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Investigation of Building Crack on Government Health Clinics in Johor and Negeri Sembilan

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Abstract: A building may be damaged as a result of cracks. This is a worldwide occurrence that happens regularly, in the form of structural or non-structural crack. Nevertheless, this issue needs to be systematically apprehended concerning the government buildings since it involves public safety. Therefore, a case study focusing on the government health clinics in Johor and Negeri Sembilan is conducted. The objectives are to identify common types of cracks and suggestions for their rectifications, and finally, to analyse the frequency of cracks in selected buildings. The study uses unpublished UTHM consultancy reports as the primary source of data. Further, to achieve the stated objectives, qualitative methods were employed throughout. The processes were assisted by a Multi-Layered Thematic Analysis (MLTA) and Atlas.ti software. The results show that there are several types of common cracks and their improvements. Meanwhile, it is observed that the frequency of defects (including cracks) is higher in Negeri Sembilan when compared to that in Johor. In conclusion, common building crack has its suggestion for improvement, and the frequency of defects recorded for each government health clinic is likewise alarming. Thus, concerted efforts are needed through organisational synergy and by revisiting current development strategies.

Keywords: Building, Crack, Health Clinic, Malaysia

1. Introduction

Cracks refer to defects in a building. Thus, the research focuses on cracks' frequencies towards health clinics in Johor and Negeri Sembilan. As cracks in a building may substantially damage the structure of the building and can grow to maturity, they are available in a wide range of varieties and destructive strengths, from light to heavy. Apart, there are several options for improvisation/rectifications on cracks.

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In general, building cracks are split into two categories; non-structural and structural [1]. A non-structural crack appears in any building components that are not posing threats to the building's structural integrity. Meanwhile, cracks that threaten the building's structural integrity are considered structural cracks [2]. Building cracks can be caused by various factors, including the use of low-quality building materials, improper work methods or faults during construction, vibration (including earthquake), improper usages and maintenance, foundations that do not meet the soil conditions, fire, and so on.

Prior to the construction of the building, a detailed analysis will be done by the developer to ensure that the structure of the building is capable of bearing the load that will be placed on it. Therefore, the structural design phase can be divided into two phases, namely structural analysis and structural design. The structural analysis must be performed to determine the forces acting on the structural components. Structural design is the second step after strength is obtained from the structural analysis [3]. This stage includes the selection of the size of the structural elements and estimating the reinforcement specifications (in the case of reinforced concrete structures). This is to ensure safe and economics, among others.

Therefore, the research aim is to understand and identify the cracks that appear in health clinics in Johor and Negeri Sembilan. To achieve those aim, there are two (2) objectives of the research, namely; (i) to identify the common type of cracks on building and their improvement/rectification, and (ii) to analyse the type of cracks and their frequency on health clinics in Johor and Negeri Sembilan. Later on, the results may be beneficial for the related authorities to take any precaution measures when developing such infrastructure. Inline, proper recommendations may be put forward for the betterment of government-linked health clinics development in the future.

2. Methodology

In order to achieve the aforementioned research's aim, qualitative research methods were adopted throughout. Table 1 shows the summary of the methods and analysis used to achieve each objective in this study.

Table 1: Summary of research objectives and methodologies

No.	Research Objective	Methodology	Analysis	Phase
1	To identify the common type of cracks on buildings and their improvement/rectification	Qualitative: Meta-data analysis towards past references	Manual: using Multi-Layered Thematic Analysis	1
2	To analyse the type of cracks and their frequency on health clinics in Johor and Negeri Sembilan	Qualitative: Document analysis towards unpublished records	Automated: using Atlas.ti (focusing on frequency analysis)	2

2.1 Phase 1: Manual: using Multi-Layered Thematic Analysis (MLTA)

MLTA is the strategy utilised to fulfil the first objective, where the central phenomenon regarding the research's keywords was concerned within past references [4]. Quite similar to Systematic Literature Review (SLR) method, layers within MLT act as screening nets to sieve pertinent information. Nevertheless, the research did not set any criteria regarding references' databases and search strings. Therefore, Figure 1 depicts the procedure for achieving the first study's objective.

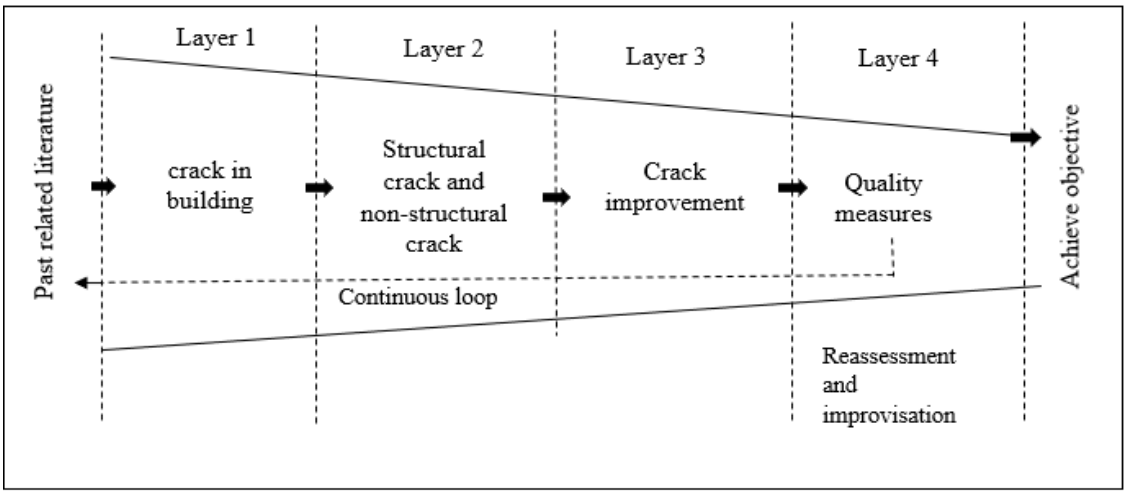

Figure 1: Multi-Layered Thematic Process

In Layer 1, the information with regard to the cracks in building was gathered. Then, Layer 2 focuses on the type of building crack, namely structural crack and non-structural crack. For this particular layer, it will include the definition and the cause for the cracking. Meanwhile, Layer 3 is dedicated to crack improvement according to different types of crack. The final layer (i.e. Layer 4) is on quality measures such as reassessment and improvisation (if needed). All references will be subjected to this layer before the final outcomes.

2.2 Phase 2: Automated: using Atlas.ti (focusing on frequency analysis)

The Atlas.ti software programme was used to analyse the frequency of cracks in Johor and Negeri Sembilan clinics, which is also the second objective of the research. Therefore, to maintain reliability, a set of screening protocols were directed to the investigation (Figure 2). Several steps were designed and adhered to, including [5]:

i. Step 1: Menu Selection
ii. Step 2: Preparing Data
iii. Step 3: Creating Codes
iv. Step 4: Creating Coding Groups
v. Step 5: Creating Output
vi. Step 6: Result analysis

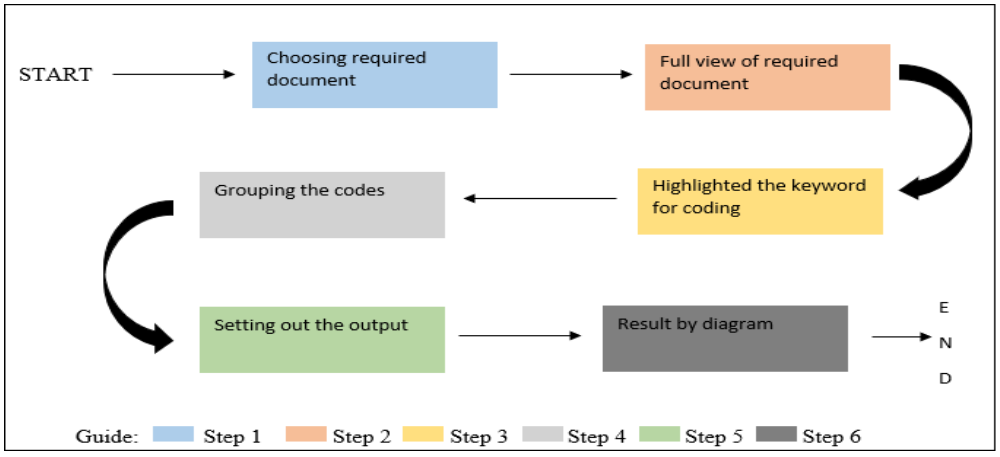

Figure 2: Overall screening protocols through Atlas.ti

3. Results and Discussion

Owing to the research's objectives and methodologies, this section highlighted the results according to the previous section's aforesaid phases.

3.1 Phase 1: Manual: using Multi-Layered Thematic Analysis (MLT)

The authors have chosen and analysed a variety of literature that is closely connected [6][7][8][9][10][11][12][13][14]. All of the literature was individually sieved using an MLT approach that had previously been developed and discussed. Results were clustered according to macro and micro levels, where types of cracks and their improvement/rectification are concerned (see Table 1).

Table 1: Cracks on building: Differentiation between Macro Level, and Micro Level

No.	Macro Level	Micro Level
1	Type of cracks	Vertical crack [6] Horizontal crack [6] Crack in the non-load-bearing wall [6] Drying shrinkage cracks [7][8] Plastic shrinkage cracks [7][9] Thermal shrinkage cracks [7] Crazing crack [7][10]
2	Improvement/ Rectification of Crack	Epoxy Injection [11][12] Gravity Filling [12] Routing and Sealing [12] Stitching [12] Plastic Shrinkage Crack i. In pre-hardened concrete - worked with a surface vibrator to close the crack. ii. In hardened concrete - filled with a suitable proprietary filler [13] Thermal shrinkage crack: In hardened concrete - a crack can be v-cut with a concrete crack chaser and filled with suitable material [13] Crazing crack: In hardened concrete - rectify the appearance of the concrete surface using a protective coating [13] Drying shrinkage crack: In hardened concrete - a crack can be v-cut with a concrete crack chaser and filled with suitable material [13]

According to Table 1, it can be seen that there were several common cracks on the building (i.e. seven (7) types). Without separating structural and non-structural cracks (as this needs further explanation), cracks related to concrete shrinkages were among the usual types. On the other hand, cracks improvement/rectifications were associated with particular cracks' types. Nevertheless, repair works by using epoxy resin are generally implemented (based on the type of crack and the condition of the crack), given its preference for strength, suitability, availability, and ease of application [14].

3.2 Phase 2: Automated: using Atlas.ti (focusing on frequency analysis)

Regarding the second phase of the research endeavour, 21 health clinics' unpublished records for Negeri Sembilan and Johor were analysed using Atlas.ti programme. This will help to achieve the second research objective, where the outcomes are more straightforward but reliable. Therefore, a summary of results through the use of a mind map is presented – as in Figure 3. Inline, to support the findings, subsequent figures were put forth, including Figure 4 and 5 - to show the frequencies of defects identified at the health clinics in Johor and Negeri Sembilan, respectively. Apart, Figure 6 and 7 are dedicated to focusing on the frequency of cracks at both locations, Johor and Negeri Sembilan, respectively.

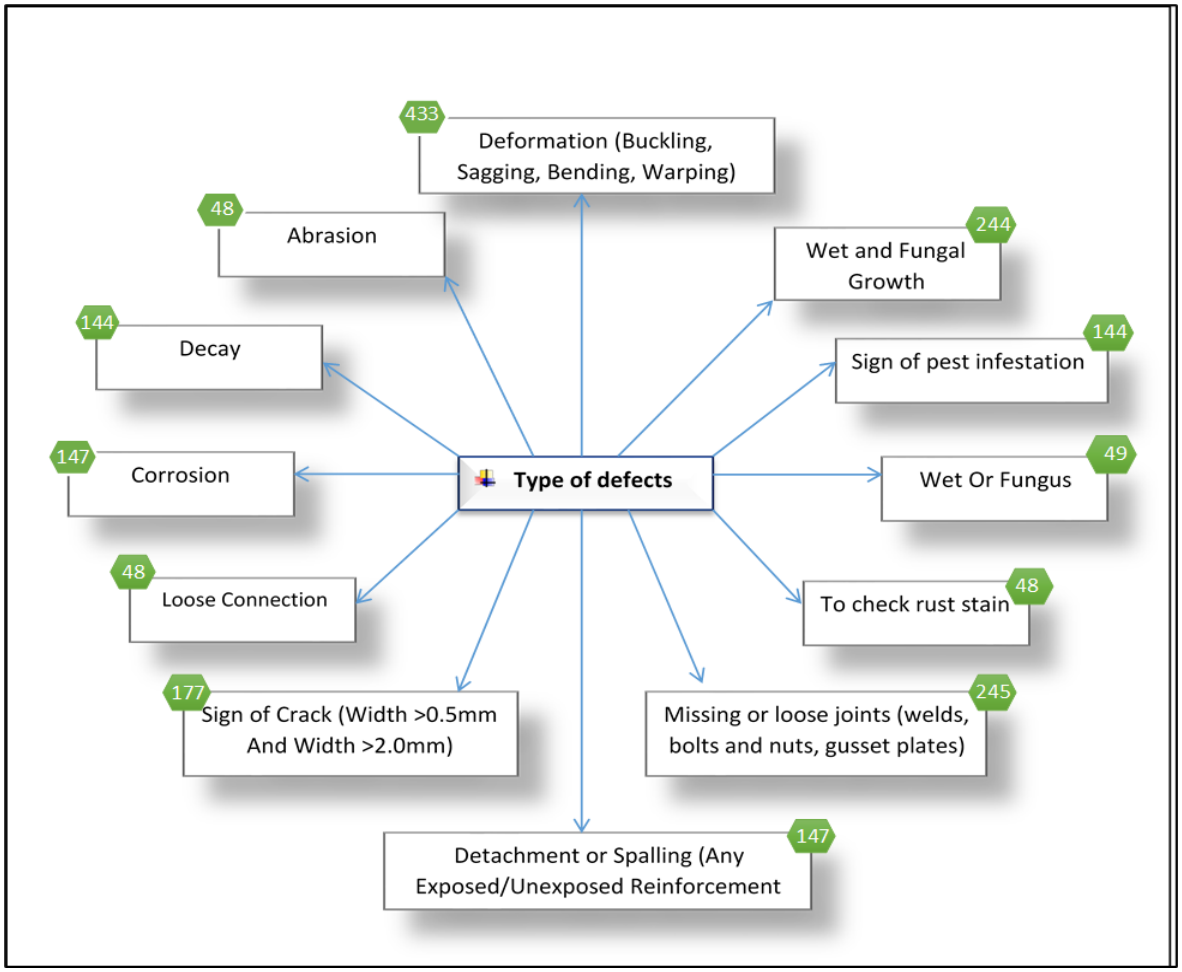

Figure 3: Summary of all types of defects and their frequencies at health clinics in Johor and Negeri Sembilan

According to Figure 3, other defects were identified within the referred reports, aside from only crack. Among them is deformation (including buckling, sagging, and others), which is recorded the highest frequency (433 no.). Given the state of deformations which normally related to components that relatively long (horizontal or vertical – e.g. beam, column, etc.), and segmental (horizontal or vertical – e.g. walls, ceiling, etc.), safety issues were imminent given the nature of the building (i.e. public building with higher pedestrians). Next are defects regarding missing/lose joints and wet and fungal growth, which recorded a frequency of 245 and 244, respectively. This was also considered to be dangerous, especially towards damp and fungal growth, since staff and patients' health is concerned. Then, in quite similar risky situations, defects relating to the sign of a crack, corrosion, and detachment/spalling were recorded 177, 147, and 147, respectively. Finally, defects that recorded the same frequency were observed to be decay and sign of pest infestation with a total of 144 numbers, while abrasion, loose connection, and rust stain with a frequency of 48.

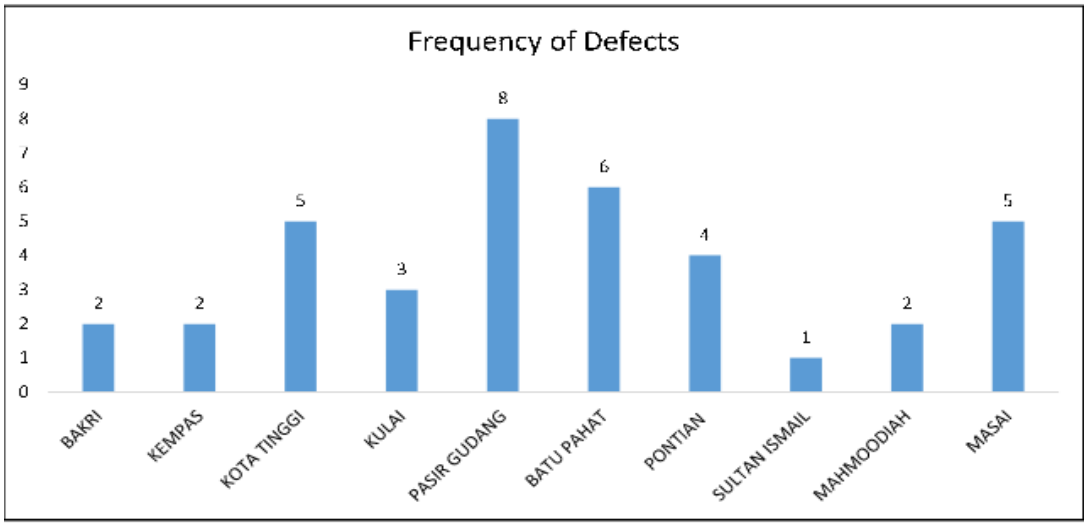

Figure 4: Summary for all defects frequencies at health clinics in Johor

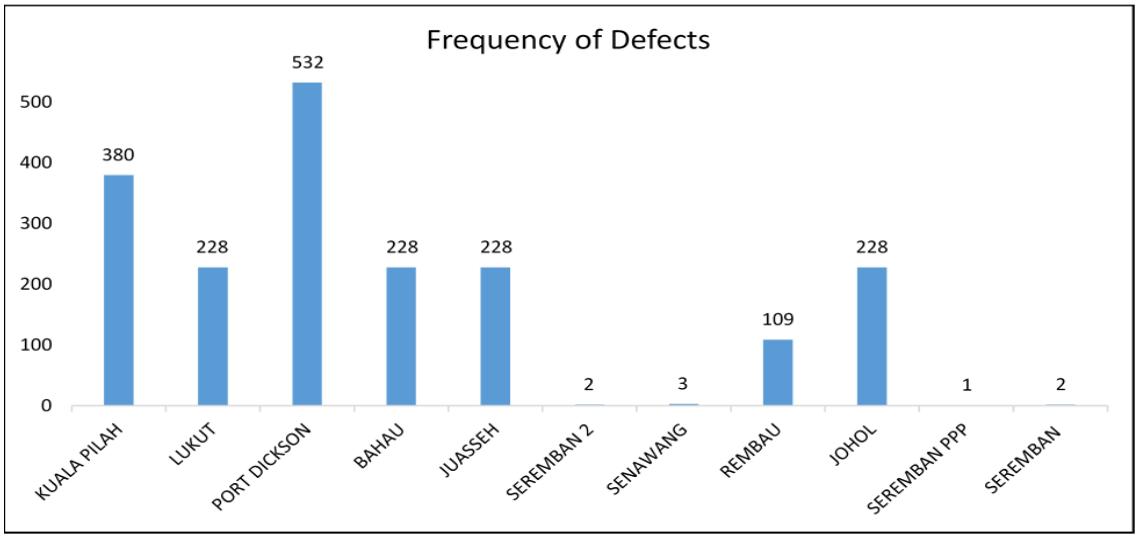

Figure 5: Summary for all defects frequencies at health clinics in Negeri Sembilan

On the other hand, in term of the number of defects according to states (i.e. Johor and Negeri Sembilan), health clinics in Pasir Gudang has recorded the highest frequency of building defects among other health clinics. At the same time, Sultan Ismail showed the lowest number (see Figure 4). Aside, Port Dickson district is the health clinic that recorded the highest frequency of building defects, while Seremban district showed the lowest record (see figure 5). Thus, by looking into the available data for both states, health clinics in Negeri Sembilan showed the highest number of defects frequency (1941 nos.); meanwhile, Johor was only 38 nos. Indirectly, since all health clinics have been operated for several years, root causes for the differences of recorded defects for both states (Negeri Sembilan and Johor) may be zeroing to the issues during its construction and maintenance phases. Also, impacts from the environment are possible (e.g. health clinic in Port Dickson is located just next to Malacca Straits), increasing the deterioration rate.

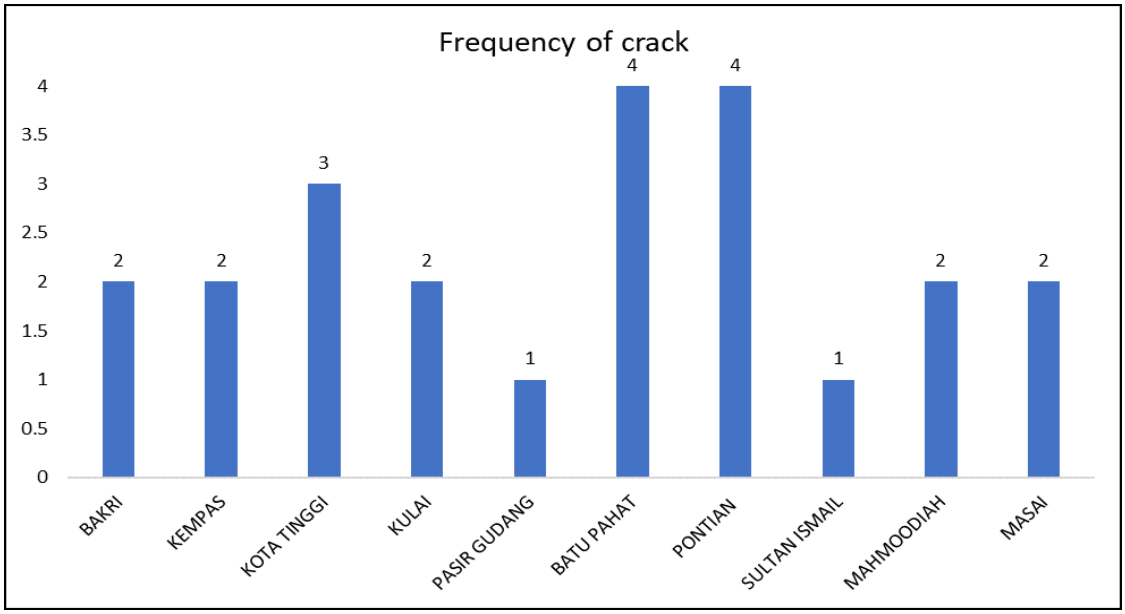

Figure 6: Summary for all crack frequencies at health clinics in Johor

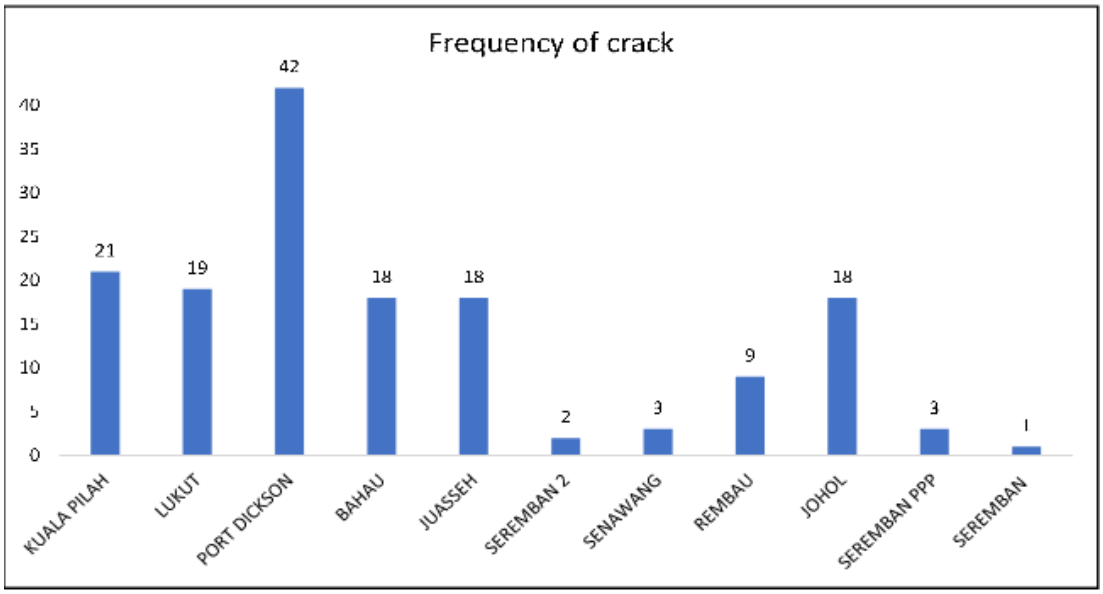

Figure 7: Summary for all crack frequencies at health clinics in Negeri Sembilan

Onto the focus on only crack data (see Figure 6 and 7), a similar pattern can be seen regarding the total number of recorded cracks issues. The results show that the crack frequency that occurs in health clinics in Negeri Sembilan (154 nos.) is higher than in Johor (23 nos.).

4. Conclusion

With regard to the types of cracks in a building, there are multiple ways to envisage its categories. Similar to its improvement or rectification, where several options are proposed by the previous researchers (according to their severity, among others). Apart, the number of recorded defects (including cracks and others) in health clinics is deemed alarming – especially to Negeri Sembilan. Since all health clinics in the research belong to the government and generally receive higher foot counts

from the people, thus safety is the utmost agenda. It is hoped that further corrective actions by the relevant authorities will be in place, which not only towards the said buildings but must be extended to the conceptualisation during the design phase and also implementation phase and maintenance phase.

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