

Annex A – Design for Maintainability (DfM) consultancy study

1. WHAT IS DESIGN FOR MAINTAINABILITY (DfM)

Definition of DfM

- a. Design for Maintainability (DfM) incorporates longer-term maintenance considerations into the design process from the outset, to help reduce maintenance costs and manpower needs during a building's life cycle.

FM Sector Transformation

- b. As Singapore's building stock grows and ages, the demand for maintenance services continues to increase. At the same time, the Facilities Management (FM) sector is facing manpower constraints due to an ageing workforce and tightening labour market conditions. These challenges cannot be addressed by simply adding more workers. We need to transform how the sector operates.

Implementation of DfM

- c. Given the synergy between maintainability and sustainability, DfM is integrated within BCA's Green Mark (GM) 2021 Certification Scheme via the **Maintainability (Mt) Section** – one of the five¹ (5) sustainability sections. It assesses how well a building's design supports labour-efficient and cost-effective maintenance.
- d. Projects that demonstrate exemplary performance in the adoption of DfM measures are awarded the **Mt Badge**.
- e. Since 2006, the public sector has taken the lead on environmental sustainability by requiring new public sector buildings to attain the GM certification. With the increasing relevance of DfM in the built environment sector, since 2021, all new and existing buildings (upon major retrofit) under the GreenGov.SG initiative, must **achieve the Mt Badge in addition to attaining the GM Platinum Super Low Energy (SLE) standards**.
- f. The Mt Badge is also a sustainability-related condition – alongside SLE – in the Built Environment Transformation Gross Floor Area (GFA) Bonus Incentive Scheme and Government Land Sales (GLS) sites since Nov 2021 and Jun 2022, respectively.

2. WHEN AND WHY WAS THE DfM CONSULTANCY STUDY COMMISSIONED?

¹ GM comprises 5 sections – Carbon, Resilience, Intelligence, Health & Wellbeing, Maintainability – from which GM points are scored for the purposes of attaining the different sustainability tiers. More details at <https://www1.bca.gov.sg/sustainability/greenmark/green-mark-2021/>.

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Impetus

- a. By considering maintenance needs upfront, higher cost and manpower savings can be reaped across the building's operational phase. However, **BCA received feedback that some stakeholders sought clearer evidence of its value and the scale of benefits that could be achieved in practice:**
 - i. **Value proposition.** The lack of quantitative information on its value proposition made the degree to which DfM considerations should be adopted in projects unclear, be it new or existing projects undergoing upgrading.
 - ii. **Short-term interest.** Those in the residential buildings (RB) space had limited motivation to incorporate long-term maintainability considerations given the immediate sale to private homebuyers.
- b. BCA therefore commissioned a DfM Consultancy Study with the primary objective of establishing the business case of DfM by analysing four local projects through a Life Cycle Costing² (LCC) approach, and considering current costs, labour intensity, and maintenance approach norms.

3. WHO WAS INVOLVED IN THE STUDY?

- a. The DfM Consultancy Study (Study) was awarded to Surbana Jurong Consultants Pte Ltd in Dec 2024, with work starting in Jan 2025.
- b. The following developers participated in the Study by offering their developments to be used as case studies:
 - i. Surbana Jurong Consultants Pte Ltd – *SJ Campus (existing commercial building w/o Mt Badge, approx. GFA ≈ 69,000 sqm);*
 - ii. CapitaLand Development – *Ascent (existing commercial building w/o Mt Badge, approx. GFA ≈ 51,500sqm);*
 - iii. Shaw Towers Realty with Lendlease as project and development manager – *Shaw Tower (new commercial building with Mt Badge, approx. GFA ≈ 52,000 sqm);*
 - iv. City Developments Limited (CDL) and Sunway MCL – *Copen Grand (new residential building with Mt Badge, approx. GFA ≈ 62,000sqm).*

² LCC is a decision-making tool to evaluate competing proposals. When a building owner, developer, or agency must choose between two or more design or construction proposals, LCC provides a structured way to compare them — not just on upfront cost, but on what each option will truly cost over its full lifespan.

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- c. The Study, completed in May 2026, **mapped the DfM features within the Mt Section onto these developments and used the LCC analysis approach to derive the potential operational cost and productivity savings** over their lifespan.
- d. More specifically, the **LCC analysis was applied on each applicable DfM feature – comprising varying service life periods** (*e.g. a façade generally last for 30 years while a chiller plant has a lifespan of 15 years*) – **for each of the buildings**. The results were then aggregated at a building level to determine the overall savings.
- e. The Study comprised research and extensive industry engagement – including with builders, trade specialists (*such as façade, cleaning, interior decoration, mechanical & electrical, and landscape contractors*), FM service providers, and designers – to obtain current costs and labour intensity data like material rates, labour cost, maintenance costs, replacement cycles, access strategies, and maintenance approach norms. These served as inputs to the LCC analysis and were used to derive productivity savings.

4. WHAT WERE THE FINDINGS AND INSIGHTS FROM THE STUDY?

- a. The summary of the findings are:
 - i. Commercial buildings
 - The additional cost of incorporating DfM was relatively modest, ranging between **0.6% and 1.5% of the initial construction cost (CAPEX)³**.
 - The potential⁴ **annual operational (OPEX)⁵ savings over their lifespan** (assumed at 30 years) ranged between \$310K and \$950K.
 - Majority of DfM measures adopted had a **payback⁶ period of less than 6 years**.
 - All DfM features studied returned productivity savings, with **many achieving productivity savings of more than 60%**.
 - ii. Private Residential Building

³ CAPEX: capital expenditure.

⁴ It is assumed that the systems/equipment are replaced at the end of their respective service life.

⁵ OPEX: operational expenditure.

⁶ Payback is the number of years it takes for the savings generated by a more expensive option to recover its additional upfront cost. It is the quickest way to gauge whether a higher-cost proposal is worth considering in an LCC analysis.

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- The additional cost of incorporating DfM measures was lower at **0.2% of the initial construction cost (CAPEX)**.
 - The potential **annual operational (OPEX) savings over its lifespan** (assumed at 30 years) was up to \$110K.
 - Majority of DfM measures had a **payback period of less than 5 years⁷**.
 - All DfM features studied returned productivity savings, with many **achieving productivity savings of more than 65%**.
- b. The study has provided valuable quantitative results to demonstrate the value proposition of DfM for new and existing buildings given the operational costs and productivity savings, with relatively modest upfront investment.
- c. For developers seeking to sell the units upon completion and building owners, the Green Mark Mt Badge provides added assurance of the asset's long-term sustainability, cost-efficient maintenance requirements and potential savings in maintenance costs.
- d. For architects and engineers, actively applying DfM considerations in projects provide greater value to your clients, and contributes to the broader efforts to transform and future-proof our BE sector.

⁷ Private residential developers would not enjoy a return on investment as the residential property is sold upon completion. This finding is shared for completeness purposes and to demonstrate the value proposition of Mt Badge to these developers which would serve as a marketability tool.

Annex B – Additional quotes from study participants

"Design for Maintainability goes beyond making buildings easier to maintain. It is about embedding long-term resilience, enhancing asset value, optimising operational performance, and creating environments that support productivity throughout the asset lifecycle. As buildings become increasingly complex, connected and data-driven, the best outcomes are achieved through the seamless integration of design, engineering, sustainability and smart facilities management from planning through to operations. At SJ Group, we believe this whole-of-lifecycle approach is essential to unlocking asset performance, reducing lifecycle costs, and delivering resilient, sustainable and future-ready development."

Praveen Hassan Chandrashekar
Regional Director (Asia)
Sustainability & Resilience Office, SJ Group

"The new Shaw Tower has been redeveloped with our beliefs in incorporating maintainability features from the outset, to support operational efficiency, sustainability and resilience that will withstand the test of time. It follows the footsteps of its predecessor, setting leading international design standards while emerging as a national icon.

We are proud to support BCA's Design for Maintainability study, which provides valuable evidence of the long-term benefits that can be achieved when maintainability is considered early in the design process. The study also reinforces our commitment to create developments that are not only sustainable and efficient today, but remain relevant and resilient for generations to come."

Alfred Yeung
General Manager
Shaw Towers Realty