OPEN ACCESS
Global Journal of Research in Engineering & Computer Sciences
ISSN: 2583-2727 (Online)
Volume 06 | Issue 01 | Jan.-Feb. | 2026
Journal homepage: https://gjrpublication.com/gjrecs/
Research Article

Structural Diagrams and Stages of Smart Hotel Operations (WBS)

*Asmaa Mutar Jaber

Department of Civil Engineering, College of Engineering, Al-Muthanna University, Samawah, Iraq.

DOI: 10.5281/zenodo.18259007 **Submission Date:** 29 Nov. 2025 | **Published Date:** 15 Jan. 2026

Abstract

This research examines how any component of technology used in the hotel and tourism sector can be systematically planned and delivered. The case study chosen is smart hotels for the survey; a modern solution that saves time and effort, enhances on-site tourism, promotes investment, and improves customer satisfaction. The goal is to design a schedule division structure to support the implementation of smart hotels. This research employs a work-breakdown/schedule-division analysis to decompose the smart-hotel project into 14 hierarchical levels, mapping its activities, responsibilities, and sequence. Level 1 is defined by seven macro-stages: licensing, general preparation, concrete structure construction, installation of smart devices and protection systems, system testing, operation and maintenance planning, and acceptance/finishing. The licensing and design approvals at Level 2 (including approvals from the Ministries of Defense, Interior, Antiquities, etc.) encompass preparation and approval of engineering drawings and hotel designs. Preliminary site-related preparation includes establishing temporary offices for engineers, technicians, and workers, as well as providing electricity, water, and internet/communication services. Level 4 organizes supplier/provider lists, clarifies authorities and responsibilities, and distributes tasks to project engineers. The novelty of the work is a practical, finely grained scheduling design for smart hotels that can be adopted as a planning template to reduce implementation uncertainty and strengthen project control.

Keywords: *Smart hotel; Scheduling; Work Breakdown Structure; Structural Diagrams.*

1. Introduction

Innovative technologies are gaining traction in the hospitality industry, integrating sensing, automation, connectivity, and data-driven services to improve operational performance and guest experience. Previous research on innovative environments shows that technology adoption affects service efficiency and resource utilization [1]. At the same time, usability and human-technology interaction are critical for the success of deployment [2]. Intelligent systems at the building level are also related to indoor environmental quality and operational performance. Technical solutions and their contribution to project delivery planning must be aligned [3-4]. Simultaneously, innovative environments raise practical concerns regarding system reliability, cyber threats, privacy, and safety, which have been widely discussed in monitoring, protection, and security-oriented deployments [5-6]. Innovative hotel systems heavily rely on integrated monitoring and control architectures [7-8]. Additionally, they must work together with conventional building services and finishing works to ensure an integrated whole [9]. Moreover, it is often needed to intelligently interpret sensor data and contextual cues to infer activities and respond accordingly. In contrast, innovative capabilities need the service workflows and information exchange mechanisms to create guest-facing value [11]. In conclusion, continuous performance requires clear procedures for the operation, maintenance, and training of human staff to sustain system operation over the long term [12].

Although there is a growing literature on smart hotels, this body of work provides limited guidance on how to plan and schedule delivery through a structured, end-to-end implementation program. Although many studies highlight the functions of technology – monitoring, control, sensing, security, intelligent response [5-12], they give less guidance on a fine-grained, hierarchical schedule division/work-breakdown structure to suit the particular context of the hotel. The gap

 *Corresponding author: **Asmaa Mutar Jaber**

is critical because smart-hotel delivery involves multiple stakeholders and approval pathways, with coordination across licensing, civil works, finishes, systems integration, testing, training, and handover.

To address this gap, the research proposes a schedule division structure for smart hotels comprising 14 stages. Level 1 shall consist of 7 macro-stages: granting of the license, general preparations, construction of the concrete structure, installation of smart devices and protection systems, systems testing, operation and maintenance planning, and acceptance/finishing [2]. The following levels decompose these phases into actions, including multi-agency approvals and design authorizations [3], and early site work and service provision, planning supplier lists, authorities and responsibilities, task allocations, schedules, and budgets [4]. The latter stages address on tools and communication systems [5], execution and related works [6-8], finishing and integration of building services [9], installation of intelligence and protection systems [10], configuration of innovative service/workflow system [11], operation, maintenance and training requirements [12], and finally the handover and guarantee [5-7].

The rest of the paper is structured as follows: Section 2 presents the methodology and analytical approach; Sections 3 and 4 discuss the proposed multi-level schedule division structure; and Section 5 presents the key implications and recommendations.

2. Methodology

The researcher created the study; the brainstorming process aimed to collect the necessary data and information on the development of new hotels as shown in Figures 1-5. The researcher analyzed the data using a cost-benefit analysis, comparing conventional hotels with smart hotels. Mind mapping was also used to present the data, and the researcher relied on decision-making techniques, voting, and feedback from specialists in the field to reach conclusions.

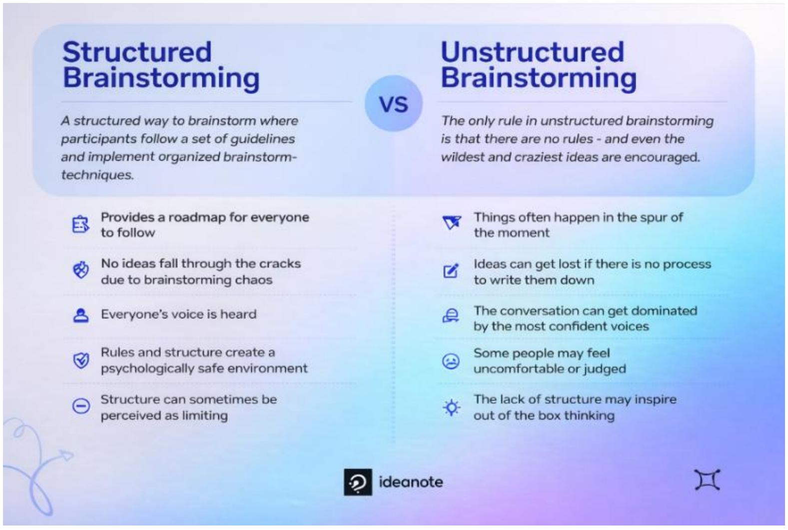

Figure (1): Structured vs. Unstructured Brainstorming: A Comparison

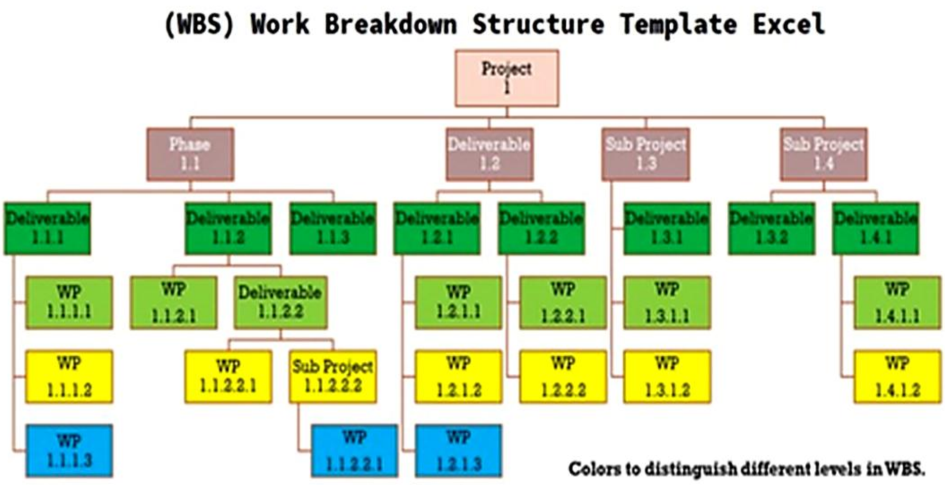

Figure (2): Work Breakdown Structure (WBS) for the Project

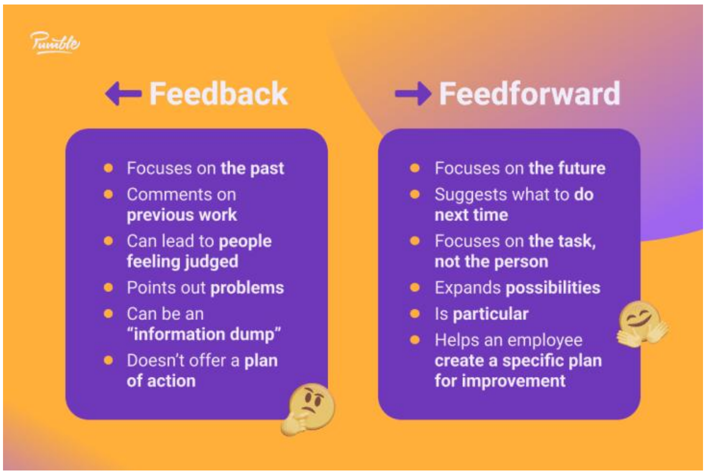

Figure (3): Comparative Framework for Brainstorming Methodologies in Research Design

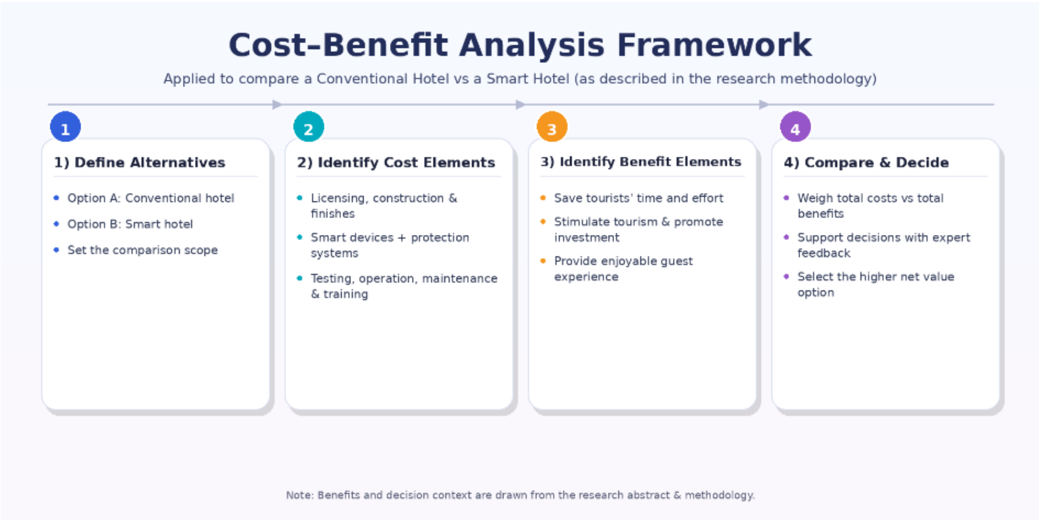

Figure (4): Cost–Benefit Analysis Framework for Comparing Conventional and Smart Hotels

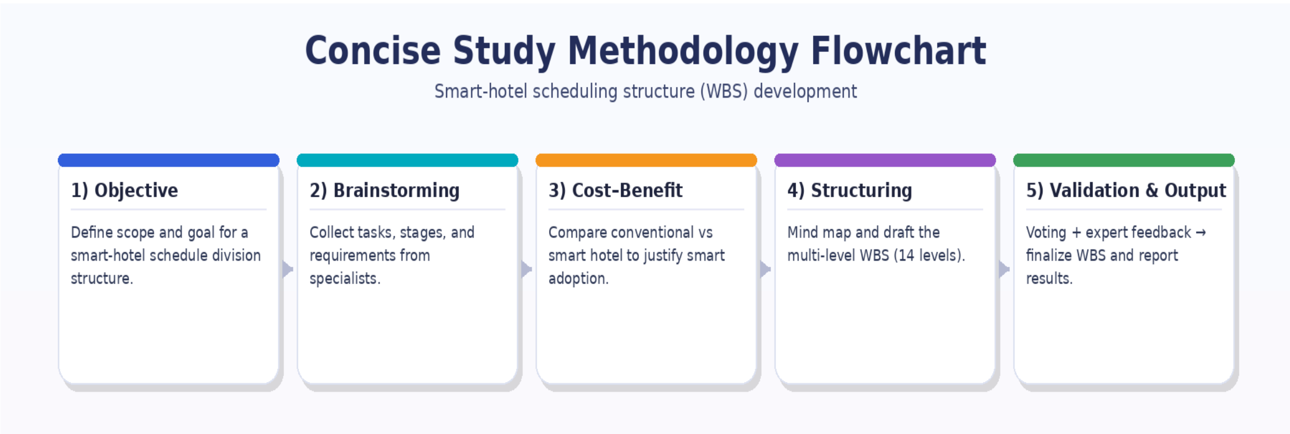

Figure (5): Research Methodology Flowchart

3. Results

Stages of developing scheduling for building a smart hotel can be listed as following:

1. Work breakdown structure (WBS) level 1 can be illustrated in Figure 6.

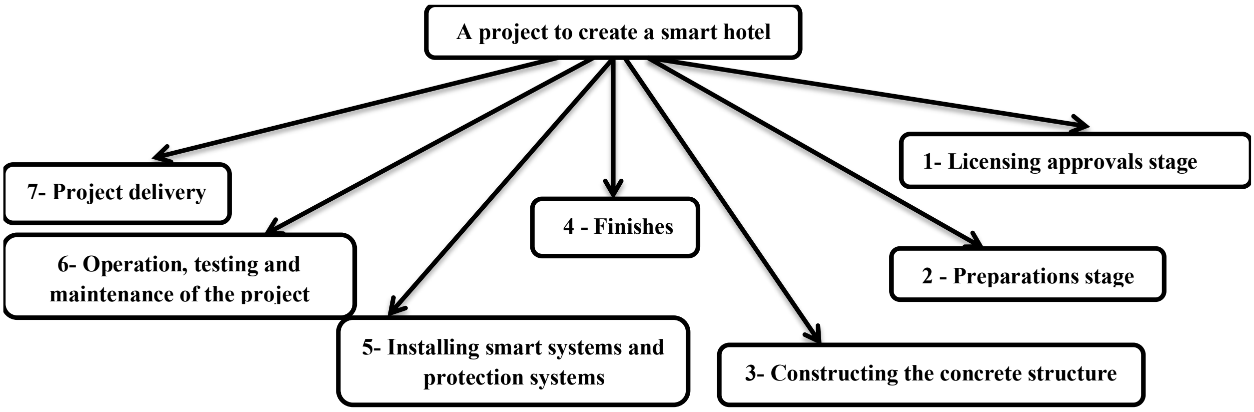

Figure (6): Work Breakdown Structure (WBS) – Level 1: Overall Smart Hotel Project

Level 1 comprises seven stages: granting licenses; general preparations for the construction of the concrete structure; installation of smart devices and protection systems; testing of the systems; guidance on their operation and maintenance; and acceptance and completion.

2. Work breakdown structure level 2 can be shown in Figure 7.

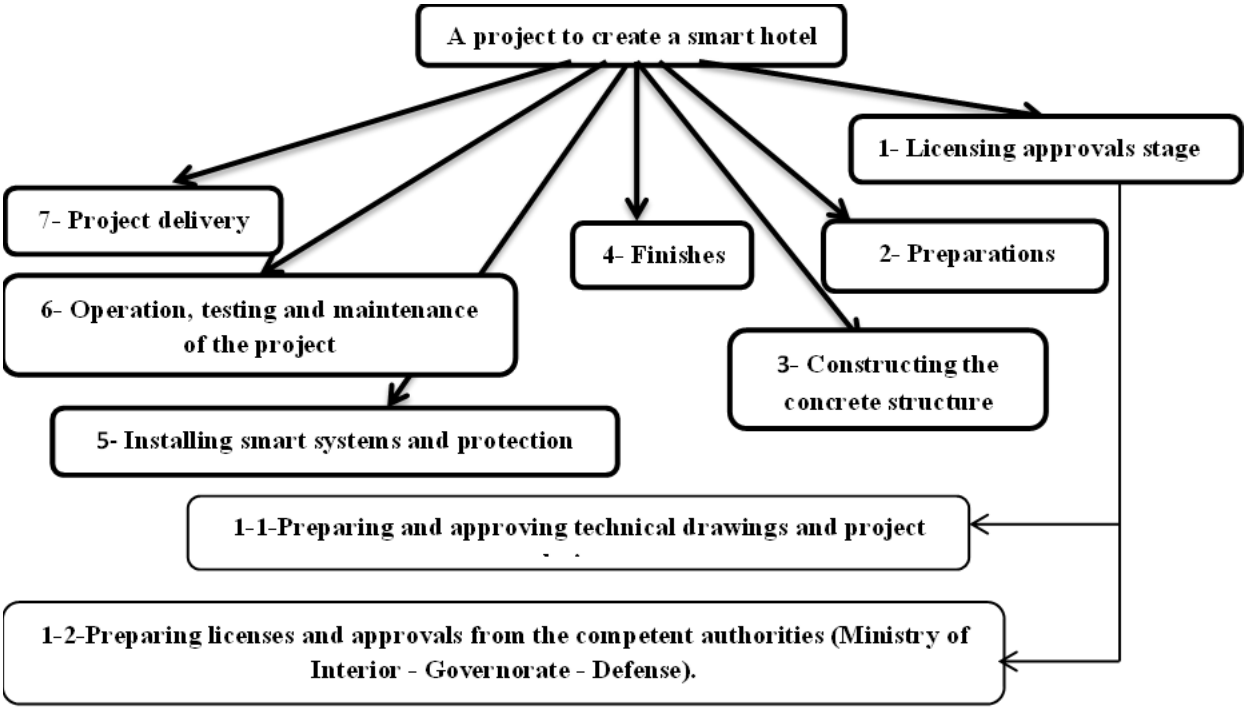

Figure (7): Work Breakdown Structure (WBS) – Level 2: Licensing and Approvals

The second level of the hotel comprises seven stages, the first of which is the Ministry of Defense, Interior, and Antiquities' approval of licenses, including approval for the preparation and review of the hotel's engineering drawings and designs.

3. Work breakdown structure level 3 can be shown in Figure 8.

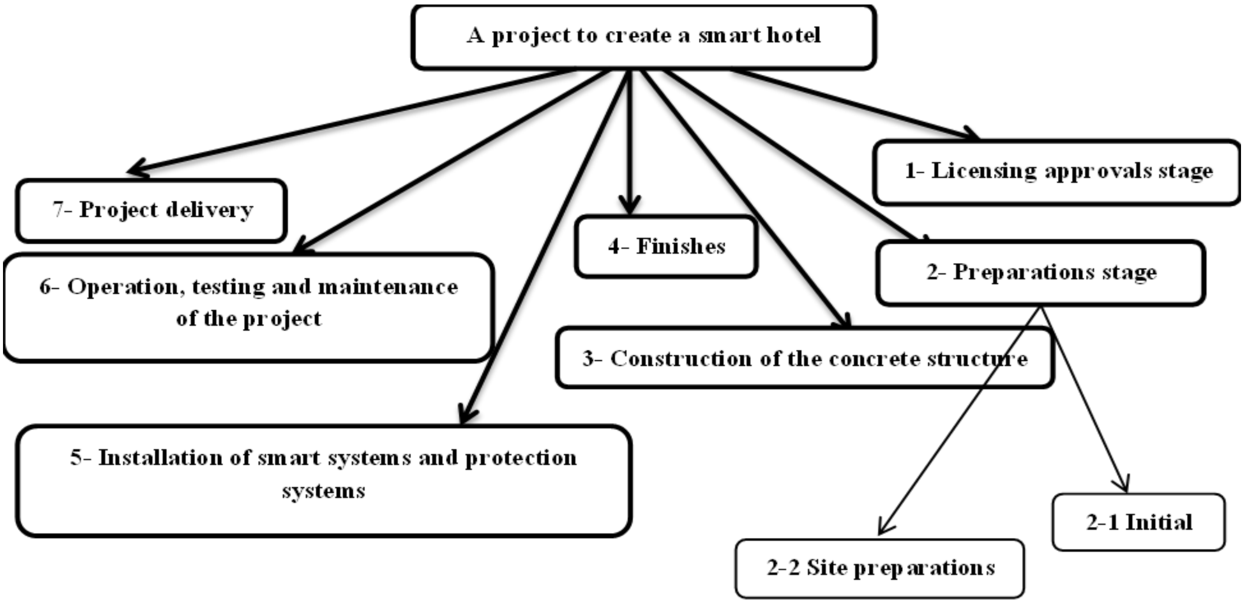

Figure (8): Work Breakdown Structure (WBS) – Level 3: Initial and Site Preparations

The third level of the divisional structure includes initial site preparations, such as temporary office space for engineers, technicians, and site workers, as well as preparations for electricity, water, fax, and internet.

4. Work breakdown structure is comprehensive 4 can be illustrated in Figure 9.

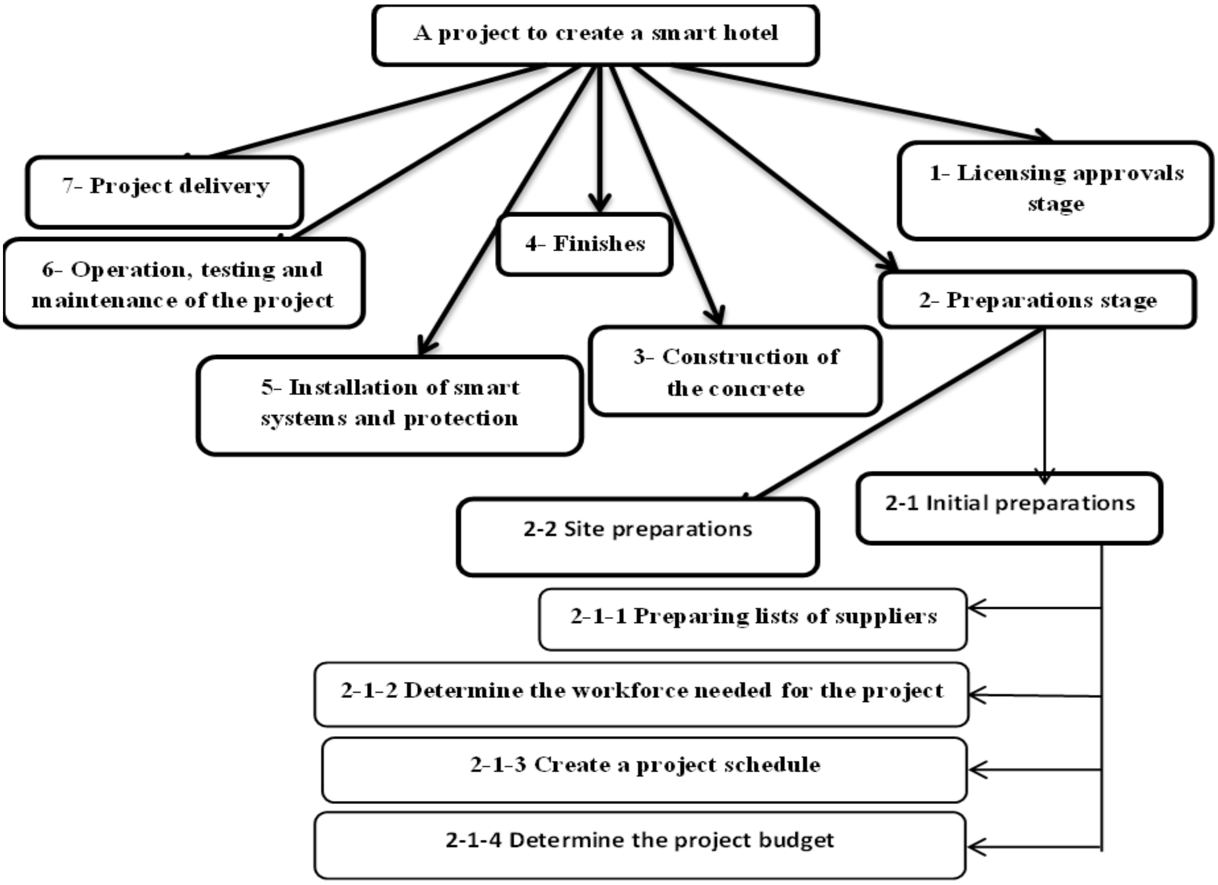

Figure (9): Work Breakdown Structure (WBS) – Level 4: Planning, Resources, and Budget

The fourth phase of the project, after the completion of temporary works, involves preparing a list of suppliers and providers, defining authorities and responsibilities, distributing tasks among project staff (engineers, technicians, administrators, and workers), developing a preliminary timeline, and determining and monitoring the project budget.

5. Work breakdown structure level 5 can be shown in Figure 10.

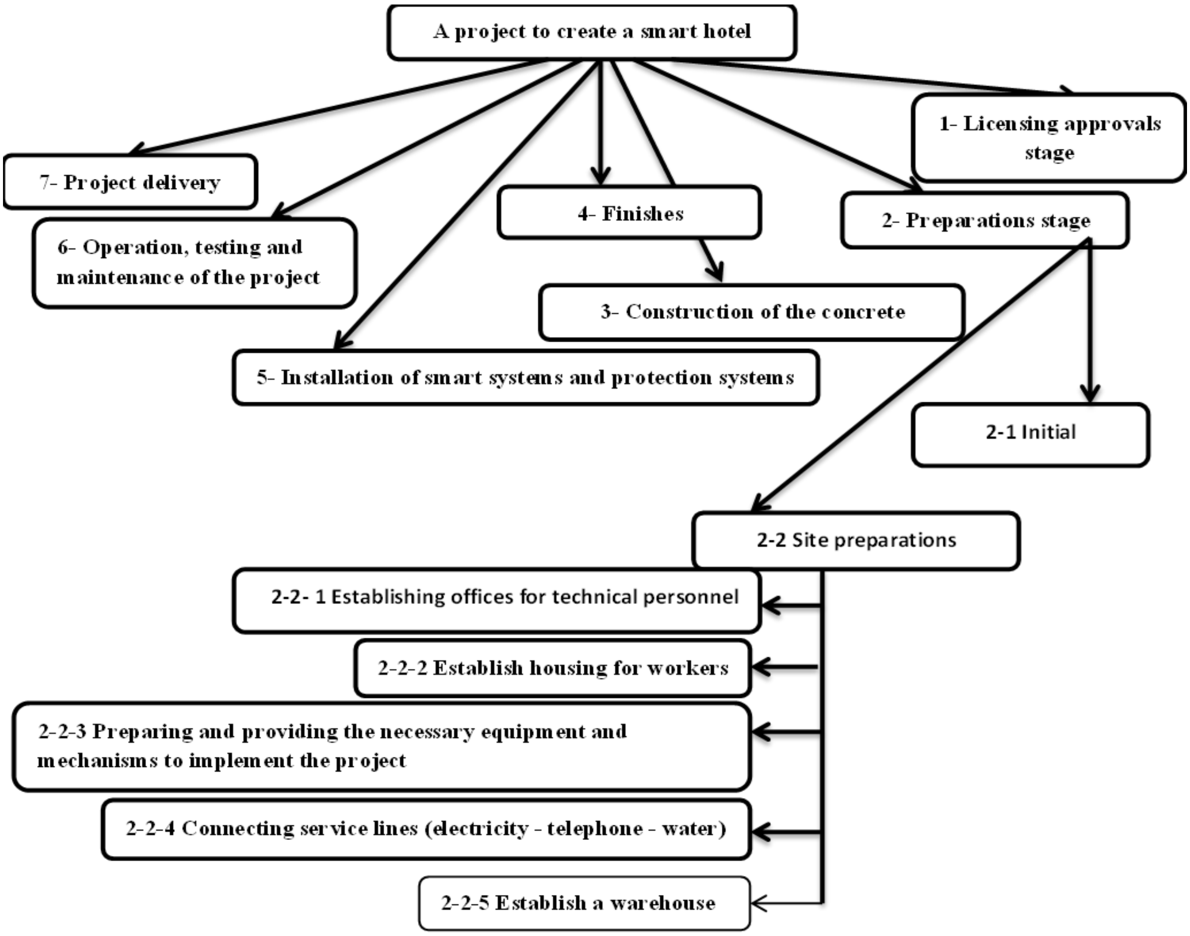

Figure (10): Work Breakdown Structure (WBS) – Level 5: Equipment and Site Facilities

The fifth phase includes providing the necessary equipment and machinery for the project, as well as communication tools.

6. Work breakdown structure level 6 can be depicted in Figure 11.

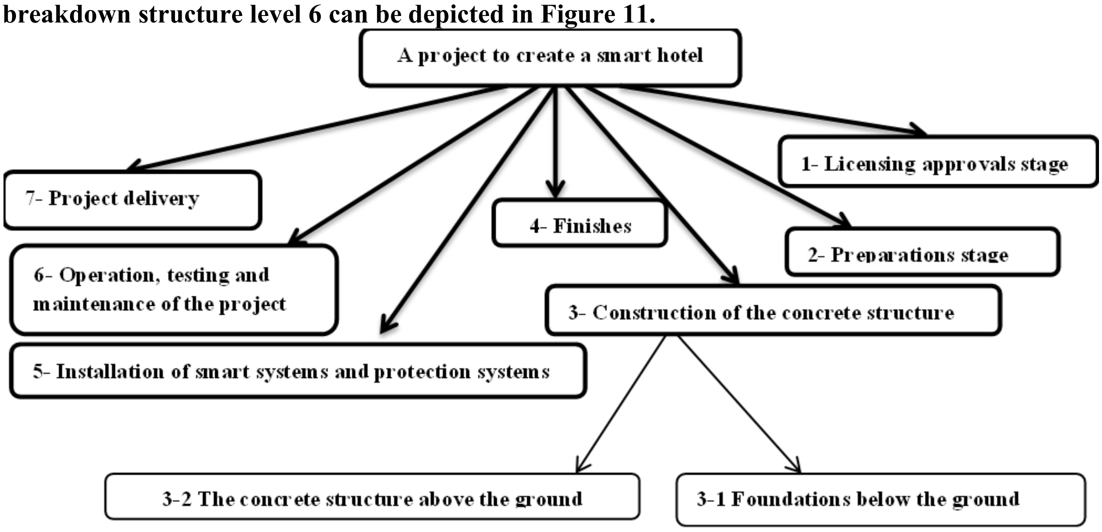

Figure (11): Work Breakdown Structure (WBS) – Level 6: Concrete Structure Construction

The sixth stage involves commencing the construction of the concrete structure, both underground and above ground.

7. Work breakdown structure level 7 can be shown in Figure 12.

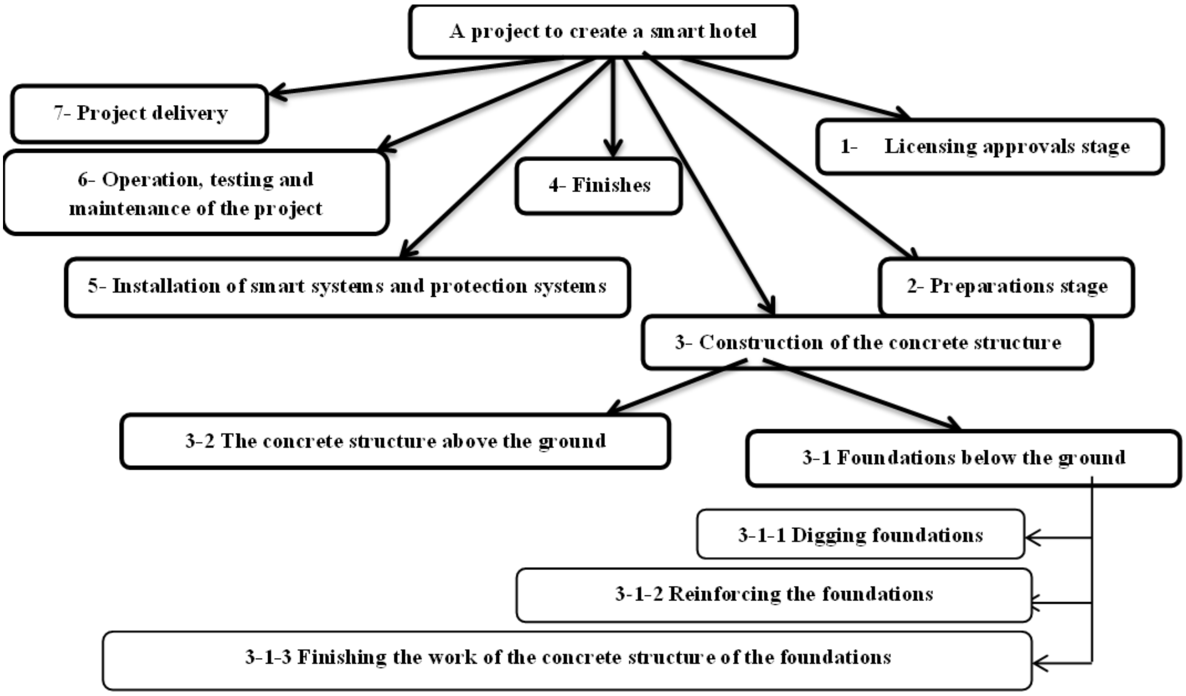

Figure (12): Work Breakdown Structure (WBS) – Level 7: Foundation Works

Phase seven includes earthworks for the foundation and foundation reinforcement works.

8. Work breakdown structure level 8 can be presented in Figure 13.

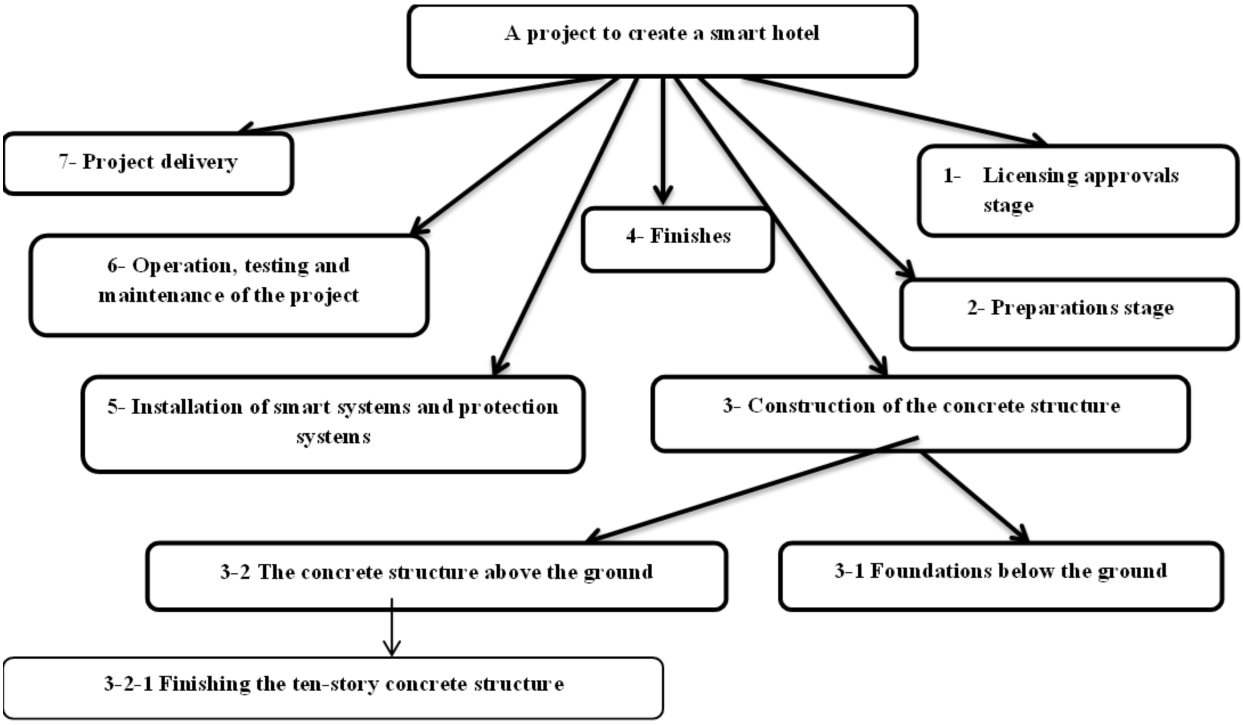

Figure (13): Work Breakdown Structure (WBS) – Level 8: Above-Ground Structure

Phase eight involves constructing the above-ground concrete structure, marking the completion of ten stores.

9. Work breakdown structure level 9 can be illustrated in Figure 14.

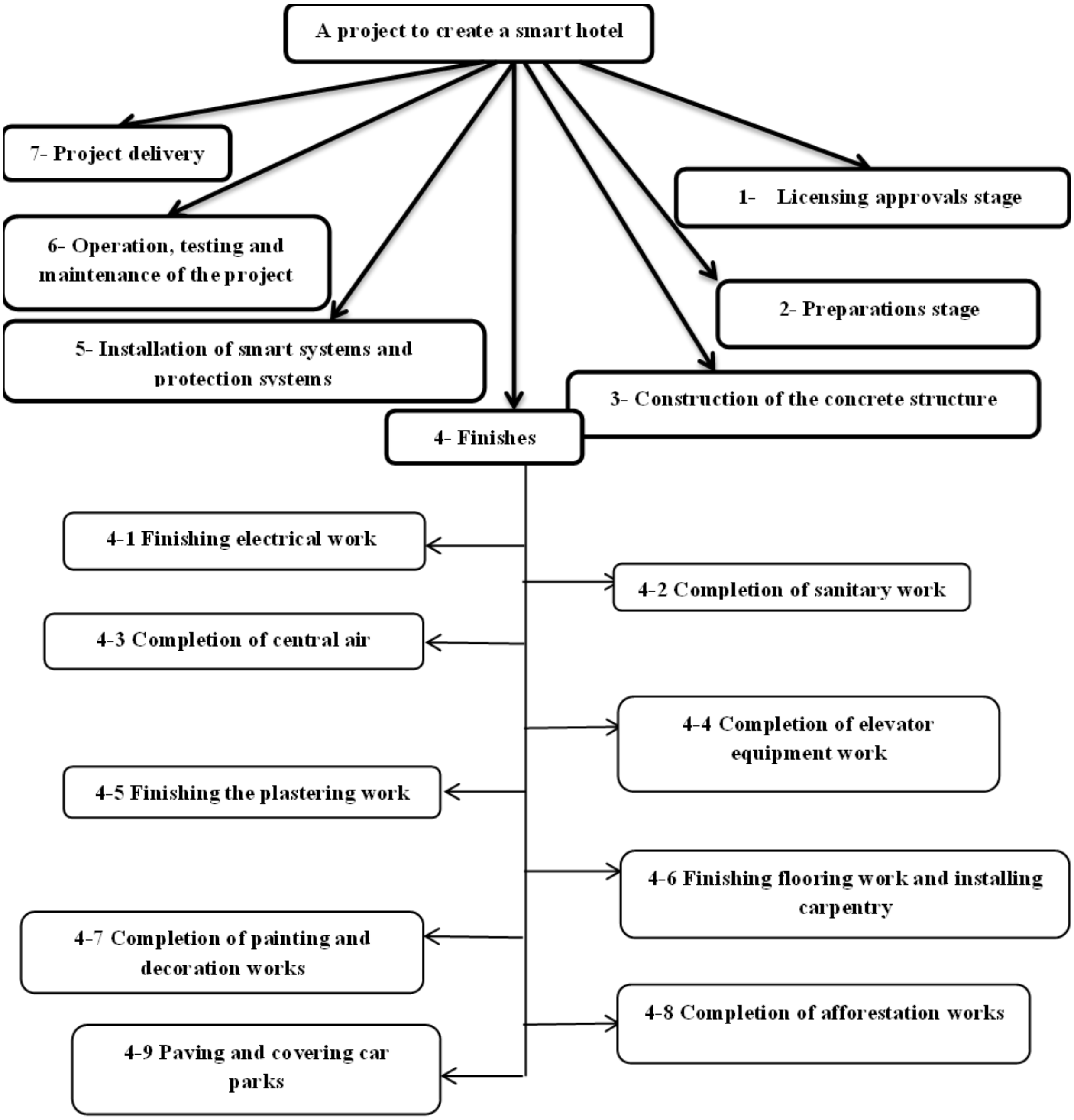

Figure (14): Work Breakdown Structure (WBS) – Level 9: Finishing Works

Phase nine of the subdivision structure includes electrical and plumbing finishing works, street paving, elevator works, decorations, and central cooling and heating.

10. Work breakdown structure level 10 can be shown in Figure 15.

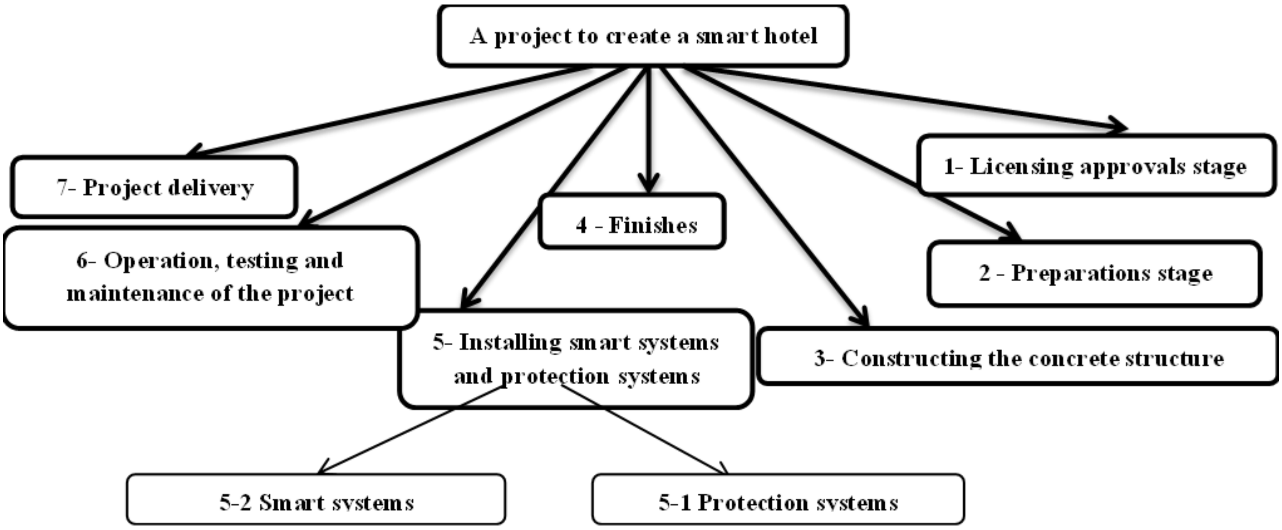

Figure (15): Work Breakdown Structure (WBS) – Level 10: Smart and Protection Systems

The tenth stage is the installation of intelligent systems and protection systems.

11. Work breakdown structure level 11 can be depicted in Figure 16.

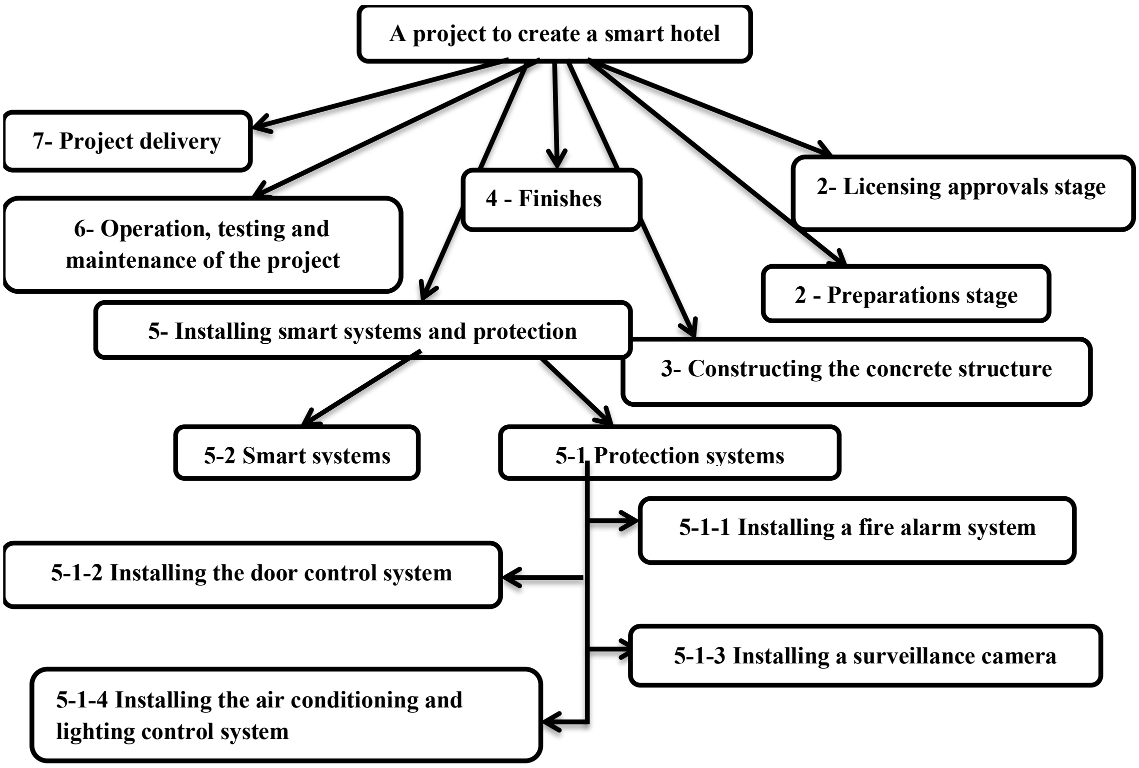

Figure (16): Work Breakdown Structure (WBS) – Level 11: Security and Control Systems

Phase eleven includes the installation of security systems, namely surveillance cameras, fire alarm systems, and intelligent systems that control door openings and closings.

12. Work breakdown structure level 12 can be illustrated in Figure 17.

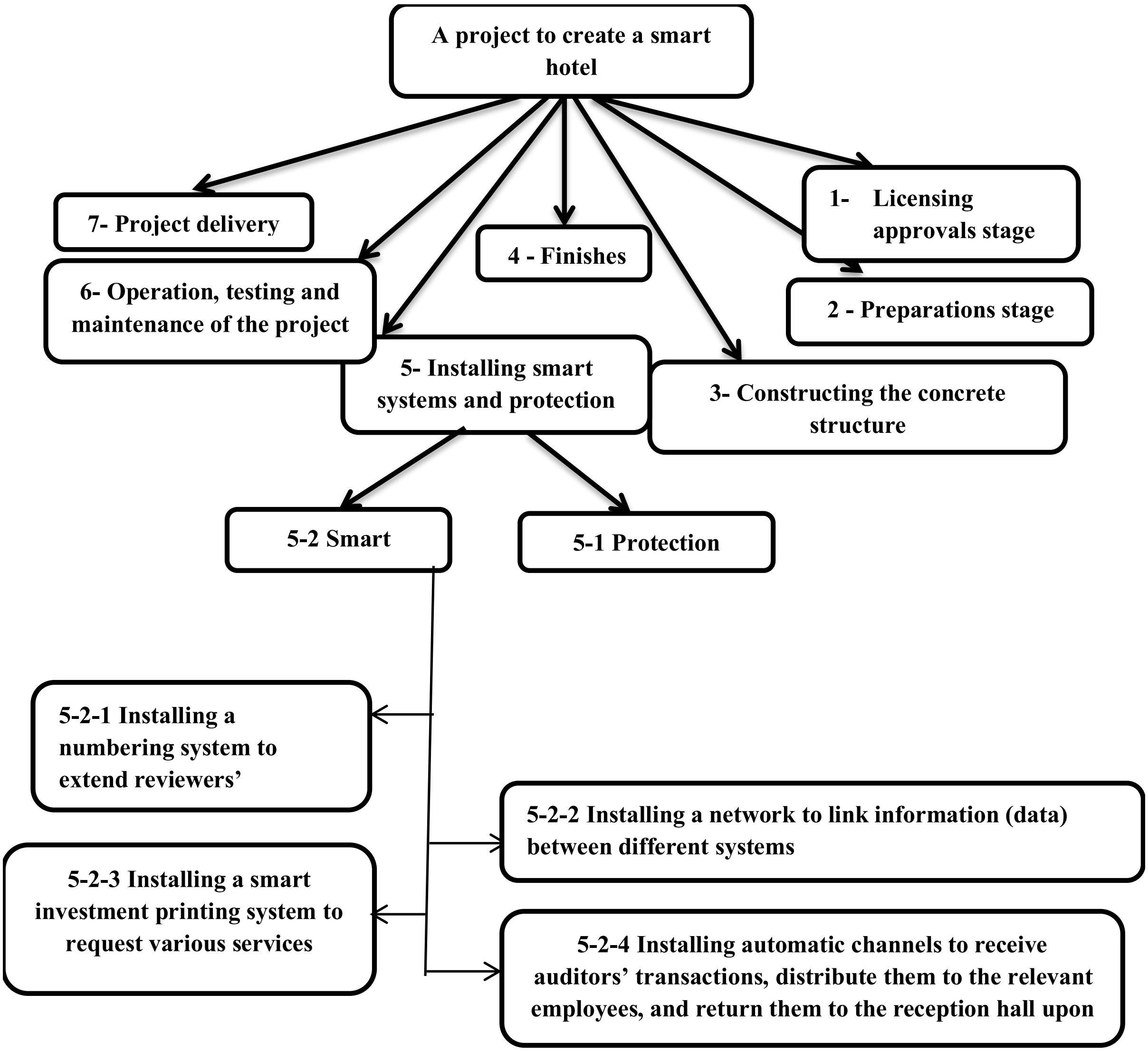

Figure (17): Work Breakdown Structure (WBS) – Level 12: Smart Operational Systems

The twelfth stage of the organizational structure is the implementation of the innovative system, which comprises establishing a priority-based numbering system for guest requests, an information exchange network within the hotel's information desk, and a printing program to fulfill these requests.

13. Work breakdown structure level 13 can be shown in Figure 18.

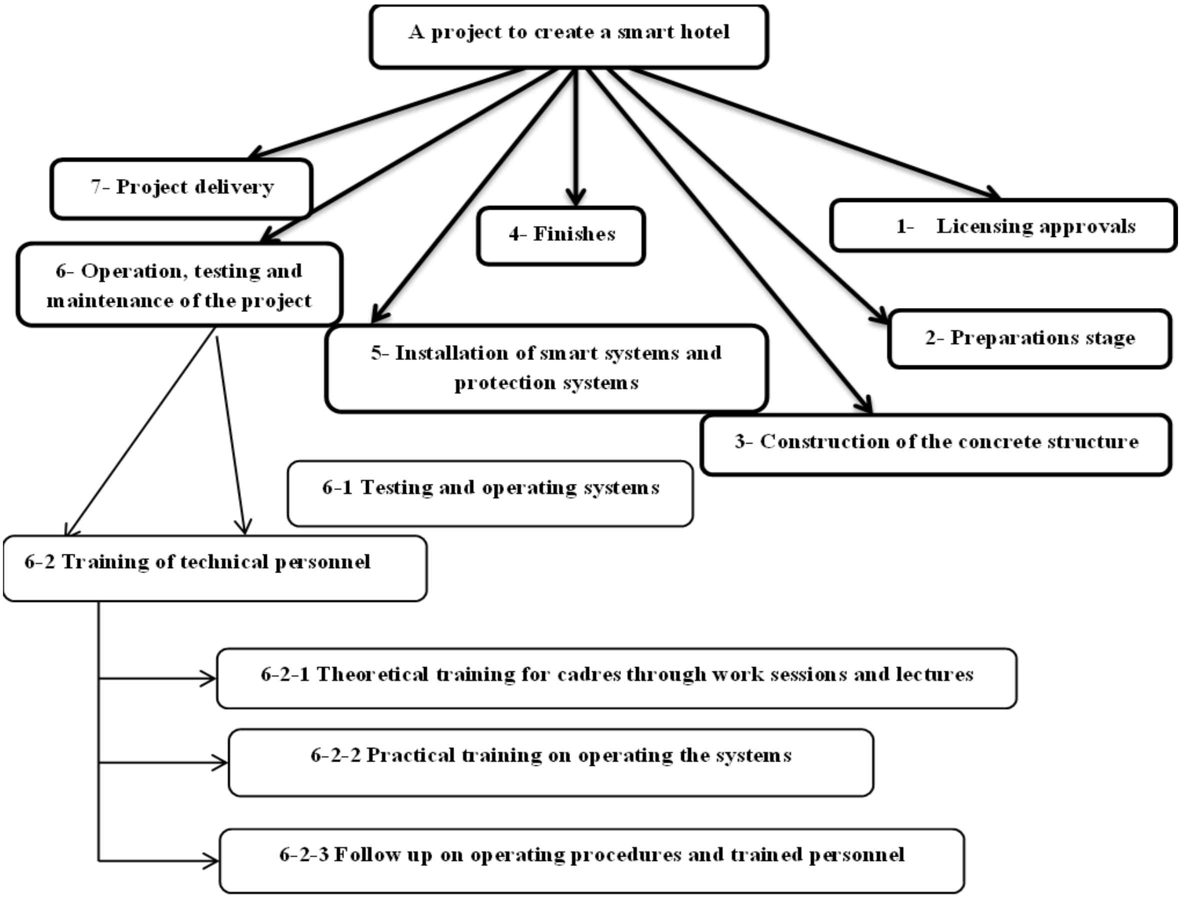

Figure (18): Work Breakdown Structure (WBS) – Level 13: Operation, Training, and Maintenance

The thirteenth phase encompasses the operation and maintenance of intelligent systems and the training of affiliates in their use, from both theoretical and practical perspectives.

14. Work breakdown structure level 14 can be presented in Figure 19.

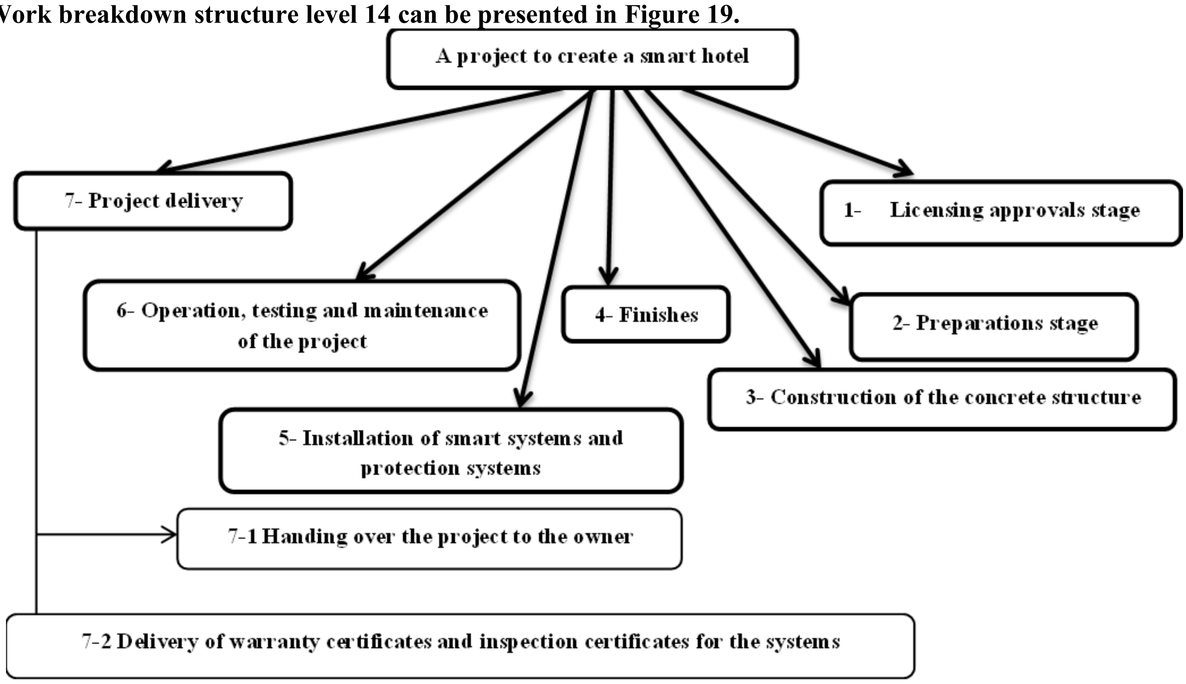

Figure (19): Work Breakdown Structure (WBS) – Level 14: Project Handover and Warranty

The fourteenth and final stage of the project lifecycle is the handover stage, where the owner receives the project from the implementing company. This first handover contains the warranty period stipulated in the contract between the owner and implementing company, as well as warranty certificates for innovative and security systems. The project's final handover occurs afterward.

4. Discussion of Results

The primary contribution of this research is the creation of a hierarchical schedule division/work breakdown structure (WBS) with 14 levels for the implementation of a smart hotel. This study operationalizes smart-hotel development into an executable delivery roadmap, unlike the existing literature, which discusses either strategic hospitality or focuses on technical functionalities that enable project teams to plan, sequence, and control implementation activities. In addition, the credibility of the proposed hierarchy is reinforced by structured decision-support and data-collection techniques that integrate experts' perspectives into a planning template geared toward practitioners (brainstorming, cost-benefit analysis, mind mapping, voting, expert comments) [13].

Seven macro-stages at the highest level are established at Level 1. The tasks consist of licensing and general preparations, smart installation and construction, acceptance and finishing, operation/maintenance planning, and testing. This is an important outcome as it creates distinct "phase gates" to support schedule tracking, interface management, and risk control. The proposed WBS improves the efficiency of planning and monitoring by demarcating the project into identifiable stages. The best practices for construction project planning and scheduling are based on sequencing and control points. They help avoid delays, rework, and misaligned handovers [14].

A significant insight from Levels 2-4 is that smart-hotel implementation should be treated as a governance-and-readiness problem rather than a construction problem. Level 2 elaborates on licensing and approvals (including the preparation/approval of technical drawings and project design) and clarifies approval pathways with competent authorities, thereby reducing a significant source of scheduling uncertainty in large projects. Level 3 records early site preparations for temporary offices, utilities, and communications. Level 4 codifies the planning, assignment of responsibilities, task allocation, and preliminary timeline/budget definition of the suppliers/providers. Together, these findings act as risk "intervention" measures as they help improve clarity of the organization, readiness of the resources before work, and systems integration commences, an approach that reflects construction management literature, which highlights resource provision and planning measures with uncertainty, which enhances project performance [15].

Findings at Levels 5-9 suggest that the roadmap maintains traditional construction logic while simultaneously preparing the physical environment needed for innovative functions. The mention of equipment, machinery, and communication indicates that the digital infrastructure must be physically and logistically enabled. The finishing work (electrical, sanitary, central air-conditioning and other building services) is to be regarded as the operating platform for subsequent intelligent control and comfort objectives. Smart hotels provide systems integration and operational service logic. What sets smart hotels apart? The WBS excludes "smart systems" and "protection systems" and defines concrete installation. These include fire alarms, door control, CCTV, and air-conditioning/lighting control. As a result, the management of security and reliability becomes an implementation stream. They shall not be treated as an afterthought. These studies on smart hotels focused on guest convenience and operational efficiency. Nonetheless, these studies often do not give a scheduling hierarchy at the implementation level [16].

Levels 13-14 broaden the interpretation of successful smart-hotel delivery beyond operational capacity to lifecycle responsibility. The WBS includes training (theoretical and practical) and follow-up on procedures alongside operation, testing, and maintenance, recognizing that benefits depend on sustained use by staff and guests, not merely on installation completion. The handover stage includes warranty and inspection certificates and formal delivery to the owner, providing mechanisms for closure that support long-term performance assurance and governance in connected environments. In this way, the proposed WBS complements operational-performance research (e.g., intelligent planning or room-division applications) by ensuring that operational improvements are supported by implementation, training, maintenance readiness, and formal handover requirements. Overall, the results contribute a missing "implementation layer" by consolidating technological, security, operational, and construction requirements into a structured scheduling hierarchy that can serve as a reusable template and a foundation for future validation through case applications and measurement of schedule/cost impacts [17]

5. Conclusions and Recommendations

This study concludes that applying scientific and structured techniques (e.g., brainstorming, cost–benefit thinking, mind mapping, voting, and expert feedback) improves the quality of data collection, analysis, and presentation, and supports more defensible decision-making in complex engineering projects. By connecting intelligent systems to civil engineering practice, this research demonstrates that 'smart' solutions are not merely add-on technologies; they can be conceived, delivered, and managed within engineering logic and structured projects. The developed approach informs decision-makers and project teams about the link between intelligent systems and the real-world value generated (efficiency, safety, service quality, and operational continuity) when a smart system is integrated throughout its whole life cycle (planning, construction, commissioning, operation, and handover). It is also highlighted that the addition of programming capacity to civil engineering processes is essential. Digital tools and structured models enable precise scheduling, linking, documentation, and performance monitoring during the execution of civil engineering projects.

Project stakeholders are encouraged to use structured decision-support methods early in innovative hotel projects (and similar projects) to reduce uncertainty, align stakeholders' priorities, and enhance schedule and risk control. Engineering teams need to scale up their digital skills, particularly in programming and more data-driven thinking, to better embed intelligence into construction planning, quality control, and facility operations. For implementation, organizations must ensure staff readiness and a smooth handover of maintenance responsibilities. They provide an intelligent system that will continue to run and remain useful.

Further studies might examine the framework in action across one or more real-world smart-hotels quality applications and assess its impact on schedule performance, cost, and rework rate. Develop a quantitative model to aggregate the net benefits of implementing smart hotels using measurable KPIs such as energy consumption, maintenance costs, guest satisfaction, and response time. Integrate a scheduling system with BIM and digital twins to enhance coordination between construction and smart-system installation/commissioning activities. Use risk-based scheduling techniques, such as Monte Carlo simulation, to account for uncertainty in approvals, procurement, and systems integration. To ensure a sustainable and trusted operation, assessment of smart-hotels may include cybersecurity, privacy, and user acceptance.

Reference

1. Sekar, A., Williams, E., & Chen, R. J. J. (2018). Changes in time use and their effect on energy consumption in the United States. 2(3), 521–536.
2. Hu, Y., et al. (2016). Smart home in a box: Usability study for a large-scale self-installation of smart home technologies. 2, 93–106.
3. Field, R. W. J., U.S. Environmental Protection Agency, Office of Radiation and Indoor Air. (2010). Climate change and indoor air quality (pp. 1–15).
4. Lin, B., et al. (2017). Analyzing the relationship between human behavior and indoor air quality. 6(3), 13.
5. Dahmen, J., et al. (2017). Activity learning as a foundation for security monitoring in smart homes. 17(4), 737.
6. Ali, W., et al. (2017, September). IoT-based smart home: Security challenges, security requirements, and solutions. In 2017 23rd International Conference on Automation and Computing (ICAC). IEEE.
7. Hall, F., et al. (2020). Smart homes: Security challenges and privacy concerns.
8. Sharma, P., & Kantha, P. J. (2020). 'Blynk' cloud server-based monitoring and control using 'NodeMCU'. International Research Journal of Engineering and Technology, 7(10), 1362–1366.
9. Fadiga, K., et al. (2021, September). To do or not to do: Finding causal relations in smart homes. In 2021 IEEE International Conference on Autonomic Computing and Self-Organizing Systems (ACSOS). IEEE.
10. Philipose, M., et al. (2004). Inferring activities from interactions with objects. 3(4), 50–57.
11. Taiwo, O., Ezugwu, A. E., & Networks, C. (2021). Internet of things-based intelligent smart home control system. Sensors and Networks, 2021, 1–17.
12. Krishnan, N. C., & Cook, D. J. (2014). Activity recognition on streaming sensor data. Pervasive and Mobile Computing, 10, 138–154.
13. Anwar, A., Kumar, S., & Manoharan, G. (2025). Revolutionizing the hospitality industry. In Advances in Hospitality, Tourism and the Services Industry (AHTSI) (pp. 271–296). IGI Global. https://doi.org/10.4018/979-8-3373-2145-5.ch010
14. Oluwatosi, E. A. (2024). Best practices for efficient project planning and scheduling in construction. International Journal of Research Publication and Reviews, 5(7), 440–449. https://doi.org/10.55248/gengpi.5.0724.1614
15. Voitovych, V. (2024). Resource provision in the construction management system considering uncertainty and risk factors. Шляхи Підвищення Ефективності Будівництва в Умовах Формування Ринкових Відносин, 2(53), 368–376. https://doi.org/10.32347/2707-501x.2024.53(2).368-376
16. Yadav, N., & Raju, S. S. (2024). Smart hotel technologies redefining guest convenience and operational efficiency. In Advances in Hospitality, Tourism and the Services Industry (AHTSI) (pp. 25–56). IGI Global. https://doi.org/10.4018/979-8-3693-7127-5.ch002
17. Ervina, E., et al. (2024). The development of a room division application implementing an intelligent planning system (IPS) to enhance hotel operational performance. Modern Management and Tourism, 1(2), 38–50. https://doi.org/10.62951/momat.v1i2.32

CITATION

Jaber, A. M. (2026). Structural Diagrams and Stages of Smart Hotel Operations (WBS). In Global Journal of Research in Engineering & Computer Sciences (Vol. 6, Number 1, pp. 29–41). https://doi.org/10.5281/zenodo.18259007