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SWOT Analysis of Smart Building Implementation in the Planning of Government Centre Building in Gianyar Regency

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Abstract

The adoption of Smart Building (Bangunan Gedung Cerdas/BGC) principles in public infrastructure has become increasingly relevant in promoting energy efficiency, environmental sustainability, and user-centred design. This study examines the extent to which BGC principles have been integrated into the planning of Government Centre Building "A" in Gianyar Regency, in line with the Indonesian Ministry of Public Works Regulation No. 10 of 2023. Using a qualitative case study approach, the analysis draws upon the 2024 Detail Engineering Design (DED) prepared by the project consultant. The research applies a SWOT (Strengths, Weaknesses, Opportunities, Threats) framework to assess internal capabilities and external factors influencing the BGC implementation process. Key strengths identified include strong regulatory support and initial incorporation of automated building systems. However, budget constraints, insufficient digital infrastructure, and limited technical human resources pose significant weaknesses. Opportunities lie in the advancement of Internet of Things (IoT) technologies and growing policy momentum toward energy-efficient public buildings. Conversely, cybersecurity vulnerabilities and resistance to new technologies are recognized as potential threats. The findings offer a practical understanding of the conditions affecting smart building deployment in local government contexts. This analysis provides a valuable reference for stakeholders seeking to align smart infrastructure development with technical readiness, policy frameworks, and financial limitations.

Keywords
Smart Building, SWOT Analysis, Public Infrastructure, Government Building, Energy Efficiency.

1. Introduction
The evolution of climate change, increasing energy consumption, and advances in digital technology have driven a paradigm shift in building design, transitioning from conventional buildings to Smart Buildings (Bangunan Gedung Cerdas - BGC). BGCs are buildings designed with the integration of advanced technologies such as automation, the Internet of Things (IoT), Artificial Intelligence (AI), and Building Management Systems (BMS), enabling efficient management of lighting, temperature, security, and energy consumption through automated processes. The implementation of this concept not only aims to enhance user comfort and operational efficiency but also supports environmental sustainability and carbon emission reduction agendas.

As a form of commitment to sustainability and digital transformation in the construction sector, the Government of Indonesia has enacted Ministerial Regulation of Public Works and Housing (PUPR) No. 10 of 2023 concerning Smart Buildings. This regulation mandates specific government buildings to adhere to BGC principles, which include autonomous operation, interconnected and integrated systems, integrated energy management, cybersecurity, data-driven machine learning, and orientation toward user comfort and safety.

The Gianyar Regency Government, through its Department of Public Works and Spatial Planning (PUPR), has responded to this policy by planning the implementation of BGC principles in the development of the Gianyar Regency Government Center (Pusat Pemerintahan - Puspem). The area will be developed in stages, starting with the construction of Building A, which is designed as a shared office building with a total area of 9,785 m² and four floors. The Detailed Engineering Design (DED) for Building A was prepared in 2024 by a planning consultant, considering space requirements, the functional needs of local government organizations, and the integration of BGC principles.

Despite efforts to integrate BGC principles into the planning documents, implementation faces several challenges. These include limited construction budgets, inadequate technological infrastructure such as data communication networks and automation devices, and the lack of technical human resources capable of managing smart building systems. On the other hand, opportunities arise from increasingly affordable digital technologies, growing environmental awareness among local governments, and the long-term cost savings potential of BGC systems. Therefore, evaluating the extent to which BGC principles have been implemented and identifying the strategic factors that influence them is critically important.

Several previous studies have evaluated the implementation of smart building concepts in contexts such as government buildings in the new capital city (IKN), private offices, and academic institutions. However, regionally-contextual studies that employ strategic approaches—particularly those considering internal and external factors (SWOT) remain limited. This highlights a research gap that this study aims to address.

This study aims to analyze the implementation achievements of BGC principles in Building A of the Gianyar Government Center in accordance with Ministerial Regulation PUPR No. 10/2023, identify the strengths, weaknesses, opportunities, and threats (SWOT) affecting BGC implementation, and provide initial recommendations for the development of a contextual and sustainable BGC planning strategy within local government settings.

1.1 Objectives
This research aims to systematically evaluate the integration of Smart Building (BGC) principles in Government Centre Building "A" Gianyar Regency through comprehensive SWOT analysis. The specific objectives are:

1. To assess the compliance level of BGC elements in the planning documentation against Ministry of Public Works Regulation No. 10/2023 requirements for Non-Simple Buildings.
2. To identify internal strengths and weaknesses affecting BGC implementation readiness through systematic evaluation of technical infrastructure, regulatory compliance, and organizational capacity.
3. To analyze external opportunities and threats influencing smart building deployment in local government contexts, including technological advancement, policy environment, and market conditions.
4. To determine strategic positioning of the BGC implementation project using SWOT quadrant analysis and recommend appropriate implementation strategies.

5. To provide a practical framework for stakeholders in local government infrastructure development to align smart building initiatives with technical readiness, policy requirements, and resource constraints.

2. Literature Review

In this section, we will provide an overview of previous research that is relevant to the current study, highlighting key findings, methodologies, and theoretical frameworks that have informed and shaped this area of inquiry.

2.1 Smart Building

Buildings represent integral elements in daily life, providing shelter and facilitating various activities such as work. However, in the modern era, expectations regarding building functions have evolved far beyond merely providing physical space. Rapid technological development has transformed buildings into intelligent and connected entities capable of enhancing how humans live, work, and interact with their surrounding environment. This fundamental shift reflects an evolution in how buildings are perceived, from static structures to complex dynamic systems (Otorita Ibu Kota Nusantara, 2023).

Bangunan Gedung Cerdas (BGC) or Smart Building is not a product, but rather a design approach with forward-thinking by implementing a harmonious combination of automation, communication, and environmental planning to create suitable commercial or office buildings. In addition to all building components being designed to be more flexible and integrated, building systems are also arranged to be more economical and effective (Hendrananta & Thahir, 2019).

The smart building concept has gained significant traction, driven by business and government awareness of the transformative potential of these advanced buildings in planning, developing, operating, and maintaining the built environment. The main driver behind this evolution is rapid advances in technologies such as Internet of Things (IoT) and Artificial Intelligence (AI), which enable unprecedented levels of efficiency and responsiveness. Furthermore, the increasingly urgent need for environmental sustainability has become an important catalyst. Smart buildings are essential for creating sustainable and comfortable living spaces, in line with global sustainable development goals (Autodesk, 2025).

2.1.1 Principles of Smart Buildings

BGC principles are the foundation that must be considered in every stage of BGC implementation, managed in an integrated manner through Building Management Systems (BMS). These principles encompass the balance between humans, environment, and technology, both directly and indirectly stated. BGC principles include several aspects:

1. Automatic Operation
   BGC uses automation systems to monitor and control various elements in buildings to operate optimally, efficiently, and responsively to user needs.
2. Interconnected and Integrated
   BGC involves the use of high technology that is interconnected and integrated between elements within buildings, between buildings within areas and cities, through data communication networks.
3. Integrated Energy Management Implementation
   BGC involves using integrated energy management systems to optimize energy use by reducing unnecessary energy consumption and identifying savings opportunities. This includes utilizing renewable energy sources to minimize environmental impact from non-renewable energy source usage.
4. Cyber Threat Protection
   BGC is equipped with security systems that can protect BGC from cyber threats (hacking) both in the form of network attacks and device attacks.
5. Data Analytics and Machine Learning Usage
   BGC uses data analytics and machine learning techniques to collect, analyze, and utilize data generated by various building elements to identify problems and take appropriate actions, thus optimizing operational performance.
6. User Satisfaction Oriented
   BGC prioritizes fulfilling user needs in safety, health, comfort, convenience, and security aspects to improve user productivity and quality of life. Fulfilling these user needs can be achieved through regulating the built environment inside and around buildings, including thermal and visual environments, drinking water provision, waste and wastewater management, and user physical security, with the help of smart technology.

7. Flexible Nature
   BGC future readiness involves scalability and flexibility considerations. Infrastructure must accommodate technological advances and evolving user needs.
8. Continuous Monitoring
   Continuous monitoring and regular maintenance must be conducted to identify potential problems, optimize performance, and extend BGC system lifespan. Monitoring and maintenance SOPs can be modified according to needs.
9. Inclusive Nature
   BGC must involve all stakeholders, including building owners, managers, and users. User education and awareness raising are needed to encourage collaborative efforts in BGC implementation.

2.1.2 Elements of Smart Building

BGC elements are building component systems or features that use high technology and are integrated into Building Management Systems (BMS) to realize BGC. BMS in Smart Buildings functions to provide data regarding specific equipment or components in building systems and provide alarms if problems or disturbances occur. BMS is usually provided by building automation system service providers and can be accessed through workstations, wireless devices, and internet access.

BMS then controls BGC elements that are specifically detailed. This elaboration is necessary to create standardization of functions or capability coverage of each BGC element. According to the Ministry of Public Works and Spatial Planning Regulation No. 10 of 2023, there are 16 BGC elements as follows shown in Table 1.

Table 1. BGC Elements according to Ministry of Public Works

No	BGC Elements
1	Sistem Alarm Kebencanaan dan Pemberitahuan Massal
2	Sistem Kamera Pengawas
3	Sistem Kontrol Akses
4	Sistem Distribusi Video dan Papan Informasi Digital
5	Sistem Audio Visual
6	Sistem Jaringan Akses Kabel dan Antena Terdistribusi
7	Sistem Kelistrikan
8	Sistem Pencahayaan
9	Sistem Pengkondisian Udara
10	Sistem Ventilasi
11	Sistem Penyediaan Air Minum
12	Sistem Pengelolaan Air Limbah
13	Sistem Pengelolaan Sampah
14	Sistem Transportasi dalam Gedung
15	Sistem Parkir

16	Sistem Pengelolaan Utilitas

These 16 elements are categorized based on building complexity and requirements. For Non-Simple Buildings (Gedung Tidak Sederhana), which includes Government Centre Building "A" in Gianyar Regency, the implementation requirements are divided into three categories:

1. Mandatory Elements (Wajib): Elements 1, 2, 3, 7, 8, 9, 11, 12, and 13 - These nine elements must be implemented to ensure basic smart building functionality and regulatory compliance.
2. Recommended Elements (Disarankan): Elements 10, 14 and 16 - These elements are strongly recommended to enhance building performance and efficiency but are not mandatory for compliance.
3. Voluntary Elements (Sukarela): Elements 4, 5, 6, and 15 - These elements provide additional functionality and enhanced user experience but are optional for implementation.

2.2 Implementation of Smart Building in Various Context

The implementation of smart building concepts in various contexts has been extensively studied, providing valuable insights for this research. Several key studies demonstrate the evolution and application of smart building principles across different building types and geographical locations.

Sukendro (2024) conducted research on smart building implementation in Government Infrastructure 1A development in the New Capital City, demonstrating significant benefits including 30% energy efficiency improvement, faster maintenance response, and enhanced security through IoT-based monitoring systems. The study concluded that smart buildings provide efficient solutions for government building management with significant economic and environmental benefits. This research shares similarities with the current study in examining smart building application in government buildings, though it differs in location and methodology.

Supriyanto (2023) focused on designing Batam City Hall with green building and smart building concepts to reduce carbon emissions in architectural design. The methodology involved site surveys, climate analysis, and secondary data collection, resulting in site and form design concepts based on climate analysis, solar path analysis, and wind analysis. While both studies examine smart building implementation in government buildings, they differ in location and research methodology.

Andika et al. (2021) evaluated the application of Green and Smart Building criteria in PT. INALUM Persero office building construction using comparative analysis against Greenship assessment standards for New Buildings Version 1.2. The research achieved a Green Building assessment index of 66 points out of 101 maximum points (65.35%), earning a gold predicate according to Greenship standards. This study shares similarities in examining smart building implementation in new buildings but differs in location and methodology.

2.3 SWOT Analysis

SWOT analysis is a strategic framework widely used to evaluate the position of an entity within its internal and external environment. This section outlines the definition, components, history, benefits, limitations, and general methodology of SWOT analysis.

SWOT analysis is a strategic planning method used to evaluate "Strengths," "Weaknesses," "Opportunities," and "Threats" involved in an organization, plan, project, or business activity. This analytical instrument is known for its simplicity yet has great power in assessing resource capabilities, deficiencies, market opportunities, and external threats to an entity's future (Thompson et al., 2013).

The basic concept of SWOT analysis is rooted in the assumption that an organization's success greatly depends on its ability to align internal activities with external realities. This analysis is a systematic way to identify factors and formulate strategies that represent the best match among them. Its main objective is to maximize strengths and opportunities while minimizing weaknesses and threats. SWOT analysis is also known as SWOT Matrix or Internal-External Analysis, indicating its focus on factors from within and outside the entity (Rangkuti, 1998).

2.3.1 Components of SWOT Analysis

SWOT analysis involves four main components grouped into two dimensions: internal factors and external factors. To understand this framework more clearly, the SWOT Analysis Matrix is illustrated in Figure 1 below.

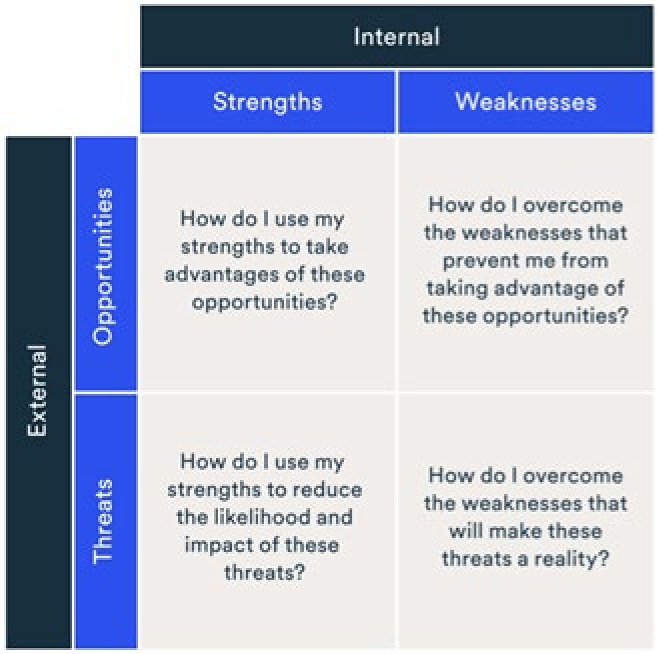

Figure 1. SWOT Analysis Matrix (BDC.ca, 2020)

Factors in SWOT are influenced by internal and external factors, each of these factors falls into two quadrants that create strengths, opportunities, weaknesses, and threats (Belal Dahiam Saif Ghaleb, 2024).

a. Internal Factors These are elements within the organization's or project's control that can be changed or managed directly.

- **Strengths**: Refer to positive internal characteristics that provide advantages or superior capabilities to the organization or project compared to competitors or industry standards. This may include resources, capabilities, or assets that make the project strong.
- **Weaknesses**: Refer to negative internal characteristics that hinder or disadvantage the organization or project. This could be resource shortages, process limitations, or areas where the project can be improved.

b. External Factors These are elements outside the organization's or project's control but have significant impact on its success or failure. Organizations must respond to these factors but cannot control them directly.

- **Opportunities**: Are favorable external factors that can be exploited to achieve project or organizational goals. This may include market trends, technological developments, or regulatory changes that are supportive.
- **Threats**: Are external factors that potentially endanger or create problems for the organization or project. This could be new competition, economic changes, or environmental risks.

By understanding these four elements, an entity can develop effective strategies to leverage strengths, overcome weaknesses, seize opportunities, and mitigate threats (Osita, 2014).

3. Methods

This section outlines the research methods employed to examine the implementation of Smart Building (Bangunan Gedung Cerdas/BGC) principles in the context of local government infrastructure planning. The methodology integrates a qualitative case study approach, contextual analysis of official planning documents, and a structured SWOT framework to evaluate strategic and technical readiness. Each subsection describes the research design, object of study, analytical tools, and evaluation criteria used to ensure a comprehensive and context-sensitive investigation of BGC implementation in Government Centre Building "A" in Gianyar Regency.

3.1 Research Approach

This study employs a qualitative approach using a case study method to analyze the implementation of Smart Building (Bangunan Gedung Cerdas/BGC) principles in the planning of Government Centre Building "A" in Gianyar Regency. This approach was selected as it enables in-depth analysis of specific project conditions and factors influencing BGC implementation within the local government context.

3.2 Research Object

The research object is Government Centre Building "A" in Gianyar Regency, which falls under the category of "Non-Simple Building" (Gedung Tidak Sederhana) according to Ministry of Public Works and Housing Regulation No. 10 of 2023. The analysis is based on the 2024 Detail Engineering Design (DED) document prepared by the project planning consultant.

3.3 SWOT Analysis Framework

This research applies a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis framework to evaluate internal conditions and external factors affecting BGC implementation. The SWOT analysis was chosen for its ability to provide a comprehensive overview of the project's strategic position and establish a foundation for developing appropriate implementation strategies.

3.4 SWOT Matrix Development

The BGC element evaluation results are then analyzed to identify internal factors (strengths and weaknesses) and external factors (opportunities and threats). Each factor is weighted based on its level of importance and impact on BGC implementation, using a 1-5 scale (1=Very Low, 5=Very High).
Table 2 presents the SWOT assessment framework used in this research, including weighting for each subfactor based on strategic importance analysis and operational impact.

3.5 SWOT Quadrant Analysis

The SWOT weighting results are plotted in a quadrant diagram to determine the strategic position of BGC implementation. The position within the quadrant guides the selection of the most suitable strategy: Quadrant I (SO) represents strategies that utilize strengths to capitalize on opportunities; Quadrant II (WO) focuses on overcoming weaknesses by leveraging available opportunities; Quadrant III (WT) aims to minimize weaknesses and avoid potential threats; and Quadrant IV (ST) involves using strengths to mitigate or avoid threats. This quadrant-based analysis serves as the foundation for developing strategic recommendations that are contextually appropriate for the implementation of Smart Building principles in Government Centre Building "A" of Gianyar Regency.

Table 2. SWOT Quadrant Scoring Table *)

Factor		Subfactor	Weight (%)	Score (1–5)	Weighted Score	Total (Max = 5)	Average
Internal	Strengths	Electrical system with high compliance (92%) supporting core infrastructure	25%	5	1.25	4.15	0.83
		Integrated air conditioning system with automatic control	20%	5	1.00		
		Digital access control system with adequate cybersecurity	25%	4	1.00		
		Surveillance camera system with open standard communication protocol	20%	4	0.80		
		Explicit and well-defined regulatory support provided by Ministry of Public Works and Housing Regulation No. 10/2023	10%	3	0.30		
	Weaknesses	Waste management system is suboptimal (64% compliance)	25%	2	0.50	2.25	0.45
		Disaster alarm system still has documentation gaps	20%	3	0.60		

		Lighting infrastructure is not fully integrated	20%	3	0.60		
		Wastewater management system requires technical improvements	20%	2	0.40		
		Limited technical human resources for managing integrated systems	15%	3	0.45		
External	Opportunities	Growth of IoT and building automation technologies	30%	5	1.50	3.80	0.76
		Government policy momentum supporting green building initiatives	25%	4	1.00		
		Potential implementation of high-performing voluntary systems	25%	4	1		
		Support from the building automation technology industry	20%	3	0.60		
	Threats	Cybersecurity risks in integrated systems	30%	4	1.20	3.05	0.61
		Budget limitations for full BGC implementation	25%	4	1.00		

		Complexity of system integration requiring continuous maintenance	25%	3	0.75		
		Dependency on technology vendors and technical support	20%	3	0.60		

*) The scoring system uses a scale of 1 to 5, where 1 indicates Very Low, 2 = Low, 3 = Moderate, 4 = High, and 5 = Very High. Each factor is assigned a weight based on its level of importance and impact on the implementation of Smart Building (BGC) principles. The total and average weighted scores are then used to determine the position of each factor within the SWOT quadrant, serving as the basis for formulating appropriate development strategies.

4. Data Collection

This research employs a document-based data collection approach, focusing on systematic analysis of technical planning documentation to assess BGC element compliance. The primary data source is the Detail Engineering Design (DED) document of Government Centre Building "A" Gianyar Regency, prepared in 2024 by the appointed project planning consultant.

4.1 Primary Data

The DED serves as the comprehensive technical planning document containing detailed specifications, system designs, and implementation plans for all building components. Figure 2 below shows the sample of the Building A DED (Figure 2 and Table 3).

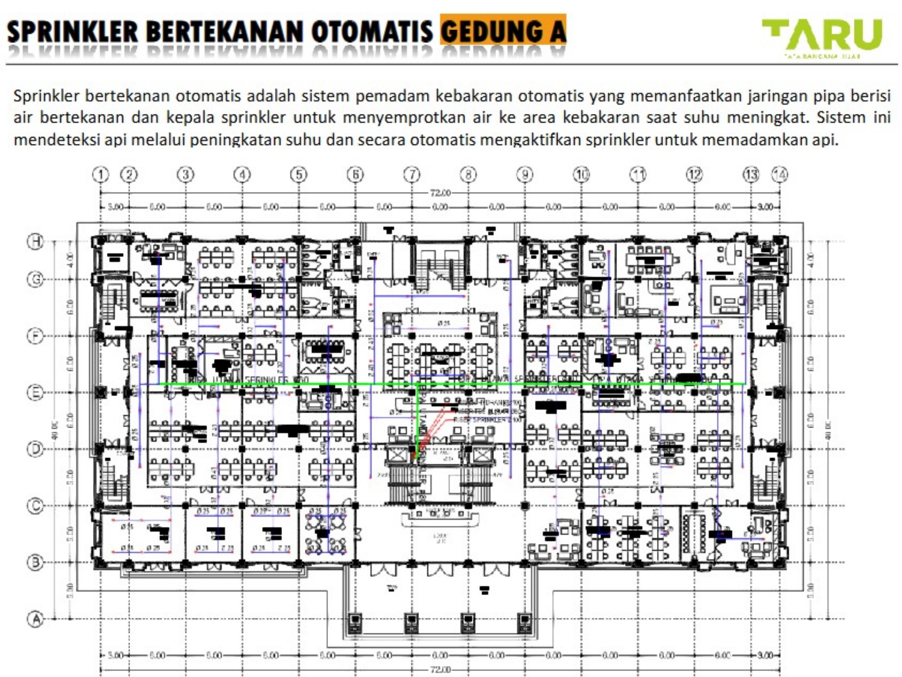

Figure 2. Building A Detailed Engineering Design (DED)

Table 3. BGC Element Checklist Samples

No	Elemen BGC	Parameter	Sub Nomor	Kriteria Unjuk Kerja	Ketentuan	Tahap Perencanaan Teknis	Kelengkapan
1	Sistem Alarm Kebencanaan dan Pemberitahuan Massal	Keamanan Siber	1.1	Memiliki sistem kendali akses jaringan pada level kontroler*	Akan dilihat dari ketersediaan referensi Datasheet kemampuan/fitur kontroler dalam menerapkan security login (hak akses)	Datasheet kontroler mengenai security login	Tercantum dan Sesuai (TS)
	Sistem Alarm Kebencanaan dan Pemberitahuan Massal	Keamanan Siber	1.2	Data disimpan di pusat data yang aman untuk mencegah data yang tidak sah*	Akan dilihat dari arsitektur layanan teknologi informasi	Gambar arsitektur layanan teknologi informasi dan RKS	Tercantum namun tidak Sesuai (TTS)
	Sistem Alarm Kebencanaan dan Pemberitahuan Massal	Keamanan Siber	1.3	Penerapan event logging*)	Akan dilihat dari alur penerapan event logging pada RKS	Alur penerapan event logging pada RKS	Tidak Tercantum (TC)
	Sistem Alarm Kebencanaan dan Pemberitahuan Massal	Protokol dan Jaringan Komunikasi	1.4	Semua protokol komunikasi utama (kontroler dan BAS) memiliki versi untuk TCP/IP?	Akan dilihat dari referensi datasheet tipe protokol komunikasi yang menggunakan protokol TCP/IP	Datasheet kontroler mengenai jaringan protokol komunikasi ke pusat data	Tercantum dan Sesuai (TS)
	Sistem Alarm Kebencanaan dan Pemberitahuan Massal	Protokol dan Jaringan Komunikasi	1.5	Memiliki protokol komunikasi standar terbuka seperti BACnet IP, LonTalk, OPC DA/UA, Modbus RTU/TCP, oBIX, SNMP, OLE, IP dan/atau protokol standar terbuka lain?	Akan dilihat dari referensi datasheet protokol komunikasi hardware	Datasheet kontroler mengenai jaringan protokol komunikasi ke kontroler	Tercantum dan Sesuai (TS)

This document represents the official planning blueprint that guides the construction and system installation phases of the project. The DED was selected as the primary data source because it contains the most detailed and authoritative information regarding the planned implementation of BGC elements in accordance with regulatory requirements.

Secondly, each BGC element is evaluated using a three-tier assessment system that considers the presence and quality of documentation within the Detail Engineering Design (DED). The first category, TS (Tercantum dan Sesuai/Stated and Compliant), indicates that the element is clearly stated in the document and meets the performance criteria established in the regulation. The second category, TTS (Tercantum namun tidak Sesuai/Stated but Non-Compliant), refers to elements that are mentioned in the document but either do not meet the required criteria or lack sufficient detail. The third category, TC (Tidak Tercantum/Not Stated), applies to elements that are entirely absent from the planning documentation. This assessment system provides an objective framework for evaluating the implementation readiness of each BGC element based on the available technical design documentation. This evaluation is presented on Table 3 above.

4.2 Data Collection Steps

The data collection process was conducted through systematic document review and analysis following these steps:

Step 1: Document Acquisition Official DED documents were obtained through formal channels from the project management office of Gianyar Regency Government. The documents were provided in digital format, ensuring access to all relevant sections and technical drawings.

Step 2: Document Categorization The DED document was systematically organized by BGC element categories to facilitate comprehensive analysis. Each of the 16 BGC elements was mapped to corresponding sections within the DED documentation.

Step 3: Systematic Review Process A structured review process was implemented to evaluate each BGC element against the performance criteria established in Ministry Regulation No. 10 of 2023. This involved:

- Identification of relevant documentation sections for each BGC element
- Cross-referencing technical specifications with regulatory requirements
- Assessment of completeness and clarity of implementation plans
- Documentation of compliance gaps and areas requiring clarification

Step 4: Compliance Assessment Each performance criterion for all 16 BGC elements was evaluated using the three-tier assessment framework:

- TS (Tercantum dan Sesuai): Clear documentation meeting regulatory requirements
- TTS (Tercantum namun tidak Sesuai): Mentioned but lacking detail or clarity
- TC (Tidak Tercantum): Complete absence from documentation

5. Results and Discussion

In this section we will explain the results of the assessment and discuss the findings.

5.1 Results

The evaluation of 16 BGC elements based on the 2024 Detail Engineering Design (DED) document reveals varying levels of implementation readiness across different system categories. A total of 198 performance criteria were assessed using the TS/TTS/TC framework, providing a comprehensive overview of the project's BGC compliance status.

Among the nine mandatory elements for Non-Simple Buildings, four elements demonstrate strong compliance levels exceeding 80%. The Sistem Kelistrikan (Element 7) shows the highest compliance at 92%, followed by Sistem Pengondisian Udara (Element 9) at 91%. Sistem Kontrol Akses (Element 3) achieves 85% compliance, while Sistem Kamera Pengawas (Element 2) reaches 81% compliance. Table 4 shows how the mandatory elements result (Table 4).

Table 4. Element content

No	Elemen BGC	Kategori	Total Criteria	TS	TTS	TC	Compliance (%)	Status
1	Sistem Alarm Kebencanaan dan Pemberitahuan Massal	Wajib	14	10	2	2	71%	Moderate
2	Sistem Kamera Pengawas	Wajib	16	13	2	1	81%	Strong
3	Sistem Kontrol Akses	Wajib	13	11	1	1	85%	Strong
4	Sistem Distribusi Video dan Papan Informasi Digital	Sukarela	12	9	2	1	75%	Good
5	Sistem Audio Visual	Sukarela	10	8	0	2	80%	Strong
6	Sistem Jaringan Akses Kabel dan Antena Terdistribusi	Sukarela	12	10	0	2	83%	Strong
7	Sistem Kelistrikan	Wajib	12	11	0	1	92%	Excellent
8	Sistem Pencahayaan	Wajib	11	8	2	1	73%	Moderate
9	Sistem Pengkondisian Udara	Wajib	11	10	1	0	91%	Excellent
10	Sistem Ventilasi	Disarankan	13	8	4	1	62%	Moderate
11	Sistem Penyediaan Air Minum	Wajib	13	10	2	1	77%	Good
12	Sistem Pengelolaan Air Limbah	Wajib	11	8	3	0	73%	Moderate
13	Sistem Pengelolaan Sampah	Wajib	11	7	1	3	64%	Weak
14	Sistem Transportasi dalam Gedung	Disarankan	12	0	4	8	0%	Weak

15	Sistem Parkir	Sukarela	14	7	5	2	50%	Weak
16	Sistem Pengelolaan Utilitas	Disarankan	13	6	3	4	46%	Weak
	TOTAL		**198**	**148**	**32**	**30**	**75%**	**Overall Good**

The compliance status is categorized into five levels based on percentage thresholds. A compliance rate of 90% or above is considered Excellent, indicating a very high level of adherence. Strong compliance is defined as achieving between 80% and 89%, while a rate between 70% and 79% is categorized as Good. A Moderate status reflects a compliance rate of 60% to 69%, and any rate below 60% is classified as Weak, indicating significant room for improvement (Table 5).

Table 5. Category Summary

Category	Elements	Average Compliance	Category Status
Wajib	9	79%	Good
Disarankan	2	54%	Moderate
Sukarela	4	72%	Good

The compliance analysis reveals that four elements achieved high performance levels (≥80%), consisting of two mandatory and two voluntary elements. Meanwhile, five elements were identified as requiring improvement (<70%), including two mandatory, two recommended, and one voluntary element. The largest compliance gap was found in the Waste Management System, with a 36% gap. On the other hand, the best-performing element was the Electrical System, which achieved a compliance rate of 92%.

5.2 Discussions

The analysis reveals that Government Centre Building "A" demonstrates moderate to high readiness for BGC implementation. The strong performance in core infrastructure systems (electrical, HVAC, security) provides a solid foundation for smart building development. However, significant gaps in waste management, emergency systems, and utility management require immediate attention to ensure regulatory compliance.

The high compliance rates in voluntary elements suggest that the planning process has considered enhanced functionality beyond minimum requirements, indicating commitment to comprehensive smart building development. Several factors emerge as critical for successful BGC implementation. Technical infrastructure readiness, evidenced by strong electrical and HVAC systems, provides the necessary foundation for smart building technologies. Regulatory compliance in mandatory elements ensures legal conformity and operational approval.

The availability of external opportunities, particularly IoT technology advancement and policy support, creates favorable conditions for implementation. However, addressing human resource capacity and budget constraints remains essential for long-term success.

The identified threats require proactive mitigation approaches. Cybersecurity risks demand comprehensive security protocols, regular system audits, and staff training programs. Budget constraints necessitate phased implementation strategies and creative funding approaches, potentially including public-private partnerships.

Technical complexity risks can be mitigated through strategic vendor partnerships, comprehensive staff training, and robust maintenance agreements. Vendor dependency risks require diversified supplier strategies and in-house technical capacity development.

This analysis provides valuable insights for local government smart building initiatives. The successful implementation of BGC principles in Government Centre Building "A" can serve as a model for other public infrastructure projects in the region. The strategic approach demonstrates how local governments can balance regulatory compliance, technical feasibility, and budget constraints in smart building development.

The findings suggest that local governments can achieve significant smart building implementation success by focusing on infrastructure foundations, leveraging policy support, and adopting phased development approaches that build upon existing strengths while systematically addressing weaknesses.

6. Conclusions

This SWOT analysis of Smart Building (BGC) implementation in Government Centre Building "A" Gianyar Regency reveals that the project demonstrates strong implementation potential with strategic positioning in Quadrant I (0.36; 0.14), indicating internal strengths outweigh weaknesses while external opportunities exceed threats. The evaluation of 16 BGC elements shows four mandatory systems achieving high compliance (Sistem Kelistrikan 92%, Sistem Pengondisian Udara 91%, Sistem Kontrol Akses 85%, Sistem Kamera Pengawas 81%), providing robust infrastructure foundations, while five mandatory elements present compliance gaps requiring attention, particularly Sistem Pengelolaan Sampah (64% compliance). Key strengths include strong regulatory support from Ministry Regulation No. 10/2023 and automated building systems integration, while weaknesses encompass budget constraints, insufficient digital infrastructure, and limited technical human resources. Opportunities lie in IoT technology advancement and growing policy momentum toward energy-efficient public buildings, whereas threats include cybersecurity vulnerabilities and technology adoption resistance. The SO Strategy (Strength-Opportunity) positioning recommends leveraging existing technical foundations to capitalize on favorable external conditions through system integration optimization, digital infrastructure development, and phased implementation approaches. This analysis provides stakeholders with practical understanding of conditions affecting smart building deployment in local government contexts, offering valuable reference for aligning smart infrastructure development with technical readiness, policy frameworks, and financial constraints while demonstrating that systematic SWOT evaluation can enhance BGC implementation success in public infrastructure projects.

References

Andika, N., Rachman, A. and Sari, R., ‘Evaluasi Penerapan Kriteria Green and Smart Building pada Proyek Pembangunan Gedung Kantor PT. INALUM Persero’, *Jurnal Arsitektur dan Perencanaan*, 5(2), pp. 101–110, 2021. *Available at:* https://doi.org/10.51510/agregat.v1i1.58.

Autodesk, ‘Smart Buildings | Technology Trends and Innovations’ 2025.

BDC.ca, SWOT analysis: An easy tool for strategic planning, BDC.ca, 2020. Available at: https://www.bdc.ca/en/articles-tools/business-strategy-planning/define-strategy/swot-analysis-easy-tool-strategic-planning (Accessed: 17 July 2025).

Belal Dahiam Saif Ghaleb, ‘The Importance of Using SWOT Analysis in Business Success’, *International Journal of Asian Business and Management*, 3(4), pp. 557–564, 2024. Available at: https://doi.org/10.55927/ijabm.v3i4.10857.

Hendrananta, S. and Thahir, A., ‘Smart Building: Konsep dan Implementasi’, *Jurnal Teknologi dan Manajemen*, 8(1), pp. 15–25, 2019.

Osita, I., ‘Organization’s Stability and Productivity: The Role of SWOT Analysis an Acronym for Strength, Weakness, Opportunities and Threat’, International Journal of Innovative and Applied Research, 2, pp. 23–32, 2014.

Otorita Ibu Kota Nusantara (IKN), ‘Smart Building Guideline’, 2014. *Available at:* https://www.ikn.go.id/storage/thd/smart-building-books/smart-building-guideline-eng-b5-200923.pdf *(Accessed: 17 July 2025).*

Rangkuti, F., *Analisis Swot Teknik Membedah Kasus Bisnis*. Gramedia Pustaka Utama, 1998.

Sukendro, A., ‘Smart Building Pada Pembangunan Sarana Prasarana Pemerintahan 1A di Ibu Kota Negara’, *Jurnal Pembangunan Infrastruktur*, 10(1), pp. 90–100, 2024.

Supriyanto, M., ‘Perancangan Gedung Balai Kota Batam dengan Penerapan Konsep Green Building dan Smart Building’, *Jurnal Arsitektur dan Rekayasa*, 9(2), pp. 75–85, 2023.

Thompson, A., *EBOOK: Crafting and Executing Strategy: The Quest for Competitive Advantage: Concepts and Cases*. McGraw Hill, 2013.

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I Made Dwi Putra Giri Sujana is a graduate student in the Master of Infrastructure and Environmental Engineering Program at Warmadewa University, Denpasar, Bali, Indonesia. He holds a Bachelor's degree in Architecture from Udayana University and has accumulated years of professional experience in the construction industry, contributing to a wide range of development projects in both the public and private sectors across Indonesia. His expertise includes managing complex and large-scale construction initiatives, where he collaborates effectively with multidisciplinary teams to ensure the successful delivery of each project. He is also a certified construction professional, holding a Construction Work Competency Certificate (SKK) as a Junior Expert in Occupational Health and Safety (K3) for Construction. His technical knowledge, combined with hands-on experience, underscores his commitment to promoting safety, sustainability, and innovation within Indonesia's built environment.

Putu Aryastana is a dedicated lecturer and researcher at the Department of Civil Engineering, Warmadewa University, Denpasar, Bali, Indonesia. His academic journey reflects a strong commitment to advancing interdisciplinary knowledge in the fields of infrastructure, water resources, and environmental sustainability. His scholarly work has been published in reputable journals and conference proceedings, with notable recognition for his study on the validation of satellite precipitation data over Bali Island, which has been widely cited and applied in environmental monitoring efforts. Aryastana integrates advanced geospatial technologies and modeling methods to support sustainable urban and regional planning in Indonesia. As a lecturer, his passion lies not only in research but also in shaping future engineers and environmental scientists who are capable of addressing the complex challenges faced by Indonesia's rapidly developing regions.

Ni Wayan Meidayanti Mustika is a dedicated lecturer and researcher in the Department of Architecture at Warmadewa University, Denpasar, Bali, Indonesia. She focuses her career on advancing sustainable and culturally contextualized architectural practices in Indonesia, particularly in Bali. Her research interests encompass green building, traditional Balinese architecture, thermal comfort, and environmentally responsive design. She has been actively involved in numerous studies that bridge traditional knowledge with modern sustainability principles. One of her notable works includes a preliminary study on green materials for green buildings in Bali, which emphasizes the use of local, eco-friendly resources in construction. She also led a recent study on the determining factors for green building certification in Bali, exploring how socio-cultural and environmental factors influence sustainable building practices in the region. Her other scholarly contributions include investigations into the acoustic environment of public spaces and thermal comfort in historical water palace architecture, such as Tirta Gangga. As an educator, she is committed to mentoring future architects who are environmentally conscious and culturally rooted in their design approach.