Current Practices and Challenges in Building Defect Inspection in Malaysian Public Hospitals: A Multiple-Case Study

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ABSTRACT

Building defect inspections are essential for keeping public hospitals safe and serviceable while healthcare activities continue. This study examines the current practices and challenges experienced by civil engineers in inspecting building defects in Malaysian public hospitals. A qualitative multiple-case study was conducted across six public hospitals in northern Malaysia. Evidence reported in the underlying research comprised semi-structured interviews with six civil engineers, maintenance-related documents and site observations. Data were interpreted through within-case thematic examination and cross-case comparison, organised around maintenance issues, problem-solving practices, ICT implementation, emerging technologies and existing maintenance systems. Visual walkthroughs, complaint-led visits, checklists, photographs and subsequent reporting through paper forms, office software or the Asset and Services Information System (ASIS) characterised inspection activities. Repeated water seepage, surface cracking and insufficient manpower were recorded in all six case matrices; limited skilled contractor personnel appeared in five. Participants also described duplicated data entry, incomplete drawings, weak access to repair histories and difficulties communicating precise defect locations. The study identifies a gap between storing maintenance information and linking observations to specific building elements and previous interventions. Its practical contribution is a set of evidence-informed information requirements for more consistent location-based defect records, historical traceability and contractor coordination. These findings describe baseline practices and do not demonstrate the effectiveness of a BIM intervention.

Keywords: Building Defect Inspection; Public Hospitals; Qualitative Multiple-Case Study; Maintenance Management; Building Information Modelling (BIM); ASIS

INTRODUCTION

Public hospitals must maintain serviceable buildings while clinical care continues. Water seepage, cracking, damaged finishes, waterproofing failures and other building-fabric problems require timely identification, documentation and follow-up. In occupied and often complex hospital estates, a defect report must convey not only what was observed but also where it occurred, what was done previously and who is responsible for further action (Salmona, 2024).

In the participating hospitals, inspection records were maintained using a combination of visual observations, handwritten checklists, photographs, electronic documents and maintenance information systems. The presence of digital records does not necessarily provide a clear link between a physical building element, a defect report and its previous repairs. This information gap matters when the same defect reappears or when another engineer or contractor must locate and assess it.

Prior studies have examined BIM applications in healthcare facilities maintenance (Wanigarathna et al., 2019), the relationship between digital records and building condition (Bruno et al., 2021) and defects in Malaysian hospital buildings (Jesumoroti et al., 2024). Work on artificial intelligence and digital-twin approaches also

demonstrates growing interest in information-enabled facilities management (Abdelalim et al., 2025). However, a technology proposal should be grounded in the inspection activities and constraints of its intended users. The present study therefore focuses on the baseline hospital defect-inspection process, rather than assessing a BIM application.

The objective is to identify the current practices and challenges faced by civil engineers in inspecting defects in public hospital buildings. The research question is: What are the current practices and challenges faced by civil engineers in inspecting defects in public hospital buildings? The article contributes a comparative account of six hospital settings and derives operational information requirements for future improvement.

LITERATURE REVIEW AND OPERATIONAL CONTEXT

Defect Inspection and Information Continuity

Building inspection relies on recognising observable deterioration, recording its location and condition, and communicating the assessment for maintenance action. For recurring problems, a stand-alone complaint record is insufficient: engineers also need access to previous observations, possible diagnoses, repair decisions and follow-up inspections (Mouhib et al., 2025) Such continuity is particularly relevant when several departments, engineers and contractor teams interact with the same building. Research on Malaysian hospital defects provides a relevant built-asset context for this concern (Jesumoroti et al., 2024).

Existing Digital Systems and Visual Information

The Asset and Services Information System (ASIS) is used for hospital maintenance- and asset-related information in the case settings. Microsoft Word, Excel and PDF documents support reporting, while Building Automation Systems (BAS) are associated with monitoring selected mechanical and electrical operations. These tools serve distinct functions. Using several of them does not, by itself, mean that their records are integrated or that a user can navigate from an observed crack to its exact building position and repair history (Limna, 2023).

BIM is relevant as a possible means of organising building-element information and visually locating maintenance records (Wanigarathna et al., 2019). Research into historic BIM emphasises structured associations between building representation and condition over time (Bruno et al., 2021). More recent facilities-management literature considers artificial intelligence and digital twins as further information-management approaches (Abdelalim et al., 2025). These studies provide a conceptual context, not evidence that any such technology was implemented successfully in the six hospitals examined here. The relevant research gap is the absence of a sufficiently explicit, case-grounded account of inspection handoffs, record fragmentation and cross-hospital differences that should guide any later digital solution.

Hospital Maintenance Problem and the Role of Historical Information

Public hospitals are heavily occupied facilities whose building elements must remain safe and serviceable while clinical operations continue. Maintenance teams inspect roofs, walls, structural members, wet areas, building fabrics and related services to identify deterioration and arrange remedial work (Salzano et al., 2025). Common defects described in the source research include water leakage, dampness, cracking, failed waterproofing, deteriorated finishes, damaged tiles and defective building connections. Delayed identification or unresolved recurrence can disrupt hospital activities and increase the burden on maintenance teams (Karim, 2025).

Inspection and reporting remain challenging where defects are recorded through a combination of handwritten checklists, photographs, separate spreadsheets and maintenance databases. The Malaysian Ministry of Health uses the Asset and Services Information System (ASIS) to support maintenance-related information and work management. The case-study material, however, distinguishes digital record storage from the ability to pinpoint a defect spatially, link it to earlier interventions or evaluate severity consistently (Karluklu et al.,

2025). These distinctions are central to understanding practitioners' existing workflow before proposing any digital enhancement.

The source study describes a mismatch between the spatial nature of building defects and predominantly text-based records. Engineers may know that a leak or crack has been reported yet still need to locate it on site, review fragmented past information and explain its extent to contractors. Manual data capture followed by later re-entry creates opportunities for duplication, missing detail and delay (Liu et al., 2025). Case descriptions also indicate that recurrent defects may be associated with inadequate investigation of root causes, constrained resources, workmanship problems and weak maintenance histories. The first step towards designing a BIM-based inspection process is therefore to establish how engineers actually inspect, document and resolve defects (Awalludiensyah et al., 2024).

The thesis background characterises traditional hospital inspections as labour-intensive processes frequently depending on visual assessment, handwritten notes and separate documents. This becomes particularly problematic in large facilities with many blocks and components (Mydin et al., 2024). Maintenance records need to distinguish defect type, precise location, urgency, previous repairs and responsibility; otherwise, subsequent work may repeat earlier inspections without resolving underlying causes. The original study cites hospital maintenance and BIM literature, including Wanigarathna et al. (2019), Bruno et al. (2021) and Jesumoroti et al. (2024), for the relevance of continuous maintenance, visual information and record-management challenges.

ASIS is described in the thesis as a web-based platform supporting asset and service management in Malaysian public hospitals. The distinction in this paper is between use of ASIS for registration, asset inventory and text-based maintenance records, and integrated visual defect management. Basic ICT tools such as Microsoft Word and Excel may help with report preparation but do not themselves create a shared, spatially linked defect history (Abdelalim et al., 2025).

METHODOLOGY

Research Design and Sampling

A qualitative multiple-case study was used to examine building defect inspection in its operational context. Six public hospitals in northern Peninsular Malaysia were included as separate cases (A–F). The source research describes purposive selection of civil engineers whose professional roles gave them direct knowledge of hospital defect inspection and maintenance. One civil engineer is represented in each case, with reported experience ranging from two to fifteen years (Table 1). Cases were not selected through probability sampling; accordingly, their findings support contextual interpretation rather than national prevalence estimates.

Table 1. Case profile and participating civil engineers

Case	Hospital and location	Experience
A	Hospital Tunku Fauziah, Kangar, Perlis	2 years
B	Hospital Sultanah Bahiyah, Alor Setar, Kedah	9 years
C	Hospital Jitra, Kedah	10 years
D	Hospital Sungai Petani, Kedah	10 years
E	Hospital Kulim, Kedah	4 years
F	Hospital Pulau Pinang, Penang	15 years

Data Collection and Interview Coverage

The source study reports semi-structured interviews with the participating civil engineers, supported by examination of maintenance-related documents and observations described in the case accounts. Interview topics covered routine and complaint-triggered inspections, recurrent defects, reporting practices, contractor engagement, problem-solving, ICT applications, ASIS and views on emerging technology. Examples of

documents discussed include Hospital Engineering Planned Preventive Maintenance (HEPPM) inspection forms, defect reports and maintenance records. The interviews were reported as voluntary, with informed consent and permission for audio recording.

The available manuscript and source account do not specify the interview dates, durations, exact recruitment steps, interview language, transcription procedure, or the number and type of documents systematically reviewed. These details should be confirmed against the original field records before submission; they have not been reconstructed or invented in this revision.

The source research describes voluntary participation, informed consent and permission to audio-record interviews. The available study materials do not establish the precise recruitment sequence, the interview duration, or a transcript-verification procedure. The study employed semi-structured interviews with six civil engineers, supported by maintenance related documents and site observations. Participation was voluntary and informed consent was obtained before the interviews, including permission for audio recording.

Data Analysis and Evidence Interpretation

The analysis proceeded at two related levels. First, interview descriptions, documents and case observations were organised within each hospital around five embedded units of analysis: (EUA1) maintenance issues; (EUA2) problem-solving approaches; (EUA3) ICT implementation; (EUA4) emerging technologies; and (EUA5) existing maintenance systems. Related interview responses were then grouped into descriptive themes concerning inspection workflow, resources and contractors, documentation, historical traceability, digital systems and corrective practices. Second, the six cases were compared using the case matrices supplied in the source research. A check mark indicates that an issue or practice was marked for that case; it does not count defect incidents or measure how frequently an event occurred.

The synthesis was interpreted alongside selected interview excerpts (H1–H6). Quotations below reproduce wording available in the original thematic summary, with only complete, attributable extracts selected. The available material does not establish a formal intercoder reliability exercise, independent audit of interview transcripts or a quantified saturation assessment. Analysis therefore emphasises transparent descriptive comparison and avoids unsupported claims of causal relationships.

FINDINGS

Inspection and Reporting Workflow

Across the interview accounts, inspection began with visual walkthroughs, scheduled condition checks or responses to complaints. Engineers examined roofs and gutters, walls, columns, slabs, wet areas, finishes and related building components. Visible defects were noted on forms or checklists and often photographed; information was subsequently entered into ASIS or compiled in Word, Excel and PDF reports. This represents a partly digitised process with a manual information-transfer stage, rather than an entirely paper-only system.

Engineer H2 explained: “Normally we use paper forms to record defects. After the site inspection, we key in the data into ASIS”. Engineer H4 described an associated limitation: “The system [ASIS] records the complaint or defect, but it’s more text-based. We cannot visualise it on the building”. Together, these accounts show that the main difficulty is the continuity and spatial meaning of the record, not simply the availability of software.

Cross-Case Distribution of Maintenance Issues

Table 2 presents selected items from the original maintenance-issue matrix. Recurring water seepage, surface cracking and insufficient manpower were marked in all six cases. A shortage of skilled contractor employees was marked in five cases, while weak piping connections, waterproofing deficiencies and recurring connection defects showed a less uniform distribution. These are case indicators, not incidence rates or validated condition grades.

Table 2. Selected issues recorded in the six-case comparison (✓ = marked; — = not marked)

Issue	A	B	C	D	E	F	Cases
Repeated water seepage	✓	✓	✓	✓	✓	✓	6/6
Repeated surface cracking	✓	✓	✓	✓	✓	✓	6/6
Insufficient manpower	✓	✓	✓	✓	✓	✓	6/6
Lack of skilled contractor employees	✓	✓	✓	✓	✓	-	5/6
Weak piping connections	-	✓	✓	-	✓	✓	4/6
Waterproofing deficiencies	-	✓	-	✓	✓	-	3/6
Repeated connection defects	✓	-	-	✓	-	-	2/6

Although water seepage and cracking appeared in all case matrices, their manifestations differed. Case A highlighted roof waterproofing deterioration and joint-related problems; Case B described condensation, dampness and visible fungal growth on finishes; Case C identified seepage around toilet walls and slabs; and Case E discussed persistent cracks and repair-quality concerns. Thus, a common defect category did not imply a shared cause, severity or appropriate remedy.

Explicit Comparison of the Six Hospital Cases

Table 3. Within-case differences in defects and maintenance responses

Case	Distinctive observations	Reported response / constraint
A	Flat-roof waterproofing, seepage, joints and cracks	Contractor monitoring; slow response and unclear technician descriptions
B	Moisture condensation and fungal growth; multiple hospital blocks	Assessment of contractor workmanship; location identification across spaces
C	Seepage in toilet areas, connection problems and cracking	Experienced staff engaged; inconsistent follow-up and repeated repairs
D	Water ponding and building-maintenance quality checks	Strengthened contractor quality assessment; staff skills and budget barriers
E	Repeated cracking and poor-quality repairs	Additional personnel/specialists; supervision and funding limitations
F	Deterioration at joints and slabs, cracking and seepage	Closer contractor supervision; difficulty linking past repairs to conditions

The comparison reveals both commonality and local variation. Cases A, C and F placed particular emphasis on joints or structural components, whereas Case B highlighted moisture symptoms affecting occupied rooms and Case D recorded water ponding. Contractor oversight featured strongly in A, B, D and F; additional technical personnel or specialist support were noted in C and E. These differences imply that a standard classification system must allow detailed contextual descriptions and evidence rather than collapse each observation into a generic defect label.

Detailed Within-Case Interpretation

Case A: Hospital Tunku Fauziah, Perlis

In Case A, the study describes corrective and preventive maintenance provided through a maintenance contractor and overseen within the hospital engineering setting. The defect-management process includes inspection, documentation, reporting, procurement-related decisions, monitoring and follow-up. Paper-based reporting remains part of the workflow even though the ASIS system is available. This coexistence is important: introducing a computerised system did not eliminate the need for field notes or manual interpretation of the condition of building elements.

The case narrative places particular emphasis on recurring roof and concrete-related deterioration. Flat-roof waterproofing, water seepage, cracks and expansion joints appear together in the account, suggesting that a single visible symptom can have several possible mechanisms. The described membrane deterioration and failures at joints illustrate why engineers need both an accurate defect location and an inspection narrative documenting the surrounding construction details. A report that only says “leakage” cannot convey what was examined or why one cause was preferred over another.

The participating engineer also described slow contractor response and difficulty obtaining sufficiently specific explanations of defects from technicians. These observations link maintenance delay to a communication and capability issue rather than merely the availability of reporting software. Engineers therefore monitored contractors and reviewed maintenance activity, but oversight was dependent on records describing the reported condition and subsequent action in a form that could be checked.

The study notes the use of ASIS to assist maintenance management and a Building Automation System (BAS) for mechanical and electrical monitoring. It does not report use of BIM in the existing defect-inspection workflow. Case A thus illustrates a partial digital environment: systems can maintain inventories or operating information, while structural defect evidence remains dispersed across reports, site knowledge and contractor communications.

Case B: Hospital Sultanah Bahiyah, Kedah

Case B concerns a large hospital comprising multiple blocks. The scale and distribution of spaces make inspection and subsequent defect identification demanding because a reported condition must be associated with the correct block, level and room. In this case, conventional reporting coexists with ASIS and BAS. Engineers remain responsible for judging the quality and adequacy of work undertaken by maintenance contractors.

The narrative highlights recurring defects associated with construction workmanship, design detailing and contractor competence. It also describes moisture condensation affecting room walls, ceilings and floors, with dampness and fungal growth shown in the thesis photographs. Such symptoms can disrupt the normal use of clinical and support spaces; their significance depends on context and should not be reduced to an isolated defect code. The thesis does not provide independent indoor-air-quality measurements, so the interpretation here is confined to the reported visible conditions.

Case B reinforces the importance of recording the inspection setting, observable evidence and whether a defect has recurred after treatment. In a building with many similar rooms, a text-only reference may be difficult to interpret consistently by different personnel. Photographs and unambiguous location labels can help convey which ceiling, wall or component needs attention, particularly when tasks pass from hospital engineers to contractor teams.

The engineer assessed maintenance contractor performance and the account identifies limited use of emerging technologies, including BIM. This is not evidence that BIM would necessarily remove moisture problems. Rather, the case provides a practical requirement for any proposed information model: inspections and remedial actions should be linked to the same identifiable space or element so that later staff can retrieve the earlier context.

Case C: Hospital Jitra, Kedah

In Case C, the thesis describes a district-hospital maintenance environment using conventional methods for complaints, inspections, maintenance planning and corrective actions. Paper reports, ad hoc databases, Microsoft Word and Excel are used together with ASIS. The system mix reflects practical adaptation to day-to-day reporting but leaves opportunities for duplication when the same defect details need to be written in more than one place. Reported technical concerns include seepage around toilet walls and floor slabs, connection failures and cracks in structural components. The respondent associated repeated defects with insufficient contractor competence and difficulties in investigating or addressing underlying causes. This distinction

matters for defect tracking: a newly observed damp patch may be a continuation of an unresolved earlier fault rather than a separate maintenance event.

The case also reports neglect or inadequate follow-up by contractors in the assessment of component deterioration. As a problem-solving measure, the contractor engaged more experienced staff to support maintenance planning. This action addresses human capability at the point of assessment and repair; improved information technology would need to complement, not replace, engineering judgement and trade knowledge.

The account states that emerging technology such as BIM was not used. The main implication for Objective 1 is a need to preserve chronological links between complaints, inspection findings, engineering decisions, assigned actions and verification of closure. The supplied case material does not report measured turnaround times, making it inappropriate to quantify the magnitude of any delay.

Case D: Hospital Sungai Petani, Kedah

Case D documents the use of traditional paper-based reports and basic ICT for hospital building maintenance. Microsoft Word and Excel support documentation and reporting, while ASIS operates alongside conventional management activities. The engineer described the need to assess contractor workmanship and strengthen the quality checks performed during maintenance work.

The case includes water ponding as a visible maintenance concern, illustrated by a location photograph. Standing water can prompt inspection of surfaces, drainage conditions and adjacent components; however, the source does not establish a single definitive cause for every reported instance. Maintaining photographs, dates and mapped locations would allow successive inspections to be interpreted in context without assuming that all ponding has the same origin.

The reported barriers to emerging technology include limited staff competency and budget considerations. This highlights the operational difference between recognising the possible value of a tool and having the resources to deploy it. Any proposed BIM-supported inspection process would require a realistic staff training programme, a workable method of collecting field information and a clear definition of who is responsible for updating records.

Case D adds evidence that quality assurance of repair work and information traceability need to develop together. A detailed record can support review, but the quality of a repair still depends on suitable inspection methods, contractor expertise and successful execution at site.

Case E: Hospital Kulim, Kedah

Case E identifies poor-quality repair work, limited supervision and financial constraints as obstacles to sustained maintenance. The hospital maintenance arrangements rely on paper reports and conventional digital files, including Word and Excel. These practices enable report preparation but do not, by themselves, guarantee that related observations from multiple inspection cycles can be connected.

The respondent linked repeated cracking or component problems with maintenance mistakes and budget limitations. The account suggests that restrictions on labour and repair resources can favour short-term responses to visible symptoms. It is therefore important to distinguish between closing a complaint in an administrative system and verifying that the physical root cause has been resolved.

As a response, contractors engaged additional staff or external technical specialists to assist maintenance planning, and the engineer considered changes to existing methods. The reported challenges show that the people who diagnose and rectify faults remain essential even when inspection information is digitised. Records should support those people by preserving defect descriptions, evidence and previous action, rather than treating technology adoption as an end in itself.

The narrative describes no active BIM application for building defect management and notes that management or budget constraints discouraged some newer technologies. For an eventual information model, this case points to the value of a phased approach with clear responsibilities and manageable data fields. Such a recommendation is an implication of the findings, not a tested cost-saving intervention.

Case F: Hospital Pulau Pinang

Case F covers maintenance of hospital buildings in a setting where the respondent described structural component deterioration, connections and recurring seepage. Conventional documentation, paper databases and email remain part of the maintenance process. ASIS is available for asset and maintenance information, but the case does not report a spatially integrated BIM defect-inspection system.

Reported problems include defects near component joints, surface cracking and internal slab cracks. The narrative discusses potential weaknesses in design, materials and ground conditions as explanations considered in the case. These should be understood as the source account of local conditions, not as independently verified conclusions about structural causation across the hospital estate.

The client-side engineer strengthened supervision of maintenance contractors to improve the examination of defects. The case therefore highlights the importance of a clear chain from the observed symptom to inspection assessment, contractor instruction and confirmation of action. A complaint record without a history can make it difficult for a new engineer to see which diagnosis or repair has already been attempted.

Case F is particularly useful for thinking about longitudinal maintenance information. Where the same joint or slab is reported repeatedly, a defect register should distinguish an ongoing unresolved event from new deterioration and retain the photographic and technical evidence used to make that distinction. The thesis documents the need for such information more clearly than it demonstrates a completed technical solution.

Resource, Skills and Contractor Constraints

Personnel limits were marked in all cases and contractor skill shortages in five. Participants linked practical difficulties to limited inspection time, incomplete building information, uneven repair workmanship and contractor follow-up. Engineer H2 stated: “Limited manpower, time constraints. Incomplete drawings and lack of accurate building information make inspection difficult”. These constraints can affect documentation and follow-up as well as the physical rectification of defects. The interviews cannot establish their independent effect on turnaround time or repair costs.

Fragmented Records, Repeated Entry and Unclear Locations

Participants described handoffs between paper notes, photographs, reports and maintenance databases. Engineer H5 stated: “Sometimes we record twice—once on paper, then again into ASIS. It is inefficient”. Engineer H6 similarly observed: “For a big hospital, explaining where exactly the defect is can be confusing.” These examples identify two related problems: repeated information entry and an inability to retrieve a spatially clear, unified defect record. They also explain why a photograph without a stable location identifier may be insufficient when a different team undertakes corrective work.

Historical Traceability, Urgency and Corrective Action

Engineers described recurring faults following temporary repairs or incomplete root-cause investigations. If information on earlier actions is difficult to retrieve, a new complaint may be treated as an independent occurrence. Engineer H1 noted a prioritisation problem: “The system shows what defect exists, but not how serious or urgent it is”. The cases therefore support preserving defect histories and recording assessed urgency, but they do not validate a numerical severity index or demonstrate a consistent prioritisation scheme across hospitals.

Coverage of existing ICT

Table 4. ICT tools marked in the original six-case matrix

System / reported function	A	B	C	D	E	F
CMMS/ASIS - asset registration/inventory	✓	✓	✓	✓	✓	✓
Microsoft Word - reports/statistics	-	✓	✓	✓	✓	✓
Microsoft Excel - reports/statistics	-	✓	✓	✓	✓	-
BAS – M&E monitoring	✓	✓	-	✓	✓	✓

ASIS/CMMS registration and inventory were marked in all six cases. Word was marked in five, Excel in four, and BAS in five. This pattern shows that digital technologies already form part of hospital maintenance; however, their different roles and parallel records do not establish full interoperability. No routine BIM-enabled defect-inspection workflow was described in the six case narratives. Participants' views on BIM concerned potential future value and should not be read as tested performance gains.

Interview Evidence and Analytical Traceability

Thematic evidence was organised by participant codes H1–H6. The selected excerpts below illustrate the observations and constraints discussed across the cases; they do not represent a count of defect incidents or independently verified performance measures.

(Engineer H2): "Normally we use paper forms to record defects. After the site inspection, we key in the data into ASIS".

(Engineer H3): "Defect inspections are mainly carried out through routine visual inspections, complaint based and scheduled condition assessment using standard checklist".

(Engineer H4): "The system [ASIS] records the complaint or defect, but it's more text-based. We cannot visualise it on the building".

(Engineer H5): "Inspection findings are recorded in written reports, defect lists or maintenance forms, often with photographs attached".

(Engineer H2): "Limited manpower, time constraints. Incomplete drawings and lack of accurate building information make inspection difficult".

(Engineer H1): "BIM could significantly improve defect inspection by providing clear visualisation, accurate locations of defect and better information access".

(Engineer H4): "If defects could be marked directly on the model, it would help us and the contractor".

(Engineer H5): "3D visualisation, defect tagging, inspection history, maintenance records and integration with inspection checklists would be very helpful".

(Engineer H4): "We don't want two separate systems. It must be linked so we don't duplicate work".

The accounts identify a common sequence that begins with visual observation on site and ends with a record in a report or maintenance system. A routine walkthrough may identify obvious surface damage or leakage, but observations can also be triggered by complaints or planned condition assessments. These routes into inspection should be kept distinct in a record because they indicate why the engineer attended the location and whether the finding reflects routine monitoring or an urgent user report.

The testimony also clarifies the practical role of paper forms. Engineers often make field notes and subsequently enter the information into ASIS. The transcription step creates a point at which technical detail

may be shortened, delayed or entered in a different format. The presence of photographs assists communication but does not ensure that an image has a stable link to a particular space or asset. The evidence supports identifying those handover points as potential information-quality risks.

The use of the word's manual and semi-digital in the source should not be interpreted as an absence of any electronic support. Word, Excel, PDF and ASIS all appear in the maintenance environment. The relevant distinction is between having several digital repositories and having an integrated inspection history that users can navigate from one defect to related evidence and decisions.

The challenge-related quotations put operational pressure alongside information problems. The lack of sufficient personnel and time affects how much can be inspected and how fully findings can be recorded. Incomplete building drawings make locating components more difficult, particularly when the current condition differs from available construction documentation. These constraints shape the reliability of the information entering any maintenance application.

The reported difficulty in deciding how serious or urgent a defect raises a separate point. A database can show that a complaint exists without supporting a systematic judgement about its consequences. Hospital engineers may need to consider location, usage, water exposure, signs of deterioration and potential disruption to services. A proposed severity field may help, but the study does not validate numerical thresholds or a universal hospital defect-risk index.

The description of repeated defects draws attention to repair cycles. If a leak is temporarily repaired and then reappears, staff need to retrieve the earlier report, the repair method and any subsequent inspections. When defect history is scattered, the apparent completion of a work order may conceal unresolved underlying conditions. The thesis treats repeated reporting and incomplete historical traceability as maintenance challenges rather than as quantified predictors of repair failure.

The reported double-entry problem is important because it consumes engineering time that could otherwise be spent assessing the actual condition. Nevertheless, a single digital entry point is not enough unless the data captured are sufficiently accurate, accessible to authorised staff and maintained over time. Organisational procedures, responsibility for updating a record and contractor engagement remain central to the quality of the final information.

DISCUSSION

Interpreting the Comparative Findings

The main finding is an information-continuity problem within an inspection process that combines conventional observation with several administrative tools. Recurrent seepage and cracking create a need to distinguish new damage from an earlier unresolved condition. That distinction depends on consistent defect identity, precise location, inspection evidence and accessible repair history. The local variations documented in Table 3 also show why detailed engineering context remains necessary: the same visible symptom can arise in different building areas and may require different technical assessments.

The findings are consistent with the value placed on maintenance information and building-asset representation in the BIM and facilities-management literature (Wanigarathna et al., 2019; Bruno et al., 2021). They add a practice-based account from six Malaysian public hospital cases, including specific double-entry, spatial referencing and contractor communication issues. Contemporary digital-twin and AI scholarship (Abdelalim et al., 2025) indicates further technological possibilities, but the present data cannot show whether these approaches would be technically feasible, affordable or effective in the participating settings.

Practical Contribution: Inspection Information Requirements

The cases point to a minimum information structure that could be adopted in an improved inspection protocol or evaluated later in a BIM-supported workflow. At the point of inspection, records should identify a unique

defect, hospital/block/floor/room or component, date, observed condition, photographs and responsible inspector. Follow-up entries should document the suspected cause separately from what was directly observed, the assessed urgency, the assigned corrective action, contractor or team, relevant prior repairs and closure/reinspection status. Common naming conventions and links to existing ASIS identifiers could help prevent repeated records; this is a proposed requirement, not a documented functioning integration.

Table 5. Evidence-informed requirements for improving inspection records

Evidence from cases	Practical requirement	Implementation caveat
Text-based location and ambiguous site references	Stable location/component identifier and linked photographs	Accurate drawings and location data are needed
Recurring seepage/cracking	Linked inspection, repair and reinspection history	Records must distinguish observation from diagnosis
Double entry across paper and ASIS	Standardised fields and defined source-of-record	Interoperability not established in this study
Limited urgency support	Documented urgency and escalation rationale	Severity criteria require separate validation
Contractor capability and follow-up gaps	Clear assignment, status and verification fields	Technology cannot replace technical skill

Implications for a Future BIM Study

Visual association of a record with a building element could potentially improve the interpretation of a defect location. Yet a BIM model alone would not resolve inadequate workmanship, manpower shortages or unclear data ownership. A subsequent phase would need to establish whether the model can be populated and updated by authorised users, whether ASIS information can be linked reliably, and whether real users can complete defined retrieval and reporting tasks. Such evaluation must be reported separately from the descriptive results presented here.

Practical Implications for Hospital Inspection Teams

Inspection Preparation

The investigation suggests that inspection preparation should include access to current drawings or a usable building location index, earlier complaint records and the relevant maintenance schedule. The absence of complete or accurate building information was explicitly raised by an interviewee. Preparing this information before entering a ward or service area would give inspectors a clearer reference for identifying where a reported component is located and whether the defect had been observed earlier. This is a procedural recommendation derived from the accounts, not a workflow that the thesis measured experimentally.

Field Observation

During inspection, staff need to describe what can be seen and distinguish observation from diagnosis. For example, a stained ceiling is an observable condition, while a failed waterproofing membrane is one possible explanation that may require further investigation. The case narratives show that leakage and cracking appear in several different settings and can be attributed to various potential mechanisms. Maintaining this distinction would help prevent an early assumption from being reproduced uncritically across later records.

Photographic Documentation

Photographs can retain visual detail that is difficult to explain through a short-written report. The interviews confirm that photographs are already used as supporting evidence. Their usefulness nevertheless depends on a clear association with a defect entry, the date of inspection and the specific room or component. Where the image does not show an easily recognisable landmark, a wider contextual photograph together with a closer

detail may support interpretation. Such a procedure follows from the problem of ambiguous locations raised by participants.

Referral and Contractor Instruction

After inspection, technical information must pass from the hospital engineering team to the party responsible for rectification. The cases describe delays, skill shortages and occasions when the contractor does not receive a full description of the problem. Referral information should therefore set out the location, observed condition, any immediate concern, supporting evidence and the task required. A record of the recipient and date of assignment would clarify accountability without assuming that an electronic referral automatically produces a timely repair.

Verification and Closure

Closing a maintenance complaint should be distinguished from confirming that the observed defect has been corrected. The presence of recurring problems in the case-study material shows the value of documenting what was repaired and what was observed during any subsequent review. Where a defect reappears, the new report should refer to the earlier entry rather than losing the connection. The interviews provide qualitative support for this approach but do not establish a standard follow-up period or an empirically tested closure criterion.

Responsibilities for Data Quality

The proposed improvements depend on consistent data entry and review. Civil engineers, maintenance contractor technicians and administrative system users may handle different stages of the same complaint. An information-management procedure should identify which role creates the original defect record, who may modify its assessment, who documents corrective work and who verifies closure. Without clear responsibilities, moving information into a new platform may preserve the same gaps that the interviews identify in the existing process.

Working within Occupied Hospitals

Hospital facilities continue operating during many maintenance activities. Practical inspection requirements must therefore consider restricted access, patient privacy and the possibility that entry into particular areas is subject to clinical schedules or safety arrangements. The supplied objective-one data does not provide a systematic comparison of ward access or clinical disruption. Nevertheless, the hospital setting gives an important boundary to the application of any proposed inspection workflow, especially where photography or a new digital data-capture device is involved.

Training and Organisational Support

Training should cover both technical recognition of defects and the consistent use of information fields. The cases report insufficiently skilled contractor staff alongside limited experience with emerging technology. These are distinct needs: a user may be competent to operate software while lacking the engineering knowledge required for diagnosis, or may diagnose defects correctly while finding an unfamiliar interface cumbersome. Implementation planning should address both groups of skills and should recognise that routine updates create continuing work after initial model creation.

Evaluating Future Improvements

The source identifies difficulties in locating defects, maintaining consistent reports and reconstructing previous inspections. These challenges can be translated into observable tasks for future evaluation, such as finding a specific defect, retrieving the last corrective action and entering a completely new report. Evaluation should specify whether participants are rating perceived usefulness, demonstrating task completion or providing measured operational data. Such distinctions are essential to avoid treating an expected benefit as a proven increase in maintenance performance.

Policy and Institutional Relevance

The results support attention to shared defect terminology, clearer maintenance reporting procedures and appropriate staff development within public hospitals. They do not establish a national rate of system failure or justify uniform software procurement for all institutions. Institutional decision-makers should assess the nature of their maintenance portfolio, the reliability of existing records and the availability of implementation support before selecting a technology. The cases are most useful in explaining why the management of defect information is a practical issue worth addressing.

LIMITATIONS AND TRUSTWORTHINESS

The six purposively selected cases, each represented by one civil engineer, provide context-specific professional accounts rather than a statistically representative sample of Malaysian hospitals. The tables identify cases in which a problem was marked, not the number of defect events, verified severity or failure rate. Technical explanations reported by participants were not independently tested for all sites. Documentary review and observation are described in the underlying source, but the available article material does not provide a complete itemised evidence inventory or an auditable triangulation matrix. The original transcript and recruitment records should be checked to confirm the fuller interview procedure and any validation steps before final submission.

The study nonetheless supports analytic comparison by presenting case profiles, retaining the same issue indicators across hospitals, distinguishing shared patterns from case-specific conditions, and attributing selected statements to interviewees. These practices support traceability while avoiding claims of generalisability, causal proof or validated BIM performance that the evidence cannot sustain.

CONCLUSION

This six-case qualitative study found that public-hospital civil engineers commonly identify defects through visual and complaint-led inspections and document them using checklists, photographs, conventional office files and ASIS. Repeated seepage, cracking and insufficient manpower were marked in every case matrix, although the reported defect contexts and maintenance responses differed among hospitals. Interviewees also identified duplicate entry, limited location clarity, fragmented histories and contractor capability challenges. The study contributes a comparative description of existing practices and a set of information requirements for clearer location-based reporting, follow-up and accountability. These requirements provide a grounded starting point for later BIM development and evaluation; they do not establish that BIM has already improved hospital maintenance outcomes.

REFERENCES

1. Abdelalim, A. M., Essawy, A., Sherif, A., Salem, M., Al-Adwani, M., & Abdullah, M. S. (2025). Optimizing facilities management through artificial intelligence and digital twin technology in mega-facilities. Sustainability, 17(5), 1826. https://doi.org/10.3390/su17051826
2. Awalludiensyah, R., Andardi, F. R., & Wahyudiono, S. (2024, March). Modeling of building information modeling (BIM) on construction projects in Malang. In AIP Conference Proceedings (Vol. 2927, No. 1, p. 030008). AIP Publishing LLC. https://doi.org/10.1063/5.0193445
3. Bruno, S., Musicco, A., Fatiguso, F., & Dell'Osso, G. R. (2021). The role of 4D historic building information modelling and management in the analysis of constructive evolution and decay condition within the refurbishment process. International Journal of Architectural Heritage, 15(9), 1250–1266. https://doi.org/10.1080/15583058.2019.1668494
4. Jesumoroti, C., Olanrewaju, A., & Khor, S. C. (2024). Defects in Malaysian hospital buildings. International Journal of Building Pathology and Adaptation, 42(5), 835–856. https://doi.org/10.1108/IJBPA-12-2021-0166

5. Karim, M. R. (2025). Optimizing Maintenance Strategies in Smart Manufacturing: A Systematic Review of Lean Practices, Total Productive Maintenance (TPM), And Digital Reliability. Review of Applied Science and Technology, 4(02), 176-206. https://doi.org/10.63125/np7nnf78
6. Karluklu, D., Rinaldi, C., Crognale, M., Figuli, L., & Gattulli, V. (2025). Enhanced image processing and storage for defect evaluation in BIM of inspected steel bridges. Discover Civil Engineering, 2(1), 11. https://doi.org/10.1007/s44290-025-00164-5
7. Limna, P. (2023). The impact of NVivo in qualitative research: Perspectives from graduate students. Journal of Applied Learning & Teaching, 6(2), 271-282. https://doi.org/10.37074/jalt.2023.6.2.17
8. Liu, S., Wang, Y., Xiao, Y., Guo, W., Li, Y., Lu, Y., ... & Liu, L. (2025). Impact of occupancy density and source location on inhalational exposure of infectious respiratory particles in a naturally ventilated fever clinic. Building and Environment, 276, 112839. https://doi.org/10.1016/j.buildenv.2025.112839
9. Mouhib, Z., Gallab, M., Merzouk, S., Soulhi, A., & Di Nardo, M. (2025). Total productive maintenance and Industry 4.0: a literature-based path toward a proposed standardized framework. Applied System Innovation, 8(4), 98. https://doi.org/10.3390/asi8040098
10. Mydin, M. A. O., Omar, R., Nawi, M. N. M., Ismail, W. N. W., & Norazman, N. (2024). Identifying and categorizing Building Defects and Failures caused by Overloading. Journal of Advanced Research in Applied Mechanics, 122(1), 186-204. https://doi.org/10.37934/aram.122.1.186204
11. Salmona, M., & Kaczynski, D. (2024). Qualitative data analysis strategies. In How to conduct qualitative research in finance (pp. 80-96). Edward Elgar Publishing. https://doi.org/10.4337/9781803927008.00012
12. Salzano, A., Cascone, S., Zitiello, E. P., & Nicolella, M. (2025). HVAC system performance in educational facilities: A case study on the integration of digital twin technology and IoT sensors for predictive maintenance. Journal of Architectural Engineering, 31(1), 04025004. https://doi.org/10.1061/jaeied.aeeng-1855
13. Wanigarathna, N., Jones, K., Bell, A., & Kapogiannis, G. (2019). Building information modelling to support maintenance management of healthcare-built assets. Facilities, 37(7–8), 415–434. https://doi.org/10.1108/F-01-2018-0012