factor usually affected the unit by bringing the rainwater through the external wall and wet-up the internal part. The finding is also leaning toward most of the SWC using not the right leakage rectification technique as well as unappropriated waterproofing materials.

Table 3, with $\bar{x}$ = 4.33 indicated that the metal roofing building part has been analyzed as the most problematic building component within any building facing the leakage source defects problems. Next on to questionnaire no. 2 for the mean statistic with 3.95 goes to the external wall while the tiling roofing part is for no.3 with $\bar{x}$ score = 3.76. Furthermore, the underground lift-pit building component holds the closest symmetrical dataset skewness close to 0 as at -.06 while the swimming pool part rated second at -.06. This trend analysis indicating the dataset has skewness essential measures the relative size of the two tails. This proved the leaking sources from leakage water piping, leakage of the air-conditioning piping system and Concrete Flat Roof (CFR) located especially within the internal space of the structure must be done in extra care materialistically or in the detailing phase or during the construction time as these three building parts rated the highest in Skewness statistic.

Table 3: SPSS analysis of BLD sources of leaking (N = 21)(SE = Std. Error).

Components	Min	Max	Mean		SD	Variance	Skewness	SE
			Statistic	SE				
Metal_roof	1.00	7.00	4.33	.50	2.29	5.23	-.26	.501
Exterior_wall	1.00	7.00	3.95	.42	1.91	3.65	-.26	.501
Tile_roof	1.00	7.00	3.76	.51	2.32	5.39	-.10	.501
Underground_lift_pit	1.00	7.00	3.71	.47	2.15	4.61	-.06	.501
Window_door_floor	1.00	7.00	3.67	.44	2.01	4.03	.30	.501
Swimming_pool	1.00	7.00	3.67	.42	1.91	3.63	.15	.501
Thermal_moisture	1.00	7.00	3.52	.42	1.94	3.76	.89	.501
Water_tank	1.00	7.00	3.43	.49	2.23	4.96	.18	.501
Skylight	1.00	6.00	3.19	.43	1.99	3.96	.21	.501
Gutter_RWDP	1.00	7.00	3.14	.48	2.22	4.93	.56	.501
Interior_wet_areas	1.00	7.00	3.14	.45	2.06	4.23	.40	.501
Ceiling	1.00	7.00	2.76	.41	1.89	3.59	.96	.501
Aircond_piping	1.00	7.00	2.38	.33	1.50	2.25	1.73	.501
Concrete_flat_roof	1.00	7.00	2.38	.37	1.72	2.95	1.30	.501
Water_piping	1.00	7.00	2.05	.29	1.32	1.75	2.77	.501
Valid N (listwise)								

4.2 LEAKAGE DEFECTS ANALYSIS ON DEFECTS CRITERIA FACTORS

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 analyzed using various statistical techniques (Rasli, 2006). The SPSS®24 Table 4 indicated that a building defects factor criteria identified on the wrong usage of the space value read SD 1.38 stay top in the list (see). It is interesting to note that some cases showed that the designed storage room has been converted to the wet kitchen area in a hotel building suggesting the wrong usage space category and contributed the most problematic design factor in this statistic analysis. Matters become worse when no proper waterproofing system treatment has been done for that particular area. Thus it affected the BLD for the underneath space.

Maintaining with the ∑N=21, 11 SPSS labels have been identified; a result of the qualitative unstructured interviews done where more internal space has been identified for the analysis. The next result found on lacking usage of innovative material with SD=1.34 and lacking building maintenance with SD=1.33 stayed at ranking no.3 position. While the problems seem to be emphasized on the defects criteria factors with the lowest ranking goes to on the wrong method or wrong rectification work system to overcome the defects problem. Less experience WSC usually uses an easy method with no creative input to tackle the leakage detail design thus enable to allow the BLD been repeating just over generally between 6-12 months period only. An excellent innovative solution using the correct and reliable waterproofing system can hold up to 3-5 years before it fails again. It is useful to stress-out that in the US, BLD with latent type received 5+3 years warranty period according to the building contract. This contract sort of protected the building owner; however, it does not happen in a particular country like Malaysia.

Table 4: SPSSv.24 analysis of BLD defect criteria factors (N = 21).

Item	Minimum	Maximum	Mean	SD
Design factors_poor_detail	1.00	5.00	2.81	1.29
Wrong method	1.00	3.00	1.76	.70
Wrong material	1.00	5.00	2.48	1.17
Poor workmanship	1.00	5.00	2.43	1.29
Lack_innovative_material	1.00	5.00	3.00	1.34
Vandalism	1.00	5.00	3.05	.86
Material aged	1.00	5.00	2.19	1.08
Environmental impact	3.00	5.00	4.05	.67
Fire factors	1.00	5.00	3.57	1.29
Lack_of_maintenance	1.00	5.00	2.52	1.33
Wrong_usage_of_space	1.00	5.00	4.00	1.38
Valid N (listwise)				

Table 4, the statistic shows on $\bar{x}$ rating 4.05 concerning the environmental impact facing the most problematic defects criteria condition followed by $\bar{x}$=4.00 for the wrong usage of space in no. 2 positions, then no. 3 with $\bar{x}$ = 3.57 for building defects caused by fire hazardous factors. The statistical refers to the average that is used to derive the central tendency of the data in question. The wrong method factor that received the lowest $\bar{x}$=1.76 and lowest SD=.70 indicated the low SD means that most of the numbers are close to $\bar{x}$.

4.3 LEAKAGE DEFECTS ANALYSIS ON THE MATERIAL USED TO SOLVE LEAKING

Using SPSS descriptive statistics from Table 5 indicated that the variables computed the Bituminous Waterproofing Membrane (BWM); the typical material that cover-up the building's Concrete Flat Roof (CFR) hold the most problematic material used to solve leaking defects with the value read SD 1.93 stay top in the list. Most of the negative cases happened when the applicator use non-trained labor to do the task. With less experience, detail works primarily on the membrane lapping that poorly been done hence allowing water to penetrate not long after inspection. The CFR surface also requires 100% dry to get the best result. It always the case where WSC oversees the site condition to pursue the close deadline for handover. Even though the BWM material is a very reliable waterproofing material, i.e. AXTER© of France with minimum carbon footprint and commitment to environmental protection and proactive sustainable development, it is the workmanship and the site condition affecting the negative factors on the survey. The next phase of writing will be touching and focusing on the sustainable BLD materials, which is the way of the IR4.0 forward-thinking in solving latent and non-latent building defects.

Maintaining with the ∑N=21, 11 SPSS labels have been identified; a result of the qualitative unstructured interviews done where more internal space has been identified for the analysis. The next result found on Cementitious Liquid Chemical (CLC) usage with wrong variables stands on SD=1.89 and lacking good record on EPDM roofing membrane with SD=1.86 stayed at ranking no.3 position. While the problems seem to be emphasized on the material used to solve leaking defects criteria factors with the lowest ranking (No. 11) goes to on the wrong method using the polyurethane (p.u) grouting or faulty rectification work system using polyurethane (p.u.) grouting injection to overcome the defects problem.

Still referring to Table 5, the next column factor of the statistic shows on $\bar{x}$ with rating 6.05 concerning the usage of polyurethane (p.u.) grouting injection technique impact facing the most problematic material used to solve leaking defects criteria condition followed by $\bar{x}$=5.48 for the problematic usage of fiber material in no. 2 position, then no.3 with $\bar{x}$ = 5.29 for building defects cause from the usage of water plug material factor. The statistical refers to the average that is used to derive the central tendency of the data in question. Again, the EPDM roofing membrane material that used to solve the leaking defects received the lowest $\bar{x}$=4.43 and lowest SD=.98 on the usage of p.u. grouting injection technique indicated the low SD does not mean that the numbers are also 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. In this case, the nearest is coming from variables of the usage of v-groove with polymer modified mortar for the concrete, usage of BWM and material called thin multi-layer coating with each of them having a value of -.15, -.35 and -.39. Each p.u. grouting injection system using the mechanical pressure grouting machine which is a short-term solution technique stays at the last position for the skewness analysis with -.1.54 as well at the previous position using SD statistic as seen in Table 5.

Table 5: SPSSv.24 analysis of BLD's material part used to solve the leaking. (N =21)

	Min	Max	Sum	Mean		SD	Skewness	
				Statistic	SE		Statistic	SE
Coating layers	1	7	98	4.67	0.37	1.68	-0.39	.50
Cementitious_liquidchemical	1	7	96	4.57	0.41	1.89	-0.89	.50
PU_grouting	3	7	127	6.05	0.21	.97	-1.54	.50
Fiber_material	3	7	115	5.48	0.25	1.12	-0.40	.50
EPDM_roof_ membrane	1	7	93	4.43	0.41	1.86	-0.44	.50
V-groove w/ polymer-modified mortar for concrete	2	7	98	4.67	0.37	1.71	-0.15	.50
Water_plug	1	7	111	5.29	0.37	1.68	-1.20	.50
Polyurethane_ liquid_membrane	1	7	98	4.67	0.39	1.80	-0.76	.50
Silicone_sealant	1	7	104	4.95	0.40	1.83	-0.52	.50
Acrylic_polymer_ waterproofing	1	7	102	4.86	0.36	1.65	-0.63	.50
Bituminous_ membrane waterproofing	1	7	98	4.67	0.42	1.93	-0.35	.50
Valid N (listwise)								

The statistical analysis proved on the agreement that most of the mentioned building components facing severe building leakage defects. That 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 element can be considered among the essential part of the building as people spent more time inside the building rather than the outside. Of course, the building must be designed excitingly to get rid of the boring feels, but it is the internal space. They are much more critical thus requires particular attention, especially to achieve a quality internal space. 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 as well as the exterior (Bussagli, 2005).

Among the 15 components mentioned (see Table 3), toilet space or the internal wet areas which are mostly located within the interior part of the building surveyed as the most affected space and mostly with leaking defects detail problem. One of the difficulties of latent defects is on building internal leakage syndrome (LDS). On the other perspective, building designers' decisions affect the long-term quality and life cycle cost of buildings. Designers' decisions are usually latent and hard to detect at the early stage of construction (Oyedele et al., 2012); the reduced level of commitment 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 on repeating, and these practices involve a considerable amount of money wasted.

5 CONCLUSION

With an analyzed total of 37 identified building defects related component categories, the result indicated that even at the pilot testing stage, the study confirmed at least 80% of the listed variables measured towards deep problematic range addressing the BLD with LDS symptom. Variables show 90% of it affected on detecting defected interior spaces where the descriptive statistical analysis study leaning towards on the agreement of 70% found leaking defects from a total of 15 categories on leaking sources and 11 classes on defect criteria factors.

Each component analysis clearly stated that building defects regardless of the leakage defects as an example needs to be looked at much more seriously. Leakage defects even play a tricky game as some time you can see the faults 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 awesome 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' to change the mind-set. The study revealed the most challenging space for the facilities manager is to maintain the wet area primarily, and it is located right inside the building. However, toilets, ablution *(wuduk)* space, shower area or even a rooftop swimming pool if not been tackled correctly these internal defects can become problematic and creating irritating sense to the occupant thus devalue the property at the same time.

1,000 building defects can be easily traced from the systematic 15 parts of building essential components, especially on the roofing part. One of its important properties is that it minimizes error in the prediction of any one value in the data set. Snyder (1984) urges the researcher to create knowledge in the built environment-related field, determine fruitful areas for inquiry, and relate the finding to the broader body of knowledge. We should view inquiry in the most explicit terms but never reject particular forms of investigation out of ignorance of the methods. This research also confirms that such knowledge can be developed using existing records extracted from the industry players like property managers or WSC took as an example together with the pilot test.

6 AVAILABILITY OF DATA AND MATERIAL

The corresponding author will be liable to provide information regarding this paper.

7 ACKNOWLEDGEMENT

The authors thank the Research Grant Division, Universiti Sains Malaysia (USM) in approving some allocation in publishing this paper (Grant No. 1001 PPBGN 8016034). Also thanks to USM's RCMO Office, Institute of Post-Graduate (IPS) office and Specialist Waterproofing Contractors (SWC)'s personnel on the outcome of this paper. This work was initiated from the Doctoral research activities as part of the publication requirement on the PhD graduation prerequisite.

8 REFERENCES

Bussagli, M. (2005). Understanding architecture. http://books.google.com.my/books?id=fMfCkY69joC Retrieved August 2019.

Glover, P. V. (2002). Building surveys book. In *Structural Survey*, Vol. 20. DOI: 10.1108/ss.2002.11020bae.003

Konya, A. (1986). *Libraries*. http://books.google.com.my/books?id=LfZTAAAAMAAJ Retrieved August 2019.

Myller, R. (1966). *The Design of the Small Public Library*. http://books.google.com.my/books?id=7JnxxgEACAAJ Retrieved August 2019.

National Building Agency. (1979). Common building defects : diagnosis and remedy. http://capitadiscovery.co.uk/brighton-ac/items/229654 Retrieved August 2019,

Olanrewaju, A. L. A., Khamidi, M. F., & Idrus, A. (2010). Quantitative analysis of defects in Malaysian university buildings: Providers' perspective. *Journal of Retail & Leisure Property*, 9(2), 137-149.

Rasli, A. (2006). Data analysis and interpretation : a handbook for postgraduate social scientists. http://eprints.utm.my/id/eprint/30009 Retrieved August 2019.

Snyder, J. C. (1984). Architectural research. http://elib.usm.my/cgi-bin/koha/opac-detail.pl?biblionumber=358480 Retrieved August 2019.

Talib, R., Boyd, D., Hayhow, S., Ahmad, A. G., & Sulieman, M. (2015). Investigating Effective Waterproofing Materials in Preventing Roof Leaking; Initial Comparative Study: Malaysia, U.K. *Procedia Manufacturing*, 2, 419-427.

Wan Muhammad Amir W. Ahmad, Nurfadhlina Abdul Halim, Nor Azlida Aleng Mohamad, & Mohd Pouzi Hamzah. (n.d.). Data analysis using SPSS: 22. http://books.google.co.th/books?id=UuJSAQAACAAJ Retrieved August 2019,

Roslan Talib is a part-time PhD student and full-time staff at Interior Design Programme, School of Housing, Building & Planning, Univ. Sains Malaysia, Pulau Pinang. He got his Bachelor's degree in Architecture at UW-Milwaukee, USA and his Master of Architecture from Kent State Univ, Ohio USA. His researches are on building defects, flat roof design and building's interior leakage syndrome and he also had 15 years industrial experience in building leakage waterproofing maintenance on private and public buildings in Malaysia.

Dr.Sr. M Zailan Sulieman is an Associate Professor at Building Technology Programme, School of Housing, Building & Planning, Univ. Sains Malaysia. He got his Master's and PhD degrees in Building Surveying from USM. His research focuses on Building Maintenance and Defects, Building's Fire Safety and Lightweight Concrete. He is a leading the HBP Concrete Laboratory; one of the Advance and Biggest in North Malaysia.

Note: The original of this article was reviewed, accepted, and presented at the 4th International Conference-Workshop on Sustainable Architecture and Urban Design (ICWSAUD2019), a joint conference with the 4th International Conference on Engineering, Innovation, & Technology (ICEIT 2019) held in Penang, Malaysia during 24-26 June 2019.