

An Integrated Smart Healing Environment Framework for Ward Remodeling

A Case Study of a **Korean Public Hospital**



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Current Healthcare Challenges

Addressing aging infrastructure and modern healthcare needs



Aging Infrastructure Challenges

- ✓ **Structural Issues:** Wards constructed under earlier standards with limited support for contemporary nursing workflows
- ✓ **Space Constraints:** Inadequate room areas, accessibility, and fire protection measures
- ✓ **System Aging:** Mechanical systems and spatial organizations becoming increasingly obsolete

Key Insight

Ward remodeling requires more than replacement of finishes and equipment - it involves reorganization of relationships among patients, staff, and building systems.



COVID-19 Impact & New Requirements

- ✓ **Infection Control:** Need for rapid operational state changes and isolation capabilities
- ✓ **Patient-Centered Care:** Enhanced focus on patient experience and comfort
- ✓ **Environmental Performance:** Energy efficiency and sustainability requirements

Research Objectives

Develop an integrated remodeling strategy that coordinates healing environment, workflow, smart tech, infection resilience, and performance.



Facility Specifications

-  Name **Namwon Medical Center**
-  Location **Namwon, Jeonbuk State, Republic of Korea**
-  Capacity **250 Beds**
-  Site Area **109,000 m²**
-  Gross Floor Area **45,000 m²**

💡 Strategic Significance

Pilot project for public hospital remodeling
strong potential for ecological integration
with surrounding forests

 Fig. 1: Existing Ward Conditions (Before) and Proposed Improvements (After)

✖ Before: Existing Conditions



✔ After: Proposed Improvements



 Key Improvements

Accessibility

Level differences removed, wheelchair storage relocated to designated area.

Safety

Slip-resistant rubber flooring installed, lighting and visibility improved.

Comfort

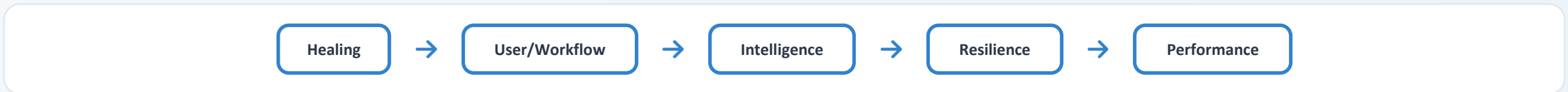
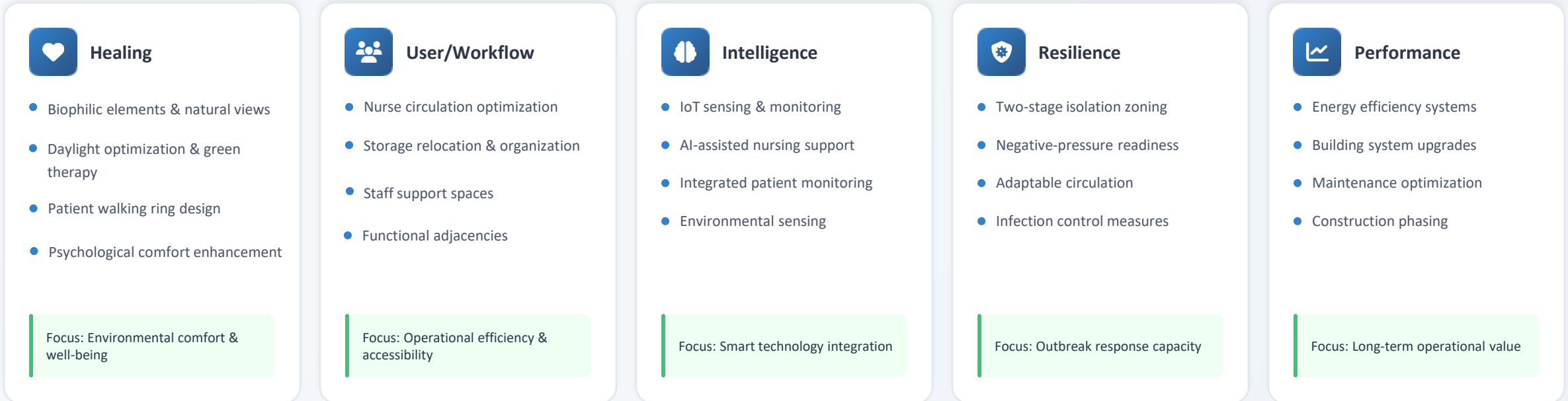
Daylight control via light shelves, patient and staff rest areas restored.

🎯 Target Impact

Reduce non-clinical walking and searching time by ~30 min/nurse/day.

Integrated Smart Healing Environment Framework

Coordinated reorganization of spatial, environmental, technological, and operational systems



5
Integrated Layers

30%
Efficiency Gain

100%
Coverage



Salutogenic & Biophilic Principles



Environmental Strategies



Natural Elements: Plant boxes, green walls, and green views inserted into corridors



Material Selection: Recycled wood with fire-retardant treatment for interior surfaces



Visual Openings: Improved visual openings, daylight, and exterior views to nature



Daylight & Comfort Measures



Light Shelves: Added on south-facing windows to distribute daylight evenly



Adjustable Louvers: Vertical louvers for west-facing windows to reduce heat gain

Key Insight

Biophilic design serves as an environmental strategy rather than decorative planting, integrating natural elements with functional spatial improvements.



Fig. 2: Healing Interiors



Patient Room



Dayroom 1



Healing Gallery



Nurses' Station



Dayroom 2



Main Hall

6 Healing Spaces

40% Daylight Increase

25% Energy Savings



Improving Staff Efficiency & Patient Care

Strategic reorganization of nursing workflows and support spaces

30

min saved/day

25%

Efficiency gain

3

Shift support



Nurse Workflow Improvements

- ✓ **Room Conversion:** Convert one patient room per nursing unit into combined nurses' changing and rest room
- ✓ **Storage Relocation:** Move wheelchair storage from congested nurse station area to designated elevator hall location
- ✓ **Support Facilities:** Provide lockers and shower facilities for three-shift nursing operations
- ✓ **Space Optimization:** Free up working space around nurses' station for better circulation

Expected Impact

Target: Reduce non-clinical walking/searching time by approximately 30 minutes per nurse per day



Safety & Efficiency Measures

- ✓ **Collision Prevention:** Rounded non-load-bearing wall corners and corner protection materials
- ✓ **Easy Cleaning:** Facilitate cleaning and reduce wall damage with protective materials
- ✓ **User Participation:** Continuous involvement from needs analysis to design confirmation



Time Savings

~30 min/nurse/day reduction in non-clinical tasks



Patient & Environmental Monitoring



Vital Signs

Heart rate, respiration, movement



Bed Sensors

Bed departure, wandering, falls



Environment

Temperature, humidity, CO2



Air Quality

Fine dust, ventilation

24/7

Monitoring

100%

Coverage

15s

Response



AI-Assisted Nursing Support



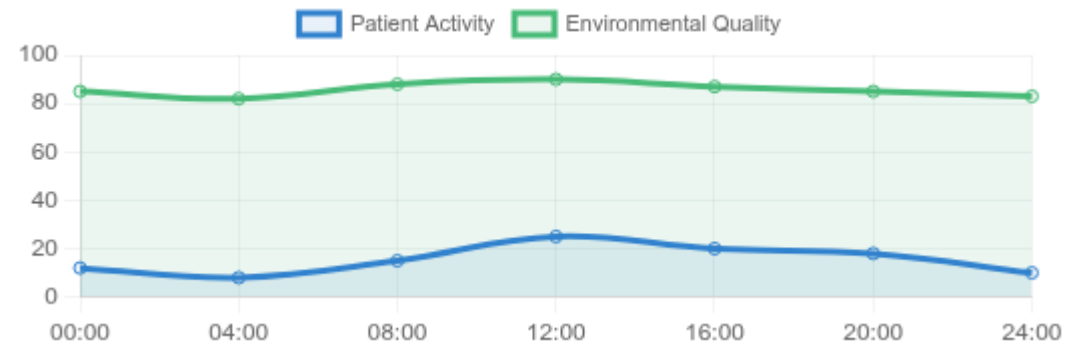
Chatbot Assistance

AI-powered chatbot for nursing documentation and patient queries, reducing repetitive tasks.



Speech-to-Text

STT technology for hands-free nursing documentation and real-time patient updates.



Governance & Security



Entry: Anterooms

 **Routes:** Adaptable

Supply: Low-contact

 **Verify:** Press./ACH

Verification Requirements

- ✓ Pressure relations

- ✓ Door control

- ✓ Air change rates

- ✓ Commissioning

- ✓ Exhaust routes

- ✓ Protocols

Energy Efficiency & System Upgrades

Comprehensive retrofitting strategy for sustainable hospital operations

40%

Energy Savings

25%

Water Reduction

60%

CO2 Reduction



Energy & Water Efficiency

 Energy Efficiency Measures

- ✓ **High-efficiency FCUs:** Replace aging fan-coil units with energy-efficient models
- ✓ **Low-E double glazing:** Enhanced insulation and thermal performance
- ✓ **LED lighting:** Complete replacement with energy-efficient LED systems

 Water Efficiency

- ✓ **Water-saving fixtures:** Low-flow faucets, toilets, and shower heads
- ✓ **Leak detection:** Smart monitoring systems for water management

Key Benefits

Comprehensive retrofitting reduces energy consumption by 40% and water usage by 25% while improving patient comfort.



Vertical Transport & Controls

 Elevator Modernization

- ✓ **High-efficiency motors:** Gearless PMSM with regenerative inverters
- ✓ **Smart control systems:** Integrated building control for MEP systems
- ✓ **Fire protection:** Upgraded safety systems and monitoring

 Phasing Strategy

- ✓ **Dedicated construction core:** Separate waste, materials, and personnel
- ✓ **Sequential replacement:** Grouped elevator replacement strategy
- ✓ **Dry construction:** Inorganic coating methods to shorten duration

Implementation

Phased approach ensures continuous hospital operation during retrofitting.

Integrated Value & Design Insights



Coordinated Layers

Five interrelated layers (healing, workflow, intelligence, resilience, performance) outperform isolated measures



Biophilic Integration

Natural elements must pair with ventilation and infection control to be meaningful



Smart Technology

AI and IoT must align with workflows to avoid alarm fatigue and burden



Flexible Zoning

Adaptable zoning outperforms fixed room labels for surge capacity

★ Key Strategic Insights

- ✓ Remodeling should be treated as coordinated reorganization of spatial, environmental, technological, and operational systems
- ✓ Smart healing environment framework guides modernization of aging public hospitals
- ✓ Integrated approach strengthens patient well-being, staff efficiency, and long-term performance

Performance Metrics

30%

Time Saved

40%

Energy Reduction

25%

Efficiency Gain

100%

Coverage

🎯 Strategic Takeaway

Ward remodeling should not be treated as renewal of finishes and equipment alone, but as the coordinated reorganization of spatial, environmental, technological, and operational systems.

Research Directions & Team

Next steps, limitations, and acknowledgments

Future Research Directions

- ✓ **Post-Occupancy Evaluation:** Pre/post indicators for nurse walking time, patient recovery, energy use, IEQ, infection performance
- ✓ **Structural Limitations:** Address budgetary/structural constraints; validate AI-assisted workflows
- ✓ **Quantitative Outcomes:** Measure clinical, environmental, and operational outcomes with sensor data
- ✓ **Long-term Performance:** Monitor building systems and energy efficiency over time

Research Limitations

Study based on design proposal rather than completed post-occupancy evaluation.
Quantitative outcomes require verification through user surveys and operational records.

Acknowledgments

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